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Characterization and Evaluation of Land Resources for Management of Barela Village in Seoni district, Madhya Pradesh using High Resolution Satellite Data and GIS

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Abstract: The present investigation was carried out in Barela village of Seoni district, Madhya Pradesh to characterize, classify and evaluate the land resources using IRS-LISS-IV and GIS. Five major landforms namely Plateau, escarpments, mound, pediment and alluvial plain were identified and delineated. Based on image characteristics, seven land uses/ land cover classes *viz.,* (single crop, double crop, degraded forest, wasteland, river, waterbody and habitation) were identified. Five slope classes *viz.,* very gently sloping (1-3%), gently sloping (3-5%), moderately sloping (5-10%), strongly sloping (10-15%) and steeply sloping (15-25%) lands have been identified using Cartosat-1 DEM (30 m resolution) and topographic information. Five soil series (Barela-1, Barela-2, Barela-3, Barela-4 and Barela-5) were tentatively identified and mapped based on landform-soil relationship. Soils, in general, were shallow to moderately deep, moderately well to well drained with moderate to severe erosion and clayey in texture. The soils are neutral to slightly alkaline in reaction and non-saline and qualify for Lithic Ustorthents/ Typic Haplustepts/ Typic Haplusterts at subgroup level. The soils were grouped under land capability sub-classes IIs, IIIes, IVst and VIst and land irrigability sub-classes 2s, 3st and 4st. The soils of Barela-4 are moderately suitable for growing gram, soybean, maize and pigeonpea. The soils of Barela-5 are highly suitable for growing pigeonpea and moderately suitable for growing gram, soybean and maize. Soils of Barela-1, Barela-2 and Barela-3 are not suitable for growing gram, soybean, maize and pigeonpea. Various soil and water conservation measures and alternate land use options have been suggested based on land resources information generated for management of land resources in the village.

Key words: *Soil characterization, land capability, land irrigability, suitability for crops, remote sensing, GIS*

Introduction

Sustainable management of land resources is essential for food security, maintenance of environment and general well being of the people. Indiscriminate use of resources coupled with lack of management has, however, led to degradation echoing the concern of planners, researchers and farmers.. It is also essential to enhance the soil productivity to meet the future demand. The characterization and mapping of different types of soils and their interpretation attains greater importance. Soil survey provides an accurate and scientific inventory of soils, their kind and nature, and extent of distribution so that one can make prediction about their

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characteristics and potentialities. Remote sensing is a powerful tool to characterize the land resources in real time and in cost effective manner. The digitally interpreted remotely sensed image provide a wealth of information of large areas and permit lithological discrimination, identification of different landform, soils and land use/land cover patterns which help in land resource characterization and their management. Several studies have been initiated on potential use of IRS satellite data for soil mapping at different scales using remote sensing and GIS (Srivastava and Saxena 2004; Patil *et al.,* 2010; Pachpor *et al.,* 2012; Nagaraju *et al.* 2014).

The Seoni district of Madhya Pradesh is experiencing frequent erratic rainfall with continuous depletion of vegetative cover and increase in soil erosion with low crop productivity. The information on detailed characterization of soils, soil related constraints and potentials and soil fertility at village-level is lacking. Therefore, the present investigation has been planned to characterize and map the soils of Bareli village in Seoni district of Madhya Pradesh for land resources management.

