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Original Research Paper

Land Suitability and Capability Classification for Different Crops in Rangareddy District of Telangana Using Remote Sensing and Gis Techniques

Science

KEYWORDS :

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ABSTRACT

In the present study fifteen representative pedons (Soil Samples) were selected based on topography from various physiographic units identified in of Ranga Reddy district in Telangana State. Remote sensing plays a key role in generation of spatial information and mapping of natural resources and inventory, especially for soil resource mapping for optimal land use for sustainable development of agriculture. Based on the land characteristics of each physiographic unit and land capability criteria for land qualities, land capability classes and sub-classes were assigned. For this study, the GIS and image processing software used were ARCGIS10. According to soil-site evaluation, most of the upland was marginally suitable or not suitable for rice, cabbage, tomato and cotton crops. The upland are moderately suitable to chilli and red gram. Most of the midlands were moderately suitable for chilli, cabbage and red gram and marginally suitable for rice, tomato and cotton. The low land were marginally suitable for these crops, were as lowland was moderately suitable for chilli, cabbage and cotton and marginally suitable for rice, tomato and cotton.

1. INTRODUCTION

The soil and land resource inventory at regional and state level are providing a basis for blanket recommendation of various package of practice including fertilizer as other inputs. The inherent diversity in soils and the adopted practices with intensive apply, the soils are evidently expressing numerous, complex problems, which are identified at different stages. Further, it is becoming difficult to provide solution at later stages. The multi pronged problems of intensive cropping are very diversified in nature and manifesting physically, chemically, biologically and ultimately nutritionally, the blanket recommendations are not providing a suite of solutions.

Considering this fact with a view to asses the site specific constraints and provide potential for development and remediation, the present study is planned taking village as a unit. Approach is in consonance with the village land use planning in this entire village soil and land resources are systematically accounted and prepared a resource inventory, which act as ready reference reckoned for any planning activity for the development and improvement of village soil and land resources further. The entire study work encompass in accounting of the soil and land resources, which is providing a medium for the crop growth.

Essential soil and land resources of Rangareddy District, Telangana are diversified in nature and characteristics in supplying nutrients and providing necessary anchorage for the crop growth and development. There are number of variations in growth and disparities in the packages adopted by farmers. Vary little attention was paid to study of the soils of this area of Ranga Reddy district. Most of the studies conducted earlier were only broad based and were conducted as a part of their study of soils of country or state. So, it is essential to understand the land suitability for certain crops of Ranga Reddy district.

2. OBJECTIVES OF INVESTIGATION

(i) To prepare physiographic soil map at 1:50,000 scale from LISS III data

(ii) To prepare land use and land cover (LULC) map

(iii)To prepare drainage map for watershed delineation

(iv) To digitize contour map to prepare DEM, and from DEM a slope map

(v) To categorize the study area according to Land Capability Classes (LCCs)

(vi) To evaluate the soil suitability for various Land Utilisation Types based framework of land evaluation.

3. LOCATION OF THE STUDY ARE

The Ranga Reddy district of Telangana state lies 7 km away from mandal headquarter Chavalla of Ranga Reddy district. This village is located between 17°15′ and 17°16′ North latitudes and 79°05′ and 77°06′ East longitudes. The village is surrounded by on Bisthapur on the north and Damargidda village on north-east, Pamena village on the east, Ekkireddypally village and Yarrabally village on the south, Thadlapally on south-east village and Ganapur on the western side.

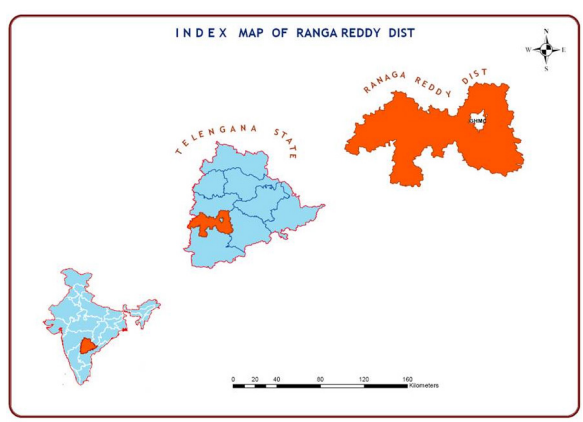

Figure 1.1: Showing the location map

4. METHDOLOGY

The details of the methodology followed in the study, which included a combination of visual image interpretation and digital image analysis, land capability classification and land suitability analysis for wheat and mango, are given below. The Geographic Information and image processing software used for the study were ARCGIS10.

