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GIS based Site Suitability Analysis on Cadastral Level for Agriculture

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Abstract Throughout human history, our association with soil and water has affected our ability to cultivate crops and influenced the growth of different civilizations. Soil is a critical part of successful agriculture and is the original source of the nutrients that we use to grow crops. The physical and chemical properties of soil play a major role in affecting agricultural production of a region. Crop cultivation without knowing location specific soil conditions results in significant decline in agricultural output as well as also results in soil deterioration over a long period. In this context, Site suitability analysis can help to articulate the approaches for development of agricultural productivity. To study site suitability for agriculture, GIS based multi-criterion decision making and analytical hierarchy process (AHP) methods is used in the present study, which is primarily based on the physical and chemical properties of soil. A case study of Malkhed village, located in Pune district of Maharashtra, India has been considered for site suitability analysis. The site suitability classes i.e. 'Low suitable', 'moderately suitable' and 'highly suitable' in the study region are precisely estimated. Moreover, the analysis is carried out on cadastral level, which incorporates the details of fine spatial resolution. Thus, the methodology, techniques and findings of the study is found to be useful to assess the site suitability for agriculture on cadastral level for Malkhed village. The same technique can also be applied to different parts having similar soil properties.

Keywords: *site suitability analysis, analytical hierarchy process (AHP), cadastral parcel level*

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1. Introduction

Soil and water have provided humans with the ability to produce food, through agriculture [1]. India is predominantly an agrarian country. Agriculture has always been the backbone of most of the Indian population. As other sectors have grown, the share of agriculture in the country's Gross Domestic Product (GDP) has declined. However, it cannot be denied that agriculture still continues to play a dominant role in the overall economic scenario of India [2]. Agriculture has been practiced in India for 4000 years, however it is still traditional in nature [3]. The uniqueness of traditional agriculture is its ecologically benign nature, public acceptability, environmental and economic feasibility. However, traditional agriculture has its own share of limitations also. Most of the land holdings in India used for agriculture are small in size, where it becomes more important to understand the suitability of land to reap maximum benefits from the small land parcel.

In this context, soil suitability analysis plays a pivotal role in determining the potential capabilities of each land parcel for cultivation. Ideal soils for agriculture are balanced in contributions from mineral components (sand: 0.05-2 mm, silt: 0.002-0.05 mm, clay: <0.002 mm), soil organic matter (SOM), air, and water [1]. The balanced contributions of these components allow for water retention and drainage, oxygen in the root zone, nutrients to facilitate crop growth; and they provide physical support for plants. The distribution of these soil components in a particular soil is influenced by the five factors of soil formation: parent material, time, climate, organisms, and topography [4]. Each one of these factors plays a direct and overlapping role in influencing the suitability of a soil for agriculture.

The present study region, Malkhed village, is a typical example of a rural village found in India, with agriculture being the main occupation. A large part of the rural population is still living below the poverty line and most of the farmers are engaged in traditional farming and individual farmer bears a small agriculture field. The government has taken measures to reduce the economic disparity between the urban and rural regions of the country through various rural development schemes and programmes. However, most of the developmental schemes are planned at village or taluka level. This

approach generalizes the soil conditions observed over a given region, seldomly benefitting individual farmers.

Every land parcel (farm land) has its own varying soil physical and chemical properties. Its usefulness and requirements need to be determined at cadastral level, so that it can make individual farmers self-sustainable and ultimately lead to socio-economic development of the entire village. In this context, soil suitability analysis can help to categorize the land parcels, and eventually help to establish the strategies for the development of agricultural productivity for each land parcel. Geographical Information System (GIS) is a useful technique for site suitability analysis, when combined with remote sensing data, as the data pertains to finer spatial resolution. The integration of multi-criteria decision analysis approaches in GIS provides a powerful spatial decision support system which offers the opportunity to efficiently produce land suitability maps. The combination of AHP with GIS is a new trend in land suitability analysis. AHP and GIS based LSA has widely been applied to numerous land suitability assessment problems in the last few decades [5,6,7,8,9,10,11,12]. With these aspects in background, the research study attempts to select the suitable site for agriculture on cadastral level using multi-criteria analysis and analytical hierarchy process (AHP) through GIS application. The study also aims to generate a gat level (land parcel level) GIS based resource profile and its assessment which will be helpful to demarcate suitable site for agriculture.

2. Introduction to Study Region

The case study of Malkhed village is taken as a representation for the land assessment at cadastral level of any given rural region. Malkhed village is situated in Mulshi taluka towards the western part of Pune district of Maharashtra state. The geographical extent of the region is from 18°22’30”N to 18°24’00’’N latitudes and from 73°41’45’’E to 73°43’00’E longitudes. The location of the study region is shown in Figure 1.

The main occupation of the village is agriculture, which primarily depends on the monsoonal rainfall received during June to September in this region. The region is characterised by hilly and undulating topography with red to reddish brown soils. These soils are not very fertile, but paddy cultivation is extensively practised in the region, owing to the high rainfall received in the area. However, most of the farms found in this area are small in size, thus limiting the scope of using modern machinery for enhancing agricultural productivity. The village has been divided into total 320 cadastral parcels, called as ‘gats’, over which the site suitability analysis has been carried out.