Materials and Methods

Study area

The Barela village in basaltic terrain, lies between 22° 32' 47” to 22° 34' 22” N latitudes and 79° 44' 51” to 79° 46' 49”E longitudes and covers an area of 480 ha in Dhanora block, Seoni district, Madhya Pradesh (Fig. 1). Barela village was divided into five major landforms *viz.* plateau (P), escarpments (E), isolated mounds (M), pediments (D) and alluvial plain (A). The elevation of the area ranges from 503 to 564 m above mean sea level (MSL). The area is associated with very gently sloping (1-3%) to strongly sloping (15-25%) lands. The climate is mainly dry sub-tropical with mean annual temperature of 28.4°C and mean annual rainfall of 1100 mm. The area qualifies for ustic soil moisture regime and hyperthermic soil temperature regime, respectively. The natural vegetation comprises of teak (*Tectona grandis*), babul (*Acacia spp*.), palas (*Butea frandosa*), charoli (*Buchanania lanzan*), ber (*Ziziphus jujuba*) *etc.* The major crops are paddy (*Oriza sativa*), pigeonpea (*Cajanus cajan*), maize (*Zea mays*) and safflower (*Carthamus tinctorius*) in *kharif* and wheat (*Triticum aestivum*) and gram (*Cicer arietinum*) in *rabi* under irrigation or stored moisture. Mango and Guava are the main fruit crops of the area.

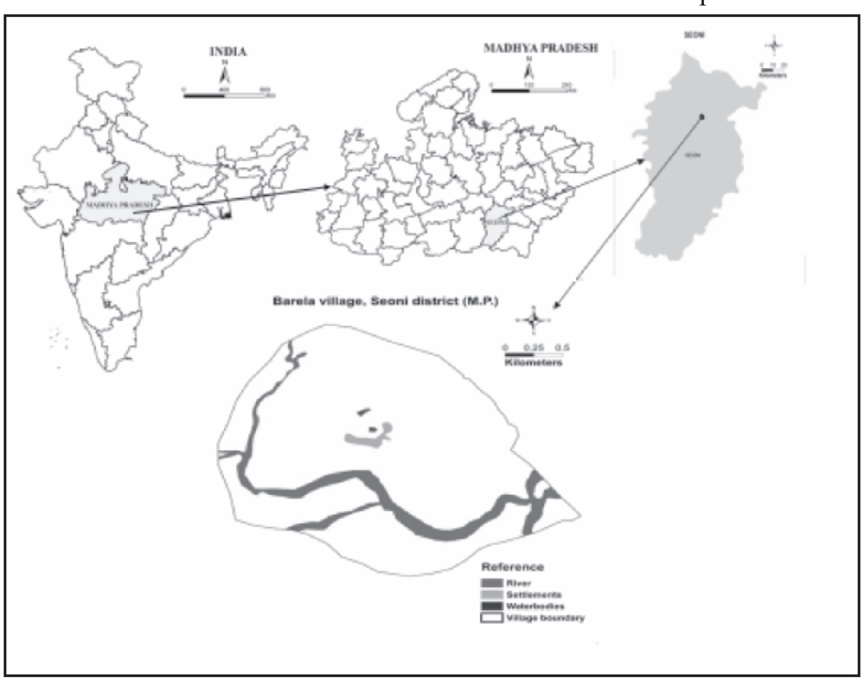

Fig. 1. Location of study area

Datasets used

Digital data of Cartosat-1 sharpened IRS-P6 LISS-IV data of (November, 2013) with a spatial resolution of 5.8 m along with LISS-III (March, 2012) with a spatial resolution of 23.5 m was used. The standard False Colour Composite (FCC) was generated with the combination of green, red and Near Infra Red (NIR) bands. Cartosat-1 Digital Elevation Model (DEM) (30 m resolution) was used for generation of slope map. Survey of India (SoI) Toposheet No. 55 N/10 and 55 N/14 (1:50000 scale) was used to collect topographic and location information. The toposheet was used to prepare base map for delineation of landforms, slope and drainage.

Methodology

The land use/ land cover map was generated by visual interpretation of geocoded satellite data based on tone, texture, pattern, shape and size. Using the interpreted maps for landforms, slope and land use/land cover maps, the area was traversed and verified. Twenty eight pedons representing different landform units were studied. Site and soil characteristics like slope, stoniness, erosion, colour, texture, structure *etc*. were recorded (Soil Survey Division Staff 2000)

Nearly 2.0 kg of representative soil sample from each horizon from representative pedons were collected for laboratory studies. Soil clods were collected from different horizons for the determination of bulk density. The analysis of physical, chemical and nutrient properties of collected samples were carried out using standard procedures (Black 1965; Jackson 1967; Lindsay and Norvell 1978). The soils were classified as per Soil Taxonomy (Soil Survey Staff 2003) and grouped into different capability sub-classes (Klingebiel and Montgomery 1961), land irrigability sub-classes (AIS&LUS 1971). The soil-site suitability analysis (NBSS&LUP 1994) was done for evaluating the suitability of different mapping units for paddy, maize, soybean, sorghum, pigeonpea and chickpea. ArcGIS software was used for generation of various spatial thematic maps.

