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Assessment of Land Use Potential for Sustainable Development of Chorgali Village of Hura block, Puruliya district, West Bengal

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Abstract: The information on soil and land resources of Chorgali, a rainfed village, Hura block, Puruliya district, West Bengal was generated through remote sensing and GIS to asses their productvity potentials and limitations. Thirteen soil series were tentatively indenfied and mapped with 26 mapping units. These mapping units (phases of series) have been grouped in different land capability sub-class and soil conservation measures have been suggested.

Key words : *Remote Sensing & GIS, micro level planning*

Introduction

The scientific information on nature, extent, limitations and potentials of soil resources is, essential for optimal utilization of the resource for sustenance (Wani *et al*. 2002; Ghorbani and KakehMami 2013). The study aims to generate valuable information on soil and land features of the area with their productive potentials and limitations, which is essential for soil specific micro level planning to undertake soil conservation measures *vis-a-vis* land use planning on sustainable basis. The land-use survey and planning at village level would enable us to apportion land for short-term and long-term requirements among uses such as agriculture, forestry, permanent vegetation, grasslands, fisheries, water bodies, watersheds, water resources, human settlements, roads, transport, industries, and brick kilns.Thus, the land capability classification and land-use study are needed in the analysis of environmental processes and problems if the living conditions and standards are to be improved or maintained at current levels and hence present study was conducted.

Study Area

Chorgali village (86^{O}32' to 86^{O} 33' E ; 23^{0} 16' to 23^{0} 18'N) is located in 2A2B4k2 micro watershed of Kangsabati catchment of Hura block, Puruliya district, West Bengal (Fig 1) and cover an area of 392 ha at an a elvation 200 mSL.The J.L. No. of the village is 540 and is covered by the Survey of India toposheet No. 73 I/ 11. The study area comes under rolling and undulating land of gneissic landscape.The area falls under sub-humid, subtropical climate zone. The rainfall of the study area is 1656 mm with mean maximum and minimum temperature recorded as 36.1^{O}C and 18.6^{O}C respectively.

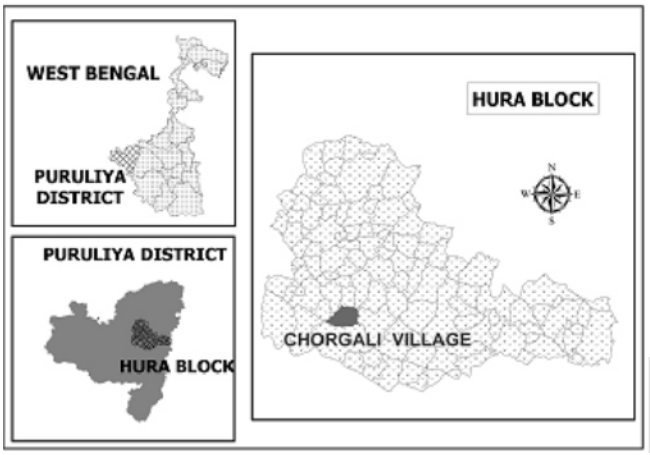

Fig. 1 Location of Chorgali village

Materials and Methods

Detailed soil survey of the area was carried out by the procedure laid out in the Soil Survey Manual of All India Soil & Land Use Survey (1970) and Soil Survey Division Staff (2000).

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Base map

The detailed soil survey of the study area was carried out using satellite imageries (LISS IV) data on 1: 10,000 scales in conjunction with Survey of India (SOI) toposheets.

Pre-field Interpretation

Interpretation of geocoded satellite imagery data has been done on screen. Study of topographical maps and interpretation of satellite imageries were done to identify and delineate boundaries of different geomorphic/landscape units, land use/land cover, and erosional hazards. Thus, a tentative interpretation key was framed based on different combination of image elements and landform units.

Field traversing

Detailed field investigation was carried out by undertaking extensive traversing and examining the soils by profile auger bores, mini pits *etc*. to correlate image interpretation units with soil phase of soil series. At selected sites of sample strip or transect, soil profiles were examined for detailed morphological studies Soil Survey Division Staff (2000) and classified Soil Survey Staff (2014). Soil profiles up to 2 m depth or up to parent material whichever comes earlier were exposed and examined in detail to record the morphology and site characteristics of the soils.

Post field interpretation

The delineation of each and every mapping unit was checked and rectified and final soil map of the village was prepared.