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(i) Digital image analysis and visual image interpretation

Survey of India toposheets were georeferenced based on latitude and longitude values. The edges of the toposheet were matched and a digital mosaic depicting the entire study area was prepared. The satellite data was then geocoded and georeferenced by extracting the GCPs (Ground Control Points) from SOI toposheets. The digital data was then enhanced and correction models were applied to make it free from errors and distortions both radiometrically and geometrically. The images were then visually interpreted based on several basic characteristics of features, color, tone, texture, pattern, size, shape and so on and a spatial (especially topographical) database of maps was generated.

(ii) Land use/Land cover (LULC):

To make a lulc map, the satellite image is classified. Image classification involves conversion of multi-band raster imagery into a single-band raster with a number of categories that denote different types of land cover. There are two primary ways to classify a multi-band raster image; supervised and unsupervised classification. Using the supervised classification method, an image is classified using spectral signatures (i.e., reflectance values) obtained from polygons that represent distinct sample areas of the different land cover types.

LAND CAPABILITY CLASSIFICATION

The land capability is mainly based on the inherent soil characteristics, external land features and environmental factors. The land capability classes and sub classes were arrived at as per the guidelines in Soil Survey Manual. The criteria used for land capability classification.

LAND EVALUATION

i) Soil-site suitability evaluation for crops

Soil suitability for major crop growing was evaluated based for land evaluation. It involved formulation of climatic and soil requirements of crop and ratings of these parameters viz., highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and unsuitable (N) for agriculture.

ii) Simple and maximum limitation method for land evaluation

In this method land characteristics (or qualities) are compared with the crop requirements and the land class is attributed according to the less favourable characteristics or quality.

The methodology suggests an evaluation of the climatic characteristics in the first place with an ultimate aim of one class level to be introduced in the total evaluation. The relationship between land classes or suitability classes and limitations are given below.

Limitations Suitability class (land class)

S1 : Highly suitable

S2 : Moderately suitable

S3 : Marginally suitable

N1 : Temporarily Unsuitable

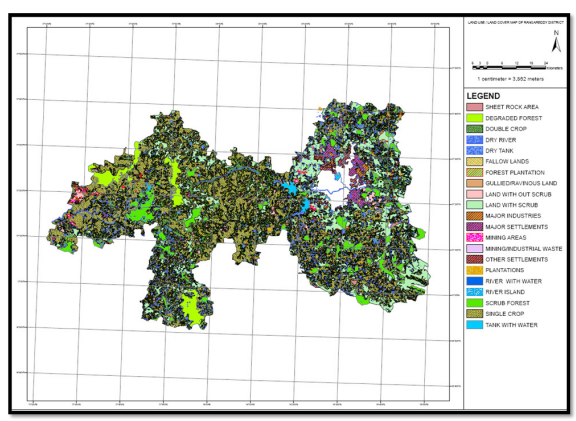
N2 : Permanently unsuitable

5. RESULTS AND DISCUSSION

LAND USE LAND COVER

Land use and land cover map of the study area gave the following results- forest, 60.9%; agriculture, 28.92%; waterbed, 4.74%; flood plain, 4.38%; and scrub, 1.04%. The study area could be divided into three major landforms (hilly, piedmont plains and flood plains) and further divided into 10 physiographic soil units. Most part of the study was covered by mountains and piedmont plains.

Figure 1.2: Showing the land use land cover map



LAND CAPABILITY CLASSIFICATION

Physiographic unit	Climate				Land form characteristics			Physico-chemical characteristics(weighted averages)						
	Rain fall (mm)	Max. temp (°C)	Min. temp (°C)	RH (%)	Slope (%)	erosion	drainage	Depth (cm)	Sur.coarse fragments (vol %)	texture	pH	OC (%)	CEC cmol (p+)/kg	B.S (%)
Pedon 1	1167	32.1	20.3	62.8	3-5	moderate	well	75+	22	scl	8.1	0.58	19.7	64.5
Pedon 2	1167	32.1	20.3	62.8	3-5	Moderate	Well	80+	23	scl	7.5	0.67	21.5	62.5
Pedon 3	1167	32.1	20.3	62.8	5-8	Severe	Well	60+	19	scl	7.6	0.60	22.0	52.7
Pedon 4	1167	32.1	20.3	62.8	3-5	Moderate	Well	30+	24	scl	7.3	0.60	13.0	68.5
Pedon 5	1167	32.1	20.3	62.8	5-8	Severe	well	27+	29	scl	7.3	0.59	22.7	72.7
Pedon 6	1167	32.1	20.3	62.8	2-3	Moderate	Mod.well	60+	20	scl	7.8	0.65	16.8	71.9
Pedon 7	1167	32.1	20.3	62.8	2-3	Slight	Mod.well	60+	19	sc	7.8	0.79	24.7	78.7