Results and Discussion

Present land use/ land cover

Based on image characteristics, the major land use/land cover identified are cultivated land, wasteland, degraded forest, habitation and water bodies (Fig.2a). Cultivated land is again delineated into single and double crop based on temporal satellite data. The extent of area under different land utilization types indicates that cultivated land occupies 58.3 per cent of the total geographical area (TGA) of which 32.1 per cent is under single crop. The area under double crop occupies 26.2 per cent of the cultivated area, where, assured/protective irrigation is available. The degraded forest land occupies 9.5 per cent of the total geographical area (TGA). Wasteland occupies 21.4 per cent of the total geographical area and river occupies 9.6 per cent of the total geographical area (TGA). Waterbodies and habitation occupy 0.1 and 0.7 per cent area, respectively.

Slope

Five slope classes *viz.,* very gently sloping (1-3%), gently sloping (3-5%), moderately sloping (5-10%), strongly sloping (10-15%) and steeply sloping (15-25%) lands have been identified (Fig.2b). The major area is under gently sloping land (36.5% of TGA). Very gently sloping, moderately sloping, strongly sloping and steeply sloping land occupy 30.5, 13.2, 1.2 and 8.3 per cent of TGA, respectively.

Landform-soil relationship

Based on visual interpretation of Cartosat-1 merged IRS-P6 LISS-IV data along with SOI toposheet and subsequent ground truth verification, five major landform *viz.* plateau (P), escarpments (E), isolated mounds (M), pediments (D) and alluvial plain (A) were identified. These landform were further sub-divided based on slope and land use/land cover (Table 1; Fig. 2c). Five soil series (Barela-1, Barela-2, Barela-3 Barela-4 and Barela-5) were tentatively identified in different landform units and mapped as phases of soil series at 1:10000 scale (Fig.2d) after establishing landform-soil relationship (Table 2).

Table 1. Landform and their description

Map Unit No.	Landform symbol	Landform description
1	P2s	Very gently sloping plateau having bluish green and pink tone with diffuse checkerboard pattern
2	P3s	Very gently sloping plateau having bluish green and pink tone with diffuse checkerboard pattern
3	P3w	Very gently slopin g plateau having bluish -green and pink tone with medium texture
4	P4w	moderately sloping plateau having bluish -green and pink tone with medium texture
5	E5df1	Strongly sloping escarpment having bluish -green and pink tone with medium texture
6	E6df2	Moderately steep to steep sloping escarpment having bluish -green and pink tone with medium texture
7	D2s	Very gently sloping pediment having bluish green and pink tone with diffuse checkerboard pattern
8	D3s	Gently sloping pediment having bluish green and pink tone with diffuse checkerboard pattern
9	D4s	Moderately sloping pediment having greenish blue with diffuse checker board pattern
10	D2d	Very gently sloping pediment having dark red tone with bold checker board pattern
11	D3d	Gently sloping pediment having Dark red with bold checker board pattern
12	D4d	strongly sloping pediment having dark red tone with bold checker board pattern
13	D3w	Gently sloping pediment having greenish blue tone with pink patches, medium texture
14	D4w	Moderately slo ping pediment having bluish green and pink tone with diffuse checkerboard pattern
15	M3w	Gently sloping mound having medium red to light red tone with some bluish patches, medium texture
16	D5f2	Strongly sloping pediment having medium red to light red tone with some bluish patches, medium texture
17	M4w	Moderately sloping isolated mound having greenish blue tone with pink patches, medium texture
18	A2d	Very gently sloping alluvial plain having dark red with bold checker board pattern