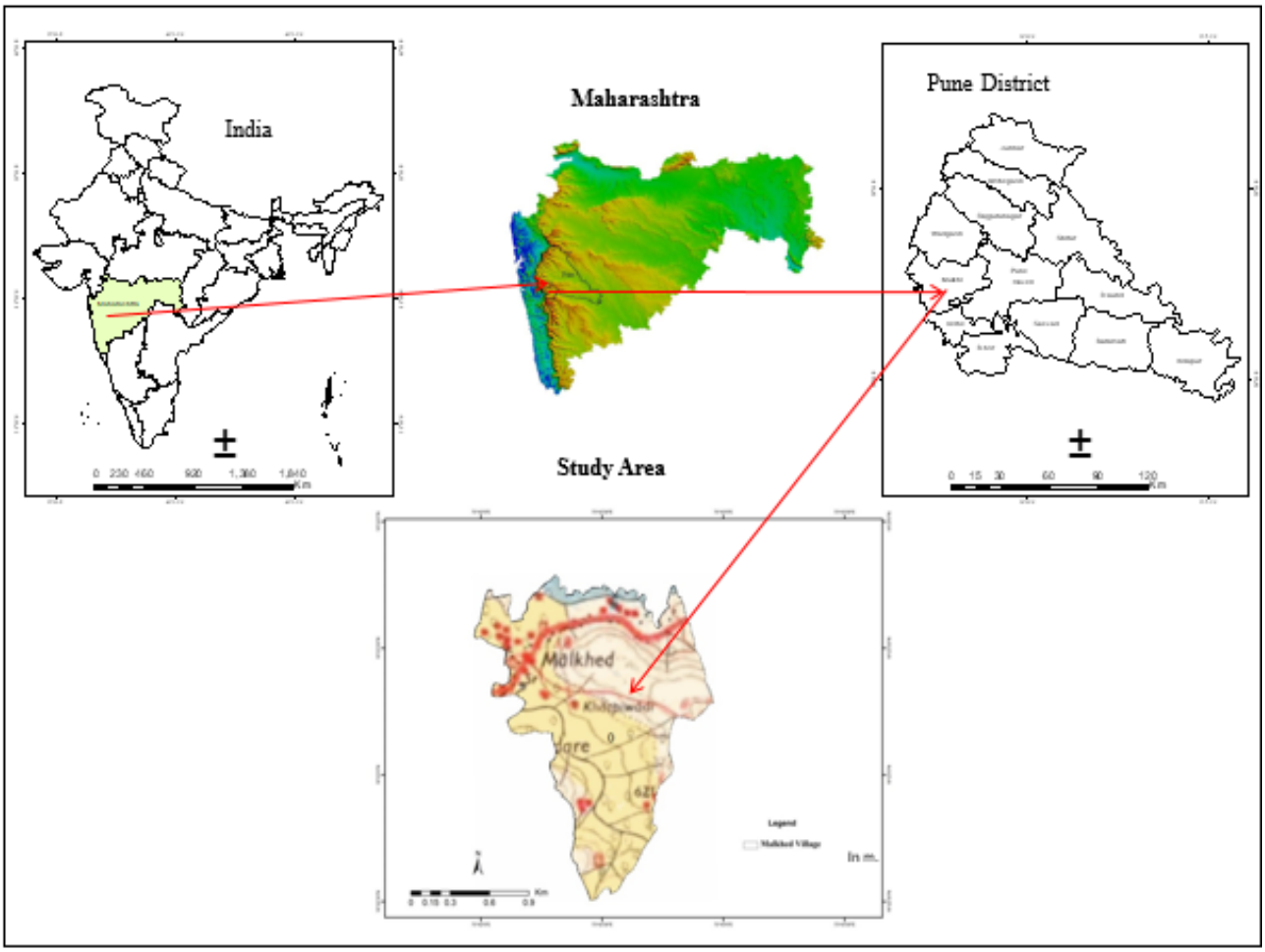

Figure 1. Study region

3. Data and Methodology

Topographical map of scale 1:50000 (47/F/11 and 47/F/15) and high-resolution satellite data (IRS P2 (Resource Sat-2) (LISS -IV) was used. Cadastral level map was procured from Soil survey department at a scale of 1:5000. A total of 33 soil samples were collected from the study region, well-distributed throughout the study region. The present analysis was divided into two major phases, namely

1. Field work and ground data collection- To collect soil samples and for ground truth verification (using GPS) of the LU/LC classes derived through satellite data.

2. Laboratory work - Soil analysis, Preparation of thematic maps and multi criteria analysis and analytical hierarchy process (AHP) for site suitability analysis.

The standard procedure followed for analysing soil's physical and chemical properties is given in Table 1.

Using Arc GIS 9.2. platform, various thematic maps namely, Relief Map, Drainage maps, land use/land cover, Geomorphology are generated from satellite image on cadastral map. On the basis of all these thematic layers weightage is given to each Cadastral Parcel as per their spatial information extracted from Satellite imagery and base map. The thematic layers of supporting database, such as demographic, climatic, soil and forest cover data, were collected from statistical handbook of Census of India, India Meteorological Department, Soil survey department and Forest department, respectively. The standard basic elements for interpretation are applied on this satellite digital image so as to extract the entropy or information extent in accordance with the above-mentioned thematic maps. This extracted information at the end of the interpretation process of all these thematic maps is used for generation of further conditional based queries. The output answer of these queries is helpful in analysis, theme-based model building and decision making. A detailed flow-chart of the methodology adopted is depicted in Figure 2.