Pedon 8	1167	32.1	20.3	62.8	3	moderate	Mod.well	60+	16	sc	7.9	0.69	26.7	70.1
Pedon 9	1167	32.1	20.3	62.8	2-3	Slight	Mod.well	60+	19	sc	7.7	0.72	33.1	60.7
Pedon 10	1167	32.1	20.3	62.8	2-3	Slight	Mod.well	80+	18	scl	8.2	0.72	23.0	70.8
Pedon 11	1167	32.1	20.3	62.8	2-3	Slight	Mod.well	100+	18	scl	7.5	0.72	23.9	71.4
Pedon 12	1167	32.1	20.3	62.8	2-3	Slight	Mod.well	60+	21	scl	7.9	0.61	21.8	56.1
Lowland														
Pedon 13	1167	32.1	20.3	62.8	0-1	Nil	Imperfect	110+	10	sc	7.8	0.71	24.6	74.5
Pedon 14	1167	32.1	20.3	62.8	0-1	Nil	Poor	110+	9	c	8.0	0.80	38.5	75.9
Pedon 15	1167	32.1	20.3	62.8	0-1	Nil	poor	110+	9	c	8.0	0.80	38.8	68.8

Based on soil properties, the soils of Chanvelly village have been classified into two land capability classes viz., III and IV. Similar observations were also made in the table. The study area represented by upland pedons 1, 2 and 4 were classified into IVs, land capability sub-class due to the limitations of texture, soil depth and pedon 3 and 5 in uplands was classified into IVs_t, due to texture, depth, erosion limitations. The midland pedons 6, 10, 11 and 12 were classified into IVs , land capability sub class due to limitations of texture whereas the midland pedon 7, 8 and 9 and lowland pedon 13 were classified as III_{St}, capability sub-class due to the limitations of texture, soil depth, coarse fragments and soil fertility limitations. The low land pedons 14 and 15 were classified into IVw, land capability sub-class due to poor drainage.

Table 1.1: Land Capability Criteria

SOIL-SITE SUITABILITY FOR DIFFERENT CROPS

The performance of any crop is largely dependent on soil parameters (depth, drainage, texture etc.) as conditioned by climate and topography. The study of soil-site characterization for predicting the crop performance of an area forms land evaluation. According to land evaluation is the rating of soil for optimum returns per unit area. The yield influencing factors for important crops have to be evaluated and the results obtained may be applied for higher production of these crops through proper utilization of similar soils occurring elsewhere in same agro-climate sub-region under scientific management practices.

The studied soils vary in their suitability for different crops, according to the criteria for the determination of the land suitability classes.

Table 1.2: Land Suitability Criteria
Paddy

Characteristics	Class-I	Class-II	Class-III	Class-IV	Class-V	Class-VI	Class-VII	Class-VIII
Topograhy(t)								
slope(%)	0-1	1-3	3-8	8-15	Upto 3	15-30	30-50	>50
erosion	Nill	Slight	Moderate	Severe	Nil	Severe	Very severe	extreme
Wetness								
Flooding	Nil (F0)	Nil (F0/F1)	slight (F1)	moderate (F3)	Mod .to severe (F0/F3)	Nil, severe (F0/F4)	Nil to very severe (F5)	——
Drinage:(1)	Well	Mod. Well	Imperfect	Poor	V.poor	Excessive	Excessive	Excessive
Pereability	Moderate	Mod. Rapid	Raid slow	V.rapid, v slow	———	———	———	———
Infiltration rate(cm/hr)	2-3.5	1-2.0, 3.0-5.0	0.5-1, 5.0-10.0	<0.5, >10.0				
Phy. characteristics								
Surface texture	Loam	Sil& cl	sl & c	Scl	S, c(m)	ls -cl	1s, s, c	1s, s, c(m)
Sur.coarse frag (%)	1-3	3-15	15-40	40-75	15-75	75+		
Sur. stoniness (%)	<1	1-3	3-5	5-8	8-15	15-40	40-75+	Rocky
Sub surface coarse fragments (%)	<15	<15	15-35	35-50	50-75	50-75	75+	Rocky
Soil depth (cm)	>150	150-100	100-50	50-25	50-150+	25-10	<10	nil
Profile development	cambic/Argi llic	A-B-C $A-B_t-C$	stratifiedA-C;A-B-C	Salic/Calcic A-Bz-C/A-Bk-C	Az-C, $A-B_z$-C	Gypsic hor. A - C_y	A-C(stony	R (bouldary)
Fertility (f)								
CEC(cmol(p+)/kg)	40-16	16-12	16-12	12-8				
Base saturation (%)	80+	80+	80-50	50-30	50-35	35-15	<15	
OC (%)	>1.0	0.75-1.0	0.5-0.75	0.3-0.5	<0.3			
Salinity EC(ds/m)	<1.0	1-2	2-4	4-8	8-15	15-35	35+	
Gypsum	0.3-2.0	2-5	5-10	1015	15-25	>25		