Table 2. Landform-soil relationship

Landform	Soil Series	Soil Characteristics	Soil Taxonomy
Plateau top	Barela-1	Shallow, moderately well drained, very dark greyish brown (10YR 3/2M), clay soils underlain by hard rock with moderate erosion	Clayey, smectitic, hyperthermic Lithic Ustorthents
Escarpment	Barela-2	Moderately deep, well drained, dark greyish brown (10YR3/1), clay soils texture with severe erosion	Fine, smectitic, hyperthermic Typic Haplustepts
Pediment	Barela-3	Very shallow, well drained, dark brown (7.5YR3/2), clay loam soils with moderate erosion	Clayey, smectitic, hyperthermic Lithic Ustorthents
Pediment	Barela-4	Deep, well drained, very dark grey (10YR3/1) to brown (10YR4/3), clay soils texture with severe erosion	Fine, smectitic, hyperthermic Typic Haplusterts
Alluvial plain	Barela-5	Very deep, moderately well drained, black (10YR2/1) to very dark grayish brown (10YR3/2), clay soils with slight erosion.	Very-fine, smectitic, hyperthermic Typic Haplusterts

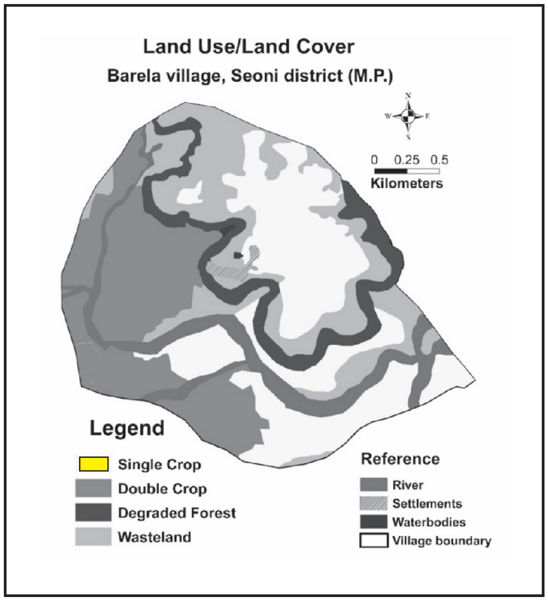

Fig. 2a land use / land cover

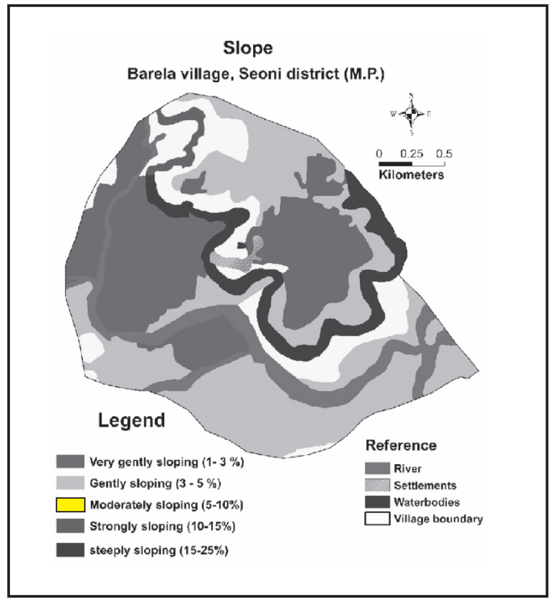

Fig. 2b slope

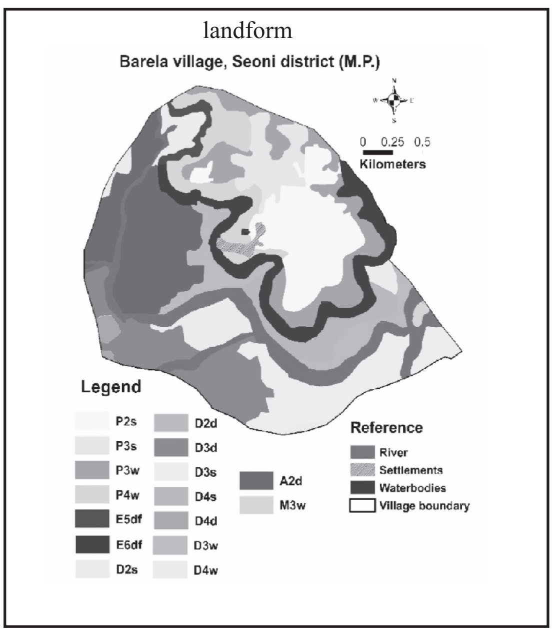

Fig. 2c Landform

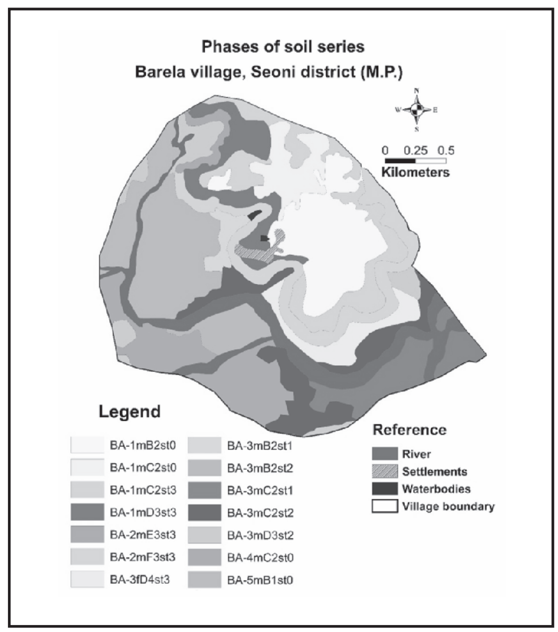

Fig. 2d Phases of soil series

Soil physical properties

The data (Table 3) indicated that the soils have higher proportion of clay compared to sand and silt. The sand, silt and clay contents in soils of plateau varied 32.1, 26.2 and 41.9 per cent, respectively and 19.4 to 23.5, 19.4 to 23.3 and 53.2 to 61.2 per cent, respectively in the soils of escarpment. The soils of pediment