Table 1. Standard procedures and methods adopted for soil analysis

Sr. No.	Parameter	Method	Reference
1	Particle size fractions	Dry sieve method + Osborne's Beaker Method	[13]
2	Bulk density	Keen's and Raczkowski Cup (1921)	[13]
3	Water-holding capacity (%)	Keen- Rackzowski box Method	[13]
4	pH (1:2.5 soil: water)	pH meter	[14]
5	Al	Gravimetric Method	[13]
6	Fe	Gravimetric Method	[13]
7	Si	Gravimetric Method	[13]
8	Ca and Mg	Titration method	[13]
9	$CaCO_3$	Rapid Titration method	[13]
10	Organic carbon	Walkley & Black digestion method	[14]

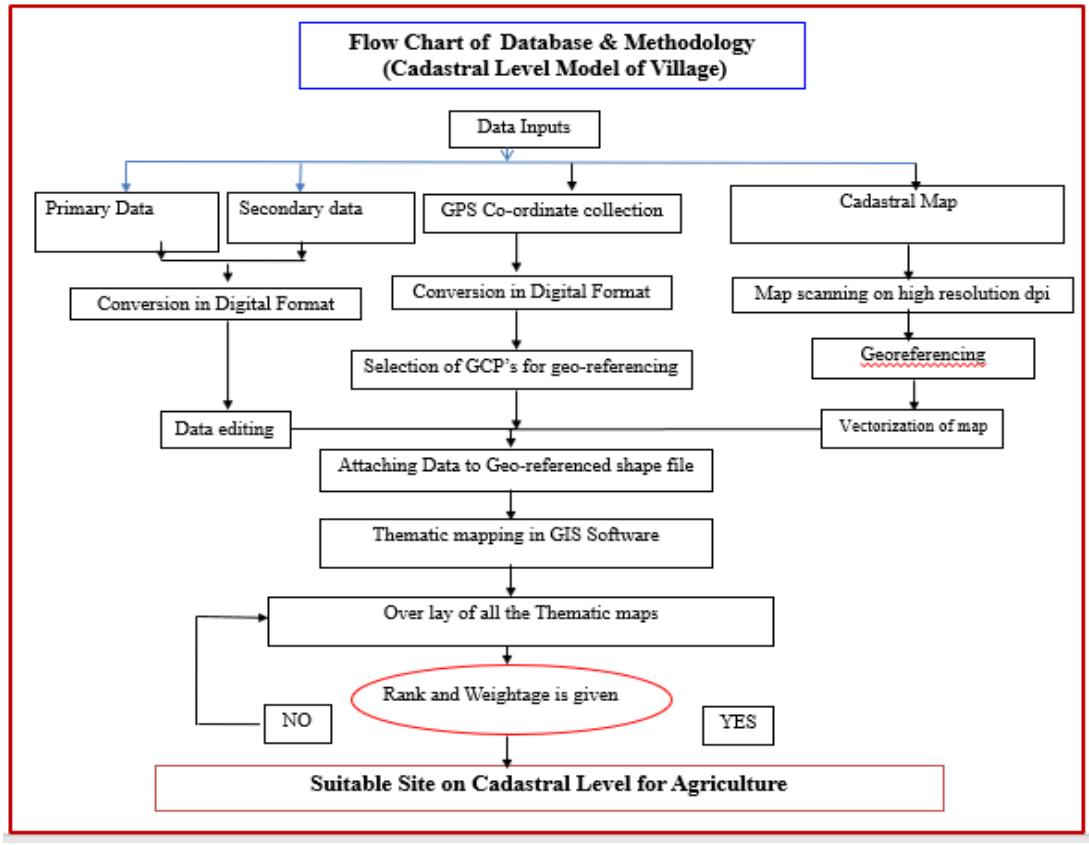

Figure 2. Flowchart of Database and Methodology

4. Analysis and Results

The physical and chemical properties of 33 soil samples were analysed in laboratory. Some of the characteristics could not be computed due to damage of the soil sample. The results obtained are tabulated in Table 2 and Table 3, which are taken as input data for the present analysis.

The landuse/ landcover (LULC) classification was performed using the unsupervised classification technique for the LISS - IV satellite image acquired from IRS P2 (Resource Sat - 2) for the year 2012. The satellite image had a spatial resolution of 5.8 m, which was a sufficiently finer resolution to map the region on a cadastral level. The classification accuracy assessment was performed using Garmin eTrex@ 10 GPS device with ±15m positional accuracy.

The LULC map classified the region into 10 classes, each of them relating to agricultural activity. The detailed map showing the LULC classification for the entire region is depicted in Figure 3. Table 4 gives a representation of the LULC statistics for Malkhed village for these 10 classes, analysed for the year 2012.