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As it requires standing water, structure less condition after puddling with high clay and silt content, the area represented by uplands (pedon 3 and 5) were permanently not suitable due to very severe limitations of slope, were as other upland pedons are marginally suitable due to limitations of drainage, slope and depth. All the midlands pedons except pedon 11, were marginally suitable due to limitations of soil reaction, where as pedon 11 was moderately suitable due to limitations of drainage, slope and soil reaction. The low land pedons were marginally suitable due to limitations of soil reaction.

Chilli

All the landscapes of the study area except pedons 4, 5, 10, 14 and 15, were moderately suitable for the crop due to limitations of salinity, coarse fragments, rain fall, drainage and soil fertility where as pedons 4 and 5 of upland area are marginally suitable due to severe limitation of depth. The midland pedon 10 was marginally suitable due to severe limitation of salinity, where as low land pedons 14 and 15 was marginally suitable due to poor drainage.

Cabbage

A soil depth of more than 60 cm, less than 15 per cent $CaCO_3$, < 4 percent slope, 450 to 800 mm rainfall and base saturation of more than 35 per cent optimum for cabbage. Because of severe limitation of depth pedon 4 and 5 were marginally suitable where as pedon 1 and 10 are marginally suitable due to sever limitation of soil reaction. The pedons 1, 2, 3, 6, 7, 8, 9 and 12 are moderately suitable due to limitations of climate, where as in pedon 2 slope is major limitation and in case of pedons 8 and 12 soil reaction is major limitation.

The study area represented by low lands pedon 13 is moderately suitable due to imperfect drainage were as in pedons 14 and 15 are marginally suitable due to poor drainage.

Tomato

The tomatoes come up well on soils having clay loamtexture , soil depth of more than 100 cm, more than 16 per cent CEC, well to moderate drained, < 4 percent slope, 450 to 800 mm rainfall and base saturation of more than 35 per cent.

The study area represented by upland pedons 1, 2 and 3 are marginally suitable due to limitations of soil fertility and depth, where as pedons 4 and 5 are not suitable due to severe limitation of soil depth. The mid land pedons are marginally suitable due to limitations of soil fertility, and the low land pedon 13 was marginally suitable due to limitations of soil fertility were as pedons 14 and 15 are marginally suitable due to limitations of poor drainage.

Cotton

The yield influencing factors on cotton are rainfall, slope, drainage, soil depth and free $CaCO_3$ (Table 13). Because of severe limitations of slope and depth, the upland pedons 3 and 5 were not suitable for cotton were as pedons 1, 2 and 4 were marginally suitable due to texture, depth and organic corbon. Similarly, midlands were also marginally suitable due texture, depth and organic corbon limitations. Whereas, lowlands were marginally suitable for cotton, because of severe limitation of drainage.

Red gram

Pegionpea is a highly drought resistant crop. Water logging, heavy rains and frost are harmfull for the crop. The crop may be grown on any type of soil but sandy loam to clay loam soils is best for crop. Soil should be deep, well drained and free from salts in them. The are represented by upland pedons (pedon 1 and 2) were moderately suitable due to moderate limitations of slope, coarse fragments and depth whereas the other upland pedons (pedon 3, 4 and 5) were marginally suitable due to limitations in slope and depth. All the mid land pedons except pedon 10, were moderately suitable due to limitations in drainage, depth and salinity were as the pedon 10 was marginally suitable due to salinity. The lowland pedons 14 and 15 were marginally suitable due to poor drainage, were as pedon 13 was moderately suitable.

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