The field sheets were further processed using ArcGIS software and digital spatial soil database was generated on 1:10,000 scales. Thematic maps were generated after finalizing the soil map.

Results and Discussion

The present study involved examination of soil-site and morphological characteristics. The soil map with 16 soil series, 26 mapping units (Soil phases) and 4 miscellaneous areas have been identified. Each soil mapping unit/ phase on the map has been delineated and represented by symbolic expression. The abbreviated symbol of mapping unit reflects information about the name of soil series, soil depth, surface texture, land slope, gradient and erosion status. The soil mapping unit is demarcated as BP5kC (A) 1/C1/B where 'BP' represents for 'Bispuria' soil series, '5' for very deep (soil depth), 'k' for sandy clay loam (surface texture), 'C (A)' for very gently sloping (3-5%) terraced with nearly level to level (0-1%), '1' for none to slight water erosion, C1 for single crop and B for bunded..

Table 1 describes the soils at phase level. The soils belong to shallow to very deep and none to slight to severely eroded, unmanaged to well managed category. landform *viz.*, upper pediplain, lower pediplain, toe slope, foot hill slope and depression were identified on gneissic terrain.

Table1. General description of soil series

Sl. No.	Series Name	Soil Phase	Landform	Soil Depth	Soil Classification
1.	Bispuria	BP5kC(A)1/C1/B	Upper Pediplain	Very deep	Fine, mixed, hyperthermic Oxyaquic Haplustalf
2.	Dumkadih	DU2dB2/PDU2dC2/F1 DU2dC3/W1/UBDU2dD3 F1DU2kC2/F1	Upper Pediplain	Shallow	Coarse-loamy, mixed, hyperthermic Typic Ustorthent
3.	Haritarn	HN3hC(A)1/C1/ BHN3kC2/W1/UB	Upper Pediplain	Moderately deep	Fine-loamy, mixed, hyperthermic Typic Ustorthent
4.	Hatimara	HT3kB(A)1/C1/ BHT3kC(A)1	Upper Pediplain	Moderately deep	Fine-loamy, mixed, hyperthermic Typic Ustorthent
5.	Ledadih	LD4dC3/F1	Upper Pediplain	Deep	Fine-loamy, mixed, hyperthermic Typic Rhodustalf

6.	Pursudha	PD4kB(A)1/C1/B	Upper Pediplain	Deep	Fine, mixed, hyperthermic Vertic Haplustept
7.	Pura	PU5kB(A)1/C1/B	Upper Pediplain	Very deep	Fine-loamy, mixed, hyperthermic Typic Haplustalf
8.	Karandih	KD5kB(A)1/C1/B	Lower Pediplain	Very deep	Fine, mixed, hyperthermic Aeric Epiaqualf
9.	Kesargarh	KG4kB(A)1/C1/B	Lower Pediplain	Deep	Fine-loamy, mixed, hyperthermic Oxyaquic Haplustalf
10.	Puruliya	PR2kB(A)1/C1/BPR2k C(A)1/C1/B	Lower Pediplain	Shallow	Fine-loamy, mixed, hyperthermic Aquic Ustorthent
11.	Mohangara	MG2dB3-SR/ F1MG2kC3-SR/W2	Foot Hill Slope	Shallow	Fine-loamy mixed hyperthermic Typic Ustorthent
12.	Karmatarn	KM4kB(A)1/C1/B	Toe slope	Deep	Fine, mixed, hyperthermic Aquic Haplustept
13.	Rukhedia	RK5cC2/CX/PB	Toe slope	Very deep	Fine-loamy, mixed, hyperthermic Oxyaquic Haplustalf
14.	Hura	HU4hB(A)1/C1/B	Depression	Deep	Fine, mixed, hyperthermic Aeric Endoaquept
15.	Nischinpur	NP5kC(A)1/C1/B	Depression	Very Deep	Fine-loamy, mixed hyperthermic Aeric Endoaquept
16.	Pratappur	PP5hB(A)1/C1/ BPP5hC(A)1/C1/B	Depression	Very deep	Fine-loamy, mixed, hyperthermic Aquic Ustifluvent
17.	Misc.	River			
18.	Misc.	ROC			
19.	Misc.	Tank			
20.	Misc.	Habitation			