Table 2. Analysis of physical properties of 33 soil samples

Sr. no.	Depth in cm	Colour	CS %	MS %	Silt %	Clay %	Textural Class	Bulk Density (gm/cc)	SP Gravity (gm/cc)	Porosity %	Moisture %	WHC %	Soil PH
1	0-33	7.5YR,5/4	47.04	15.1	30.76	7.1	SC	1.27	1.95	60.2	4.85	71.61	7.8
2	0-13	2.5YR,6/4	49.14	15.7	37.66	7.5	SCL	1	1.8	49.8	4.7	70.45	7.6
3	0-12.5	10YR,2/1	47.53	9.52	33.45	12.5	C	0.774	2.312	66.52	4.35	55.49	9.7
4	0-14	2.5YR,6/4	53.72	6	27.78	12.5	C	1.27	1.93	61.73	5.5	78.05	7.5
5	0-14	2.5YR,6/4	46.85	41.15	6	6	SC	1.29	2.19	41.1	*	*	7.2
6	0-33	7.5YR,5/4	54.23	4.3	30.47	11	SC	1.08	1.8	53.82	7.05	54.91	7.05
7	0-10	7.5YR,5/4	56.8	18	15.2	10	SCL	0.43	1.36	68	*	*	6.7
8	0-10	7.5YR,5/5	59.85	19	12	9.15	CL	1.09	1.72	36.22	*	*	7.55
9	0-17	10YR,2/1	70.66	16.9	22.69	9.75	SC	1.296	2.7	52.06	4.05	62.94	9.9
10	0-9	7.5YR,5/4	44.17	15.1	30.73	10	C	1.27	1.96	60.2	4.82	71.61	7.8
11	0-35	7.5YR,5/4	53.72	6	27.78	12.5	SL	1.27	1.93	61.93	5.6	78.05	7.5
12	0-13	10YR,5/1	30.47	11.1	23.43	35	L	0.92	1.6	60.05	6.45	70.18	7.6
13	0-30	7.5YR,5.4	40.47	11.1	23.43	35	C	0.92	1.6	60.05	6.45	70.18	7.6
14	0-15	2.5YR,6/4	18.83	40.6	37.35	3.25	C	1.06	1.8	48.27	4.42	53	6.2
15	0-14	7.5Yr,4/4	50.72	5.15	30.13	14	C	1.1	1.87	49.13	5.65	45.13	7.15
16	0-16	7.5YR,4/4	43.47	11.6	29.93	15	SC	1.08	1.7	49.13	3.75	42.02	7.03
17	0-11	7.5YR,4/4	78.67	5.69	22.64	13	C	1.05	1.69	56.48	8.55	49.34	6.96
18	0-18	7.5YR,5/4	43.95	7.75	35.8	12.5	C	1.13	1.86	60	4.6	66.22	6.58
19	0-20	7.5YR,2/1	37.76	18.8	35.94	7.5	C	1.11	1.91	53.93	3.5	64.61	7.6
20	0-15	10YR,5/1	35.07	11.1	33.83	20	SCL	1.04	1.69	56.02	5.2	66.93	7.6
21	0-20	7.5YR,5/4	35.07	11.1	33.83	20	CL	1.04	1.69	56.02	5.2	66.93	7.6
22	0-19	7.5YR,5/4	30.02	19.8	32.68	17.5	SCL	1.08	1.96	56.58	3.05	66.92	7.4
23	0-10	7.5YR,5/4	45.42	7.75	29.63	17.2	CL	1.23	1.34	8.37	*	*	6.38
24	0-10	7.5YR,5/4	25	48	14	13	SCL	0.83	2.08	60.15	*	*	7.5
25	0-19	10 YR, 6/1	30.02	19.8	32.68	17.5	SCL	1.08	1.96	56.28	8.05	56.92	7.4
26	0-15	10YR,5/1	53.32	14.6	32.08	10	SC	1.03	1.95	65.26	6.25	66.77	7.5
27	0-15	7.5YR,4/4	43.46	11.6	29.93	15	C	1.08	1.7	44.95	3.75	54.02	7.03
28	0-10	7.5YR,5/4	42	15	20	23	SCL	1.08	2.85	62.36	*	*	7.6
29	0-10	7.5YR,5/4	17	12	46	25	CL	1.25	1.47	15.06	*	*	7.6
30	0-10	7.5YR,5/4	39	15	28	18	SCL	1.59	1.75	9.4	*	*	6.9
31	0-10	7.5YR,5/4	44	14	17	13	SCL	1.53	1.63	6.46	*	*	6.6
32	0-17	7.5YR,4/4	45.67	14.9	29.15	10.3	SC	1.07	1.9	55.2	6.1	53.66	6.48
33	0-11	5YR,4/4	45.95	14.9	29.15	10	C	1.07	1.9	46.22	6.1	53.66	6.48

Note: * not calculated.

Table 3. Analysis of chemical properties of 33 soil samples

Sr. No.	T.S.S %	Organic Carbon %	Organic Matter %	$CaCO_3$ %	Fe %	Al %	Si %
1	0.2	0.57	0.98	3.4	*	*	*
2	0.26	0.69	1.18	4.7	*	*	*
3	0.24	0.02	0.05	0.05	20.1	12.3	22.3
4	0.23	0.72	1.24	4	*	*	*
5	0.3	0.15	0.27	25.4	17.9	13.18	71.73
6	0.33	0.93	1.6	2.8	*	*	*

Sr. No.	T.S.S %	Organic Carbon %	Organic Matter %	$CaCO_3$ %	Fe %	Al %	Si %
7	0.2	0.23	0.4	18	15..55	12.42	45.13
8	0.2	0.04	0.07	13	20.3	14.54	70.12
9	0.22	0.008	0.014	0.06	18.1	10.2	20.1
10	0.2	0.57	0.98	3.4	13.2	14.34	20.22
11	0.23	0.72	1.24	4.9	11.2	15.3	22.34
12	0.14	0.27	0.46	3	0.8	0	0
13	0.14	0.27	0.46	2.8	12.3	16.3	20.35
14	0.17	1.06	1.82	1.7	10.3	13.48	22.34
15	0.23	0.82	1.41	2.8	*	*	*
16	0.23	0.96	1.65	2.5	*	*	*
17	0.33	1.27	2.189	3	*	*	*
18	0.24	0.6	1.03	2	12.3	14.5	22.37
19	0.21	0.51	0.88	4.5	10.11	14.5	18.34
20	0.13	1.12	1.93	2.8	*	*	*
21	0.13	0.12	1.93	3	11.22	16.12	20.22
22	0.18	0.72	1.24	3.2	11.34	16.5	20.25
23	0.4	0.31	0.54	32.4	20.28	14.54	2.015
24	0.2	0.13	0.22	16	20.28	15.6	74.15
25	0.18	0.27	1.24	3.2	*	*	*
26	0.11	0.82	1.41	2.9	*	*	*
27	0.23	0.96	1.65	2.5	10.31	15.34	26.34
28	0.5	0.2	0.35	20.4	17.44	11.81	57.62
29	0.1	0.08	0.14	25.4	22.04	14.69	18.13
30	0.2	0.08	0.14	7.4	15.41	13.78	8.463
31	0.2	0.2	0.35	9	18.52	6.212	72.93
32	0.4	0.82	1.41	2.8	12.35	16.17	25.33
33	0.4	0.82	1.41	2.8	*	*	*

Note: * not calculated.