had sand, silt and clay content ranging from 17.1 to 39.5, 16 to 28 and 36 to 58.3 per cent, respectively.The sand, silt and clay contents in soils of alluvial plain varied from 2.1 to 13.8, 21.2 to 34 and 52.2 to 75.2 per cent, respectively. The bulk density of surface and sub-surface soils varies from 1.32 to 1.69 and 1.42 to 1.69 Mgm^{-3}, respectively. Bulk density of sub-surface horizons was higher than that of surface horizons which might be due to compaction caused by the overburden of surface layers (Ahuja *et al.* 1988) and lower bulk density in surface layer may be due to cultivation, organic matter and biotic activities (Rao *et al.* 2008).

Table 3. Physical properties of soils

Horizon	Depth (cm)	Sand 2-0.05 (mm) (%)	Silt 0.05-0.002 (mm) (%)	Clay <0.002 (mm) (%)	BD (Mgm^{-3})
Barela-1: Clayey, smectitic, hyperthermic Lithic Ustorthents					
Ap	0-15	32.1	26.0	41.9	1.37
Barela- 2: Fine, smectitic, hyperthermic Typic Haplustepts					
A	0-17	19.4	19.4	61.2	1.34
Bw1	17-34	20.5	22.2	57.3	1.46
Bw2	34-51	23.5	23.3	53.2	1.57
Barela-3: Clayey, smectitic, hyperthermic Lithic Ustorthents					
Ap	0-10	36.0	28.0	36.0	1.39
Barela-4: Fine, smectitic, hyperthermic Typic Haplusterts					
AP	0-18	30.3	27.4	42.3	1.34
Bw	18-38	17.1	24.6	58.3	1.42
Bss1	38-55	21.9	27.3	50.8	1.48
Bss2	55-75	26.1	22.0	51.9	1.56
Bss3	75-101	39.5	16.0	44.5	1.63
Barela-5: Very -fine, smectitic, hyperthermic Typic Haplusterts					
AP	0-18	4.4	24.4	71.2	1.32
Bw	18-42	3.6	21.2	75.2	1.46
Bss1	42-76	3.0	22.0	75.0	1.55
Bss2	76-102	2.1	23.0	74.9	1.61
Bss3	102-132	3.0	22.0	75.0	1.65
2Bss4	132-150	13.8	34.0	52.2	1.69