Land Capability Classification

Land capability is the natural environmental ability of the land to preserve a range of land uses and management practices in the long term without degradation to soil, land, air and water resources (Sonter and Lawrie 2007). Land capability classification is a system of grouping mapping units (phases) based on their inherent soil characteristics, external landscape features and climatic conditions. In this system, mapping units are grouped at three levels *viz.* land capability classes, land capability sub-classes and land capability units as described below:

Land capability classes

The land capability classes are designated by Roman number I to VIII which indicates degree of limitation in increasing order. The soils in class I to IV are suitable for agriculture with increasing limitations that affect their use under agriculture, whereas class V to VIII lands are not suitable for cultivation but are suitable for pasture, afforestation and wild life preservation. The sub-class of land capability class indicate various kinds of limitations such as erosion and run-off (e), root zone limitations, unfavourable texture affecting vegetation (s), drainage, wetness, over flow hazard (w) and the climatic limitations (c).The sub-classes are further sub-divided into the land capability units based on the degree of limitation. These groups of soils that are alike in their management requirements and are suited to similar landuse having similar response to treatment and have same kind of productivity. They are indicated on the maps as IIc-1, IIe-1, IIs-1, IIes-1, IIIes-1, Ives-1, and so on. The phase-wise distribution of are under different land capability units is given in the table 2.

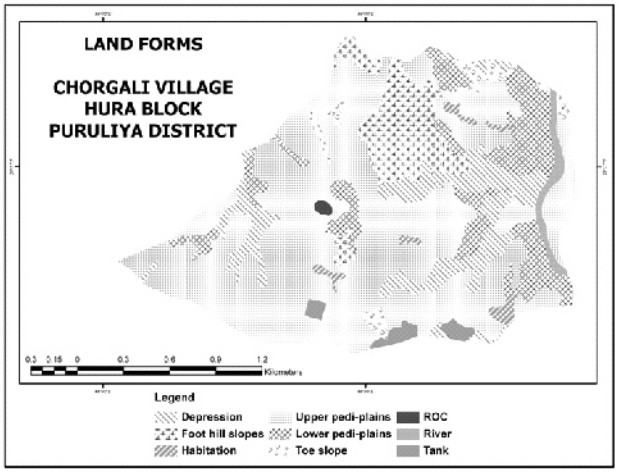

Fig. 2. Landform

It is seen from the above table that Class-II land occupies 117 ha. (29.84%) followed by class VI 112 ha (28.57%), class III 75 ha (19.13%) and class IV 69 ha (17.60%). Large part of the area is under godd cultivation and small portion is fairly good lands with occasional cultivation with major limitation.

The inherent problem of the land capability unit IIc-1 is that the soils are susceptible to moderate to rapid permeability and low in fertility status. They are well managed, protected from erosion and are well adapted to paddy. Bispuria, Pursudha and Pura series belong to this unit. The inherent problem of the land capability unit IIe-2 is prolonged dryness, low to moderate vegetation and having root zone limitation. They are adapted to rainfed cultivation with land capability unit IIw-1 is suffers from prolong wetness and slow permeability. They are well protected from erosion by bunds and well adapted to paddy. Karandih, Kesargarh, Karmatarn, Nischintapur and Pratappur series belong to this units. The inherent problem of the land capability unit IIsw-1 is of poor drainage and moderate soil fertility. Hura series belongs to this units. This soil is well protected from erosion by leveling and bunding and well adapted to paddy cultivation. The inherent problem of land capability unit IIIs-1 is that the soils under this unit are susceptible to waterlogging and have low fertility status and are well bunded and protected from erosion and adopted to paddy cultivation. Hatimara and Haritarn series belong to this unit. Prolonged dryness is the inherent character of land capability unit IIIs-3. Soils are poorly bunded, moderately eroded and under plantation and wasteland. Soils of Haritarn series belongs to this unit. The inherent problem of the land capability unit IIIes-2 is prolonged dryness, root zone limitation. The soils are poorly managed and susceptible to moderate erosion and are mostly under plantation and vegetable orchard around homestead. Mohangara series belongs to this unit. Soils of Puruliya series belong to IVs-1 unit. These soils are susceptible to waterlogging and root zone limitation. Soils are well bunded and protected from erosion and adapted to paddy cultivation. Soils under IVes-3 unit belong to forest vegetation. The inherent problem of the land capability unit VIes-1 is severe erosion hazards, low fertility status, low water holding capacity, and rockiness. These soils are mostly unculturable waste lands, unmanaged and face very severe erosion. Dumkadih and Mohangara series belong to this group.