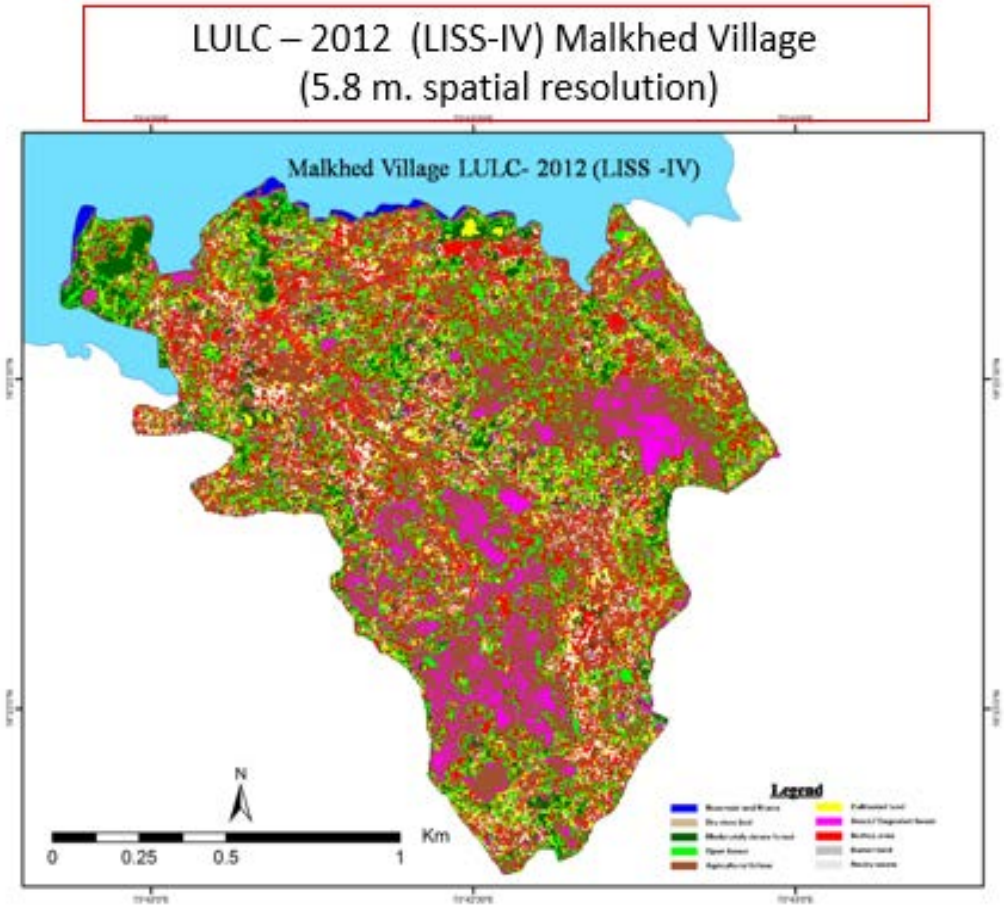

Figure 3. LULC Map of Malkhed village 2012

Table 4. LULC Statistics 2012 (LISS-IV) Malkhed Village

Sr. No	Land cover class	Area in Ha	Area in %
1	Reservoir and rivers	2.86	1.49
2	Dry river bed	3.05	1.59
3	Moderately dense forest	4.32	2.25
4	Open forest	17.24	8.97
5	Agricultural fallow	74.02	38.51
6	Cultivated land	17.01	8.85
7	Scrub / degraded	28	14.57
8	Barren land	2.02	1.05
9	Settlement	41.81	21.75
10	Rocky waste land	2.57	1.34
	Total	192.9	100

4.1. Cadastral Parcel Level Suitability

All the 320 cadastral parcels of the Malkhed have been prioritized, considering the results of the physical and chemical properties of the soil. The suitability limits for agriculture or plantation are taken from the Soil Survey and testing department, as given in Table 5.

Table 5. Suitability limits of soil for agricultural and plantation

	High	Moderate	Less
Bulk Density	<1.20 gm/cm^3	1.20 to 1.40 gm/cm^3	<1.40 gm/cm^3
Porosity	<40%	40 to 60%	>60%
pH	6.00 to 7.00	7.00 to 7.50	>7.50
$CaCo_3$	<2.50%	2.50 to 5.00%	>5.00%
Organic carbon	>0.60%	0.40 to 0.60%	<0.40%

On the basis of priority within the properties cumulative weightage have been assigned to each of the cadastral parcels. Based on ranks cadastral parcels are have been grouped into: high priority, moderate priority, and less priority.

4.1.1. Suitability as Per Physical Properties

The cadastral parcels with different suitability levels are shown in Table 6.

Table 6. Cadastral Suitability as per physical properties

Sr. No	Suitability classes	Priority classes based on Physical Properties	No of Land parcel	Area in Ha. (in %)
1.	**High**	4,5,6,7,8,23,23a,31 to 44,56 to 64, 64a,65,66,66a, 67,69 to 82, 101 to 104,106,121 to 123,126,127,127a,128 to130, 132,133,135, 136,136a,139,141,142,142a,142b, 143 to 146,146a,149,152,155, 156,158 to 163,163a,164,166 to 168,171 to 182,185,186, 188, 188a,189 to 192,194,195,197, 200 to 208,212 to 217,219 to 222, 222a, 224 to 228,228a,229 to 233,236,238,240,240a, 241 to 243, 246, 248, 249, 251,254,255,257 to 259,267,268,278, 279,279a, 280 to 284,287 to 292,294 to 297,299 to 315,319,320,326 to 329, 331 to 333,334,335,335a,336,336a,338 to 345,347,347a, 348 to 351, 353,355,357,358,362,366,371,391 to 401,407, 408,410,453, 456,458,461,462,464,500.	**248**	**147.2 (76.31)**
2.	**Moderate**	3,6a,8a,9, 45 to 49, 49a, 50, 52 to 55,64b,65a, 147,148,150,151,156a, 184,324,333a, 359 to361, 363,363a, 364,365, 366a, 368,372 to 378.	**41**	**29.9 (15.50)**
3.	**Low**	51,83,84,86 to 95,107 to 115,119,120,124,139a, 165,169,170,183,199.	**31**	**15.8 (8.19)**