Chemical properties

Soils of the village are neutral to alkaline with pH values ranging from 6.5 to 7.9. The organic carbon content in soils ranged from 0.17 to 1.92 per cent in different horizons (Table 4). In general, the organic carbon content decreased gradually with depth, mainly due to the accumulation of plant residues on the soil surface. The calcium carbonate content varied from 1.45 to 5.3 per cent through depth. The exchangeable calcium content of the soils ranged from 20 to 34.5 cmol $(p^+)kg^{-1}$ soil being higher in soils of Barela-4 and Barela-5. Exchangeable magnesium content of the surface soils ranged from 16.8 to 21.5 cmol$(p^+)kg^{-1}$ soil. Exchangeable sodium ranged from 0.57 to 0.58 cmol (p)kg^{-1} soil. Exchangeable potassium ranged from 0.15 to 0.21 cmol (p^+) kg^{-1} soil. The exchangeable cations were found in the order of $Ca^{2+}>Mg^{2+}>Na^{+}>K^{+}$ indicating the presence of calcium bearing minerals in parent rocks. Similar result was reported by Sarkar *et al.* (2001). Cation exchange capacity (CEC) of surface soils ranged from 39.1 to 62.6 cmol (p^+) kg^{-1} soil.

Soil fertility

The available nitrogen content of the surface soils ranged from 107 to 390 kg ha^{-1} and it was low in soils of Barela-1, Barela-2 and Barela-3 (Table 4). The available phosphorus in the surface soils varied from 7.9 to 34.3 kg ha^{-1} being low in soils of Barela-1, moderately high in soils of Barela-2 and Barela-5 and high in soils of Barela-3 and Barela-4. Available potassium content in the surface soils varied from 342.4 kg ha^{-1} to 492.8 kg ha^{-1}. DTPA- Fe ranged from 11.1 to 33.6 mg kg^{-1} (Table 4) which is above the critical value of 4.5 mg kg^{-1} (Lindsay and Norvell 1978). The DTPA-Mn ranged from 10.1 to 43.1 mg kg^{-1} and was above the critical limit 3.0 mg kg^{-1} (Takkar *et al*. 1989). DTPA-Cu varied from 2.3 to 6.4 mg kg^{-1} and higher than the critical value of 0.2 mg kg^{-1} (Katyal and Randhawa 1983). The DTPA–Zn ranged from 0.15 to 0.59 mg kg^{-1} and was below the critical level of 0.6 mgkg^{-1} as suggested by Katyal and Randhawa (1983).