Landfrom and soil map of the Chorgali village are presented in Fig. 2 and Fig. 3 respectively.

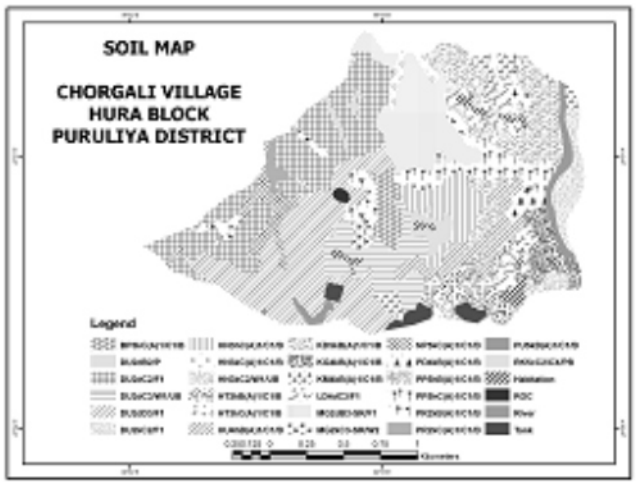

Fig. 3. Soil map

Six type of land uses are found in this area namely single crop cultivation, vegetable and orchard, forest with <10% canopy, waste land suitable for cultivation, occasionaly cultivated land and miscellaneous land including river, ROC, tank and habitation. Land capability and Management units are depicted in Figure 4 & 5.

Table 2. Land capability and soil conservation measures of Chorgali village, Puruliya

Sl. No.	Mapping Unit	Area (ha)	Soil Erosion	Management	LCC	SCM Unit	Proposed Soil Conservation
1	BP5kC(A)1/C1/B PD4kB(A)1/C1/B PU5kB(A)1/C1/B	8 5 2	None to slight	well managed (WB)	IIc-1	SCM1	Land leveling, maintenance of bunds, Application of balanced fertilizer and organic manures as per soil test data, crop rotation.
2.	LD4dC3/F1	16	Severe	Moderately	IIe-2	SCM8	Gully control measures, safe disposal of run-off water, grassed disposal drain, Afforestation
3.	RK5cC2/CX/PB	2	Moderate	poorly managed (PB)	IIe-2	SCM4	Land leveling, contour bunding, Application of balanced fertilizer and organic amendments as per soil test data.
4.	KG4kB(A)1/C1/B KM4kB(A)1/C1/B NP5kC(A)1/C1/B PP5hB(A)1/C1/B PP5hC(A)1/C1/B	11 5 8 1 17	None to slight	well managed (WB)	IIw-1	SCM1	Land leveling, maintenance of bunds, Provision of drainage, Application of balanced fertilizer and organic manures as per soil test data, crop rotation.
5.	HU4hB(A)1/C1/B KD5kB(A)1/C1/B	14 28	None to slight	well managed(WB)	IIsw-1	SCM1	Land leveling, maintenance of bunds, Application of balanced fertilizer and organic manures as per soil test data, crop rotation.
6.	HN3hC(A)1/C1/B HN3kC(A)1/C1/B HT3kB(A)1/C1/B HT3kC(A)1/C1/B	15 3 14 1	None to slight	well managed (WB)	IIIs-1	SCM10	Maintenance of field bunds, Application of fertilizer and organic amendments as per soil test data, suitable crop rotation
7.	HN3kC2/W1/UB	9	Moderate	Moderately	IIIs-3	SCM11	Land leveling and bunding, Agri-horticulture, Agri - pasture.
8.	MG2dB3-SR/F1	33	Severe	moderately	IIIes-2	SCM8	Gully control measures, safe disposal of runoff water, grassed disposal drain, Afforestation
9.	DU2dB2/P DU2kC2/F1	5 8	Moderate	moderately	IVes-1	SCM11 SCM12	Land leveling and bunding, Agri-horticulture, Agri–pasture, Afforestation with shallow rooted species.
10.	DU2dC2/F1	42	Moderate	moderately	IVes-3	SCM12	Land Preparation, Afforestation with shallow rooted species.
11.	PR2kB(A)1/C1/B PR2kC(A)1/C1/B	11 3	None to slight	well managed (WB)	IVs-1	SCM10	Maintenance of field bunds, Application of fertilizer and organic amendments as per soil test data, suitable crop rotation
12.	DU2dC3/W1/UB DU2dD3/F1	21 58	Severe	Unmanaged (UB)	VIes-1	SCM7	Gully control measures, Safe disposal of run-off water, grassed water way, plantation
13.	MG2kC3-SR/W2	33	Severe	poorly managed (PB)	VIes-2	SCM7	Gully control measures, Safe disposal of run-off water, grassed water way, plantation
14.	River	6	Misc.				
15.	ROC	1	Misc.				
16.	Tank	5	Misc.				
17.	Habitation	6	Misc.				