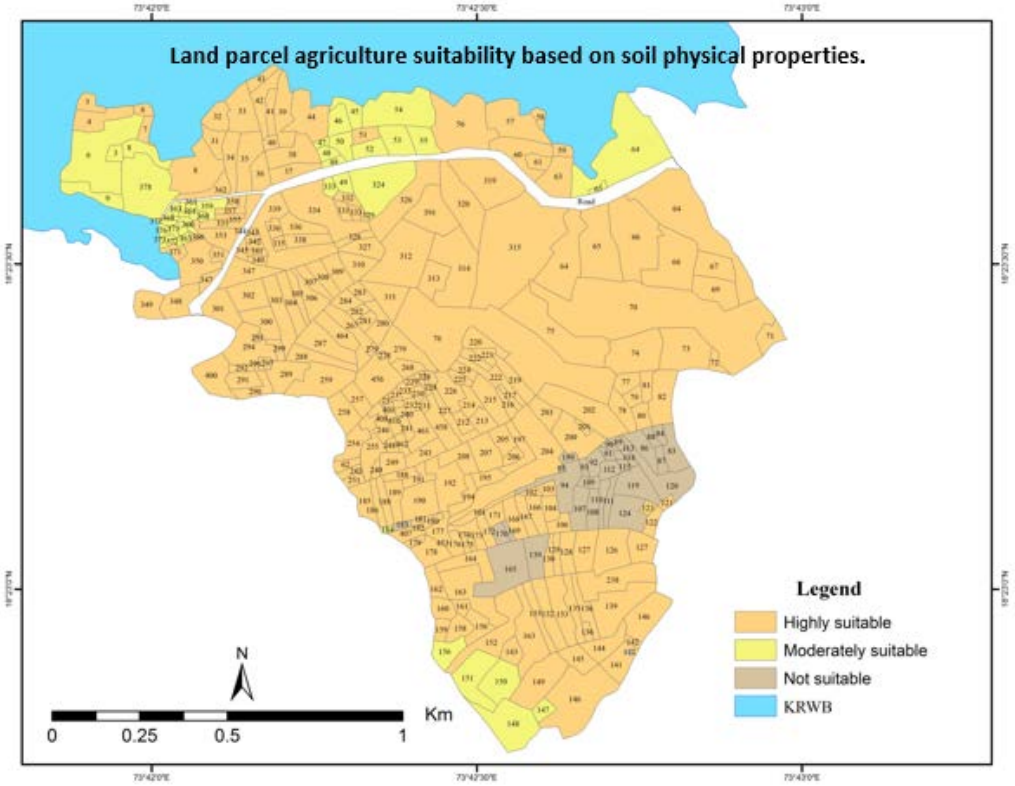

Figure 4. Cadastral level suitability of land for agriculture based on physical properties of soil

The cadastral parcels with high suitability level cover an area of about 147.2 hectors with 248 cadastral parcels. In the Malkhed village 76.31% (147.31 ha.) all the area is highly suitable for agriculture or plantation except north western, north central and northeastern parts of Malkhed, which is due to proximity of the backwater of Khadakwasala dam. The southern parts also cannot be marked as highly suitable due to barren nature of land.

Moderate suitability is found in about 15.5 5 of the study region with 41 cadastral parcels. It is sited at north western, north central, northeastern parts and southern parts of Malkhed village.

Low: The cadastral parcels with low suitability as per physical properties covers 15.8 hectors (8.19%) area with 31 cadastral parcels. The low suitability for agriculture or plantation is located at the central eastern hilly parts of Malkhed, as seen from Figure 4.

4.1.2. Suitability as Per Chemical Properties

The cadastral parcels with different suitability levels are shown in Table 7.

Table 7. Cadastral Suitability as per chemical properties

Sr. No	Suitability classes	Priority classes based on Chemical Properties	No of Land parcel	Area in Ha.
1	**High**	3 to 6, 6a,7,8a,9, 23,23a,32,62, 64b, 66a,67,69,71 to 84, 86 to 90, 113 to 115, 120 to 124,127a, 136a,139a, 141,142, 142a,142b,144 to 146, 146a,147,149,164,175 to 186, 188, 188a,189 to 192, 200 to 203, 208,212 to 217,219 to 222,222a,224 to 228, 228a,229 to 233,236,238,240,240a, 241 to 243,246,248, 249,251, 254, 255,257,258,268,279a, 313,314, 320, 349,378,400,401,407,408,410,453, 456,458,461,462.	**134**	**85.3 (44.23%)**
2	**Moderate**	8,31, 33 to 49,49a,50 to 56,64a,66, 70,91 to 93,101,112,119,126, 132, 133,135,136,143,148,150 to 152, 155,162,163, 163a,165,169 to 174, 194,195,197,199,204 to 207, 259, 267,278,279 to 284, 287 to 292,294 to 297,299 to 306,311,312,315, 319,326,347a,348,355,357 to 359, 361,362,363a,364,368,391,464.	**110**	**71.35 (36.98%)**
3	**Low**	57 to 61,63 to 65,65a,94,95,102 to 104,106 to 111, 127 to 130,139, 156, 156a,158 to 161,166 to 168, 307 to 310,324,327 to 329,331 to 333, 333a, 334,335,335a,336,336a,338 to 345, 347,350,351,353,360,363,365,366,366a, 371 to 377,500.	**76**	**36.25 (18.79%)**

The location of these cadastral parcels can be visualized in Figure 5.

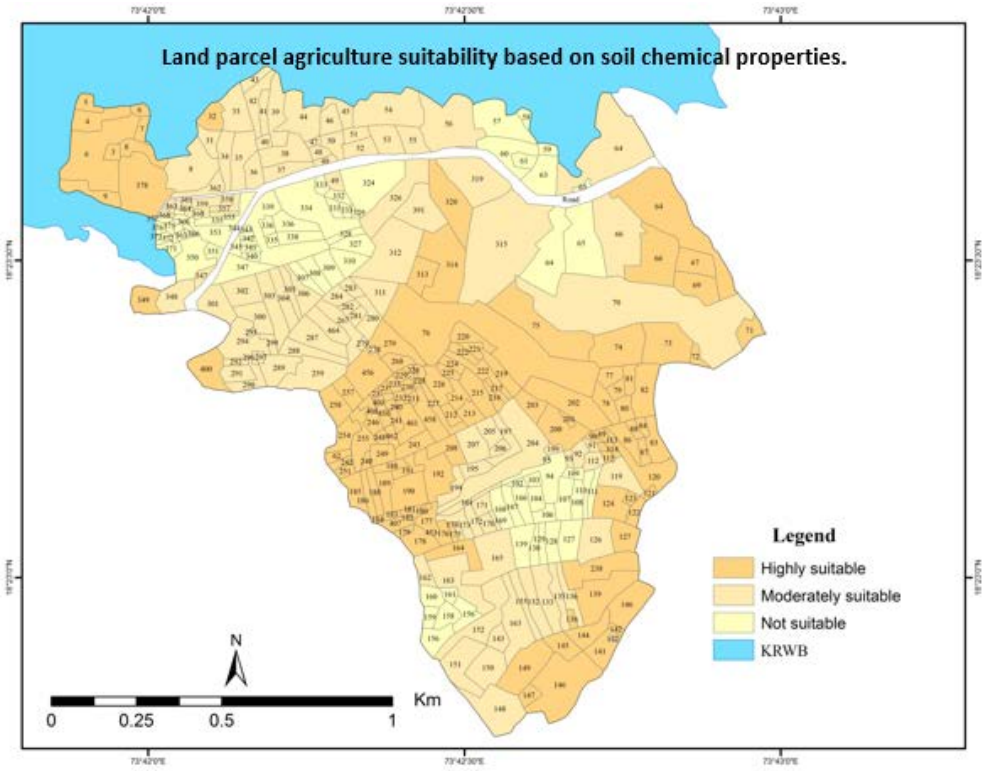

Figure 5. Cadastral level suitability of land for agriculture based on chemical properties of soil

It is clear from both the table and the map that the cadastral parcels with high suitability for agricultural activities, as grouped according to chemical properties, almost reduces to less than half of the total study region. These high suitability cadastral parcels cover an area around 85.3 hectors with 134 cadastral parcels. In the Malkhed village only 44.23% has been highly suitable for agriculture or plantation (as per chemical properties) because this is the area where organic carbon proportion is higher.

Moderate suitability of land parcels, as classified based on chemical properties, include an area of 71.35 hectors

(36.98%) with 110 cadastral parcels. It is sited along the farm lands of the Malkhed village.

The remaining cadastral parcels covering 18.79% of the total area (36.25 hectors) with 76 cadastral parcels is classified as land having very low suitability for agricultural activities. Due to intensive agriculture activity this area has now been rendered as unfit for agriculture or plantation.

4.1.2. Suitability as Per Physical-Chemical Properties

In order to assess the suitability of agricultural activities in Malkhed village based on both physical as well as chemical properties of the soil, priority classes of both the groups were integrated and a composite priority rank was assigned to all the cadastral parcels. The final priority classes were prepared based on the composite ranks of physical and chemical groups, as represented in Table 8.

Table 8. Composite ranks given based on both physical and chemical properties of soil

Sr. No.	Latitudinal Extent	Longitude Extent	Cadastral parcel Nos.	Priority classes based on Physical properties	Priority classes based on Chemical properties	Priority classes based on Physical and Chemical Properties
1	18.395	73.699	3	Moderate	High	Moderate
2	18.395	73.699	4	High	High	High
3	18.396	73.698	5	High	High	High
4	18.395	73.699	6	High	High	High
5	18.396	73.700	6	Moderate	High	Moderate
.	.	.	.	.	.	.
315	18.389	73.706	456	High	High	High
316	18.388	73.707	458	High	High	High
317	18.387	73.707	461	High	High	High
318	18.387	73.706	462	High	High	High
319	18.390	73.705	464	High	Moderate	Moderate
320	18.393	73.702	500	High	Less	Moderate

The final land suitability map with associated statistics in different classes is given in Figure 6 and Table 9. It is found from the analysis that in Malkhed village, only 33.44 % of the total area is highly suitable for agricultural or plantation activities. The cadastral parcels with high suitability levels cover an area of 64.5 hectors, located along the gentle slopes and lower extent of the farm land.

Moderately suitable land includes an area of 109.71 hectors or 56.87 %) with 182 cadastral parcels. It is sited along the farm lands of the Malkhed village. 31 cadastral parcels represented very low suitability of land useful for agricultural activities. These cadastral parcels cover 18.69 hectors (9.69%) area with 31 cadastral parcels. The immediate attention towards soil conservation measures is required in these cadastral parcels to preserve the land from further erosion and to alleviate natural hazards.