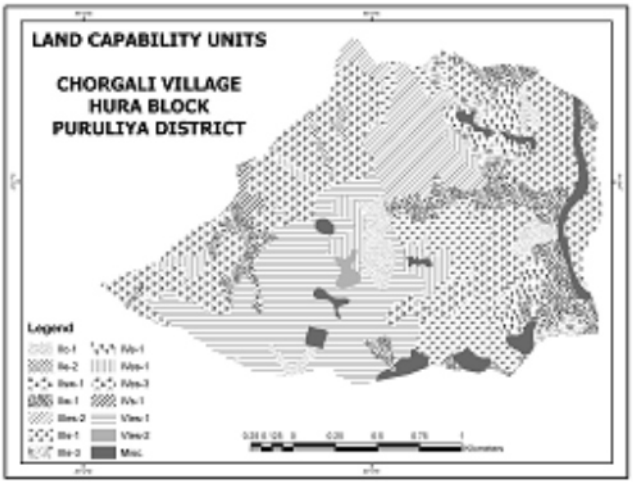

Fig. 4. Land Capability units

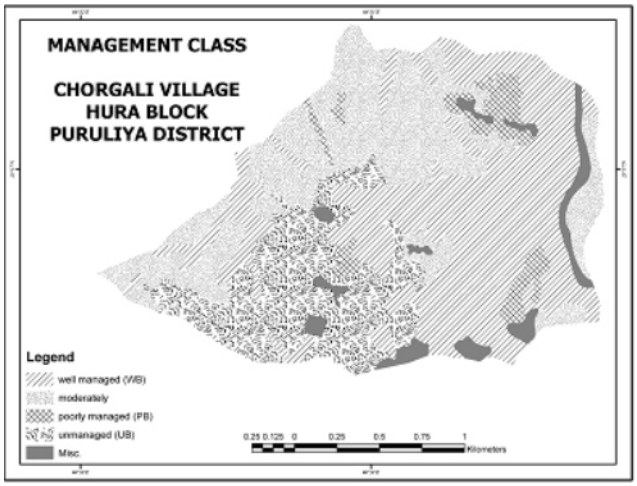

Fig. 5. Management class

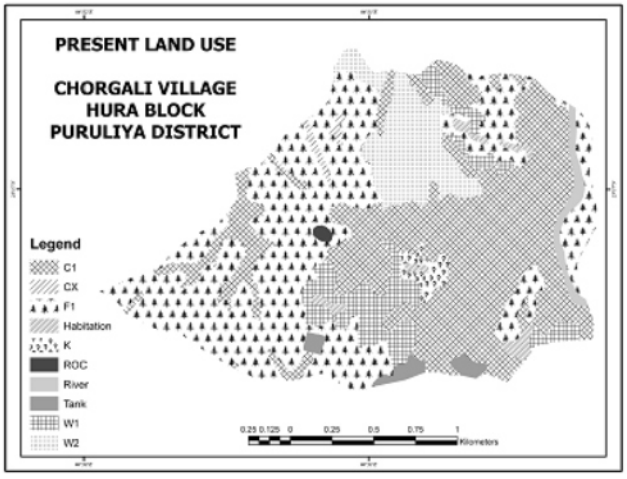

Fig. 6. Present land use

From Table 3, it is seen that the Chorgali village occupies 158 ha agricultural land (39.84%), 173 ha forest land (36.76%), 5 ha plantation, 37 ha an waste land and 19 ha as habitation, river, ROC and tank.

All the soil mapping units have been critically analyzed for their effective land use and conservation measures (Tables 2 and 3). Present and proposed land use and soil conservation measures are depicted in figures 6, 7 & 8 respectively.