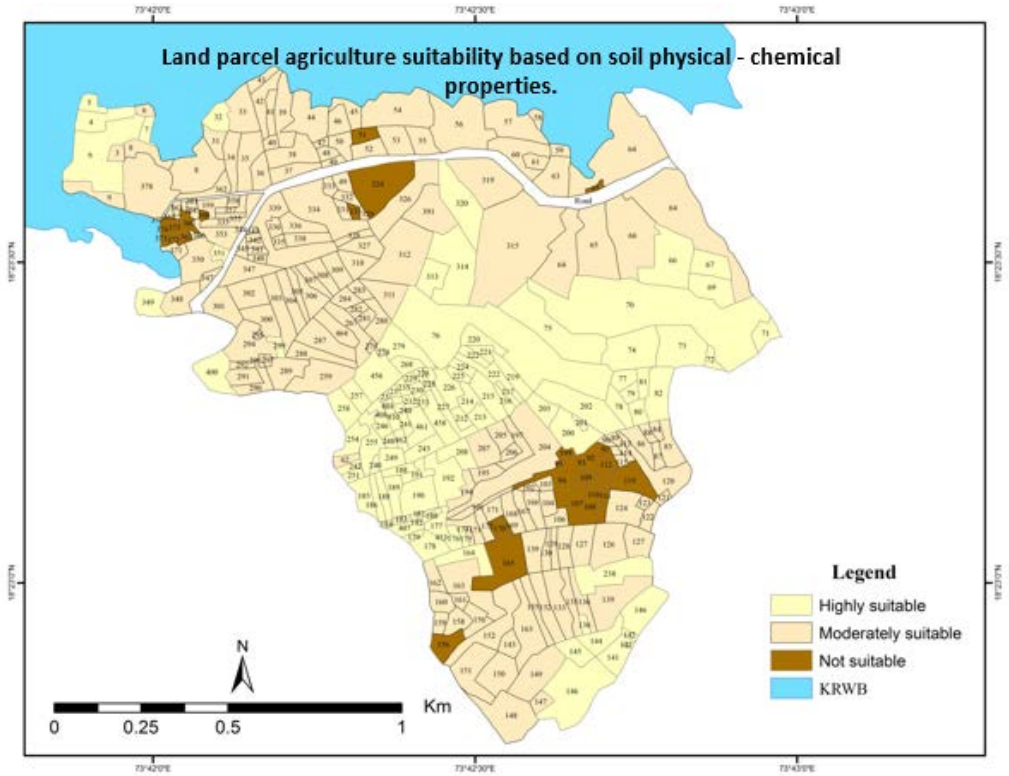

Figure 6. Cadastral-level land suitability for agriculture based on physical and chemical properties of soil

Table 9. Cadastral Suitability as per physical and chemical properties

Sr. No	Suitability classes	Priority classes based on Physical and Chemical Properties	No of Land parcel	Area in Ha.
1	**High**	4 to 6,7, 23,23a,32,62,66a,67,69,71 to 82, 136a,141,142,142a,142b,144 to 146,146a, 164,175 to 182,185,186,188,188a,189 to 192, 200 to 203, 208,212 to 217,219 to 222,222a, 224 to 228,228a,229 to 233, 236, 238, 240, 240a,241 to 243,246,248,249,251,254,255,257,258,268, 279a, 313,314,320,349,400,401, 407,408,410,453,456,458,461,462.	**107**	**64.50 (33.44%)**
2	**Moderate**	3,6a,8,8a,9,31,33 to 49,49a,50,52 to 61,63,64,64a,64b,65, 66,70,83,84,86 to 90,101 to 104, 106,113 to 115,120 to 124,126,127,127a,128 to 130, 132,133,135,136,139,139a,143,147 to 152, 155, 156,158 to 163,163a, 166 to 168,171 to 174,183,184,194,195,197,204 to 207,259, 267,278,279 to 284,287 to 292,294 to 297,299 to 312,315,319,326 to 329,331 to 333 to 335,335a,336,336a,338 to 345,347,347a,348,350,351,353,355,357 to 359,361,362,363a,364,366,368,371,378,391,464,500.	**182**	**109.71 (56.87%)**
3	**Low**	51,65a,91 to 95, 107 to 112,119,156a,165, 169,170,199,324, 333a,360, 363,365,366a,372 to 377.	**31**	**18.69 (9.69%)**

5. Conclusions and Suggestions

Based on the research work carried out of the study area following conclusions are made:

1. The village level maps showing several land form details would help in proper scientific developmental planning of the villages. High-resolution IRS P6 LISS-IV MX shows fabulous prospective to prepare the village level thematic maps.

2. Administrators need to be made aware about the benefits of this technology as it simplifies the decision making, planning and assessment process in a more scientific and logical manner.

3. It is useful to find out the drawbacks and potential of any area before going for any developmental activities. This information can be used to evaluate the capacity of the area for its shortcomings and therefore to improve the productivity. India is a developing country and for the development of Indian economy rural development is an important factor.

4. Spatial Information System covers various aspects including gathering data, solving problems arising from due to lack of micro level details, preparation of thematic maps like cadastral map, the maps of soil physical and chemical parameters of soil maps using ArcGIS platform.

5. For detail micro level it provides more precise information of each and every parcel of Cadastral map.

6. Malkhed Village is an agricultural area most the people in the village depends on agriculture but there are no market facilities, no bazaars, no market yards and no cold storages for the farmers. So, is highly recommended that there should be an immediate market for the farmers. The low suitability area can be used to developed agriculture supplementary business-like poultry farming, goat farming or constructions of cold storage/ warehouse etc.

Thus, for in-depth micro level planning of agriculture, present work is supportive as it gives more precise Gat wise information (land parcel) of the Malkhed village.

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