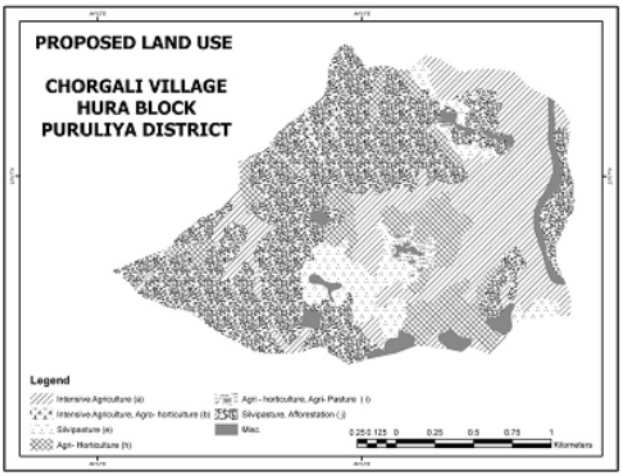

Fig. 7. Proposed land use

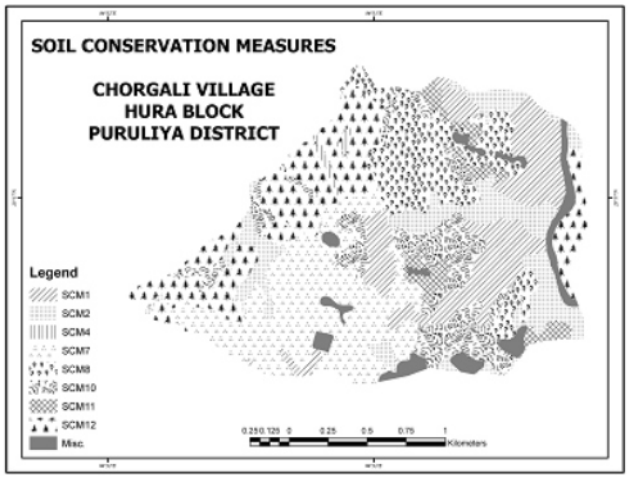

Fig. 8 : Soil Conservation Measures

Table 3. Present and proposed land use of Chorgali village, Puruliya

Sl. No,	Mapping unit	Area (ha)	Present land use	Proposed land Use
1.	BP5kC(A)1/C1/B HU4hB(A)1/C1/B KD5kB(A)1/C1/B KG4kB(A)1/C1/B KM4kB(A)1/C1/B NP5kC(A)1/C1/B PD4kB(A)1/C1/B PP5hB(A)1/C1/B PP5hC(A)1/C1/B PU5kB(A)1/C1/B	106	Single crop cultivation (C1)	Intensive agriculture (a)
2	DU2dB2/P	5	Vegetable and orchard (P)	Agri - horticulture, agri-pasture (i)
3	DU2dC2/F1	60	Forest (<10% canopy cover) F1	Silvipasture, afforestation (j)
4	DU2dC3/W1/UB MG2kC3-SR/W2 HN3kC2/W1/UB	37	Waste land suitable for cultivation (W1)	Silvipasture (e)
5	DU2dD3/F1 DU2kC2/F1 LD4dC3/F1 MG2dB3-SR/F1	113	Forest (<10% canopy cover) F1	Afforestation, silvipasture (f)
7	HN3hC(A)1/C1/B HN3kC(A)1/C1/B HT3kB(A)1/C1/B HT3kC(A)1/C1/B PR2kB(A)1/C1/B PR2kC(A)1/C1/B	50	Single crop cultivation (C1)	Agri- horticulture (h)
26	RK5cC2/CX/PB	2	Occasional cultivation (CX)	Intensive agriculture, agri - horticulture (b)
27	River	6	Misc.	
28	ROC	1	Misc.	
29	Tank	6	Misc.	
30	Habitation	6	Misc.	
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According to the table 2 & 3, the present land use of single crop cultivated area (rainfed area) with Land capability class II can be used for intensive agriculture after taking proper soil –water conservation measures and effective agronomic practices *i.e.* land leveling, maintenance of bunds/ terracing, application of recommended doses of balanced fertilizer and organic manures, crop rotation and provision of assured irrigation facility. Similarly forest land may be used as silvipasture or afforestation after taking gully control measures like safe disposal of runoff water through grassed waterway.

Conclusion

Soil mapping using remote sensing and GIS technologies are effective in formulation of conservation strategies. The study proved that detailed soil &land resource database can be effectively used for suggesting the site specific soil and water conservation measures and comprehensive micro level developmental plans for sustainable development.

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