Table 4. Chemical properties of soils of Barela Village

Horizon	Depth (cm)	pH (1:2.5)	EC (dS m^{-1})	O.C (%)	$CaCO_3$ (%)	Exchangeable cations				Sum of cations	CEC	Available nutrients						
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}			N	P	K	Fe	Mn	Cu	Zn
						(cmol (p+) kg^{-1})						(kg ha^{-1})			(mg kg^{-1})			
Barela-1: Clayey, smectitic, hyperthermic Lithic Ustorthents																		
Ap	0-15	7.4	0.17	1.90	2.1	20.0	12.5	0.13	0.02	32.7	39.1	183	7.9	492.8	22.2	27.0	5.4	0.58
Barela-2: Fine, smectitic, hyperthermic Typic Haplustepts																		
A	0-17	6.5	0.08	1.92	2.2	25.4	21.0	0.20	0.01	46.6	49.5	156	26.8	342.4	28.6	43.1	6.4	0.54
Bw1	17-34	6.5	0.08	1.48	4.7	23.2	20.0	0.17	0.02	44.4	47.6	132	16.1	291.6	27.4	32.5	5.1	0.44
Bw2	34-51	6.7	0.07	1.42	5.3	21.7	18.3	0.14	0.02	40.2	45.1	107	11.3	223.4	23.8	27.5	3.2	0.27
Barela-3: Clayey, smectitic, hyperthermic Lithic Ustorthents																		
Ap	0-10	6.9	0.09	0.93	4.1	20.1	15.2	0.16	0.04	35.5	39.1	151	30.0	369.6	33.6	37.6	3.5	0.43
Barela-4: Fine, smectitic, hyperthermic Typic Haplusterts																		
Ap	0-18	7.6	0.20	0.64	2.2	25.1	16.8	0.57	0.15	42.6	45.2	390	34.3	368.8	19.4	31.1	4.5	0.39
Bw	18-38	7.7	0.17	0.61	2.8	31.1	19.7	0.46	0.18	51.4	53.4	350	26.4	346.4	18.7	28.5	4.2	0.31
Bss1	38-55	7.9	0.26	0.59	3.3	29.9	18.1	0.35	0.19	48.5	50.3	315	22.7	276.4	16.6	24.2	3.0	0.27
Bss2	55-75	7.3	0.23	0.47	5.2	30.2	18.8	0.39	0.16	49.6	51.4	270	17.7	223.1	15.4	21.5	2.7	0.21
Bss3	75-101	7.7	0.19	0.26	6.5	27.5	16.3	0.45	0.14	44.4	47.7	125	10.5	196.5	13.2	19.8	2.4	0.15
Barela-5: Very -fine, smectitic, hyperthermic Typic Hap lusterts																		
Ap	0-18	6.5	0.10	0.72	1.45	31.5	21.5	0.58	0.21	53.8	57.4	384	23.3	362.8	29.7	34.1	4.7	0.59
Bw	18-42	7.8	0.07	0.62	2.20	34.5	22.3	0.47	0.15	57.4	62.6	362	21.5	340.6	25.9	29.5	4.3	0.52
Bss1	42-76	6.7	0.07	0.47	2.69	33.3	21.5	0.37	0.22	55.4	61.7	333	16.8	295.7	21.4	27.2	3.6	0.40
Bss2	76-102	7.5	0.14	0.32	3.48	32.6	22.7	0.32	0.25	55.9	59.3	274	14.8	272.9	18.5	19.8	3.1	0.31
Bss3	102-132	7.6	0.20	0.30	3.65	34.4	19.6	0.34	0.26	54.6	61.7	218	11.8	220.5	14.6	12.8	2.8	0.27
2Bss4	132-150	7.6	0.08	0.17	4.25	27.5	15.4	0.38	0.26	43.5	48.8	125	8.2	152.7	11.1	10.1	2.3	0.18

Land capability, land irrigability and soil suitability for crops

Based on the criteria of land capability groupings, four land capability sub-classes *viz.* IIs (14.5 % of TGA), IIIes (9.7 % of TGA), IVst (55.9 % of TGA) and VIst (9.5 % of TGA) have been identified (Table 5; Fig. 3a). The soils of Barela-1, and Barel-3 are fairly good cultivable lands (IVst) with severe limitations of soil depth, slope and erosion. The soils of Barela-2 (VIst) are non-arable lands mainly under degraded forest with strong and steeply sloping lands with severe limitation of soil depth, slope and erosion. The soils of Barela-4 (IIIes) are moderately good cultivable lands with moderate limitations due to soil depth, slope and erosion. The soils of Barela-5 (IIs) are good cultivable lands with high smectitic clay posing drainage problem

Land irrigabilty evaluation indicated that soils of Barela-1, Barela-2, and Barela-3 have very severe limitations of soil depth and texture and hence grouped under land irrigability sub-class 4st. The soils of Barela-4 are grouped under 3st with severe limitations of slope, surface texture. The soils of Barela-5 are grouped under 2s with moderate limitations of soil texture and soil drainage (Table 5; Fig. 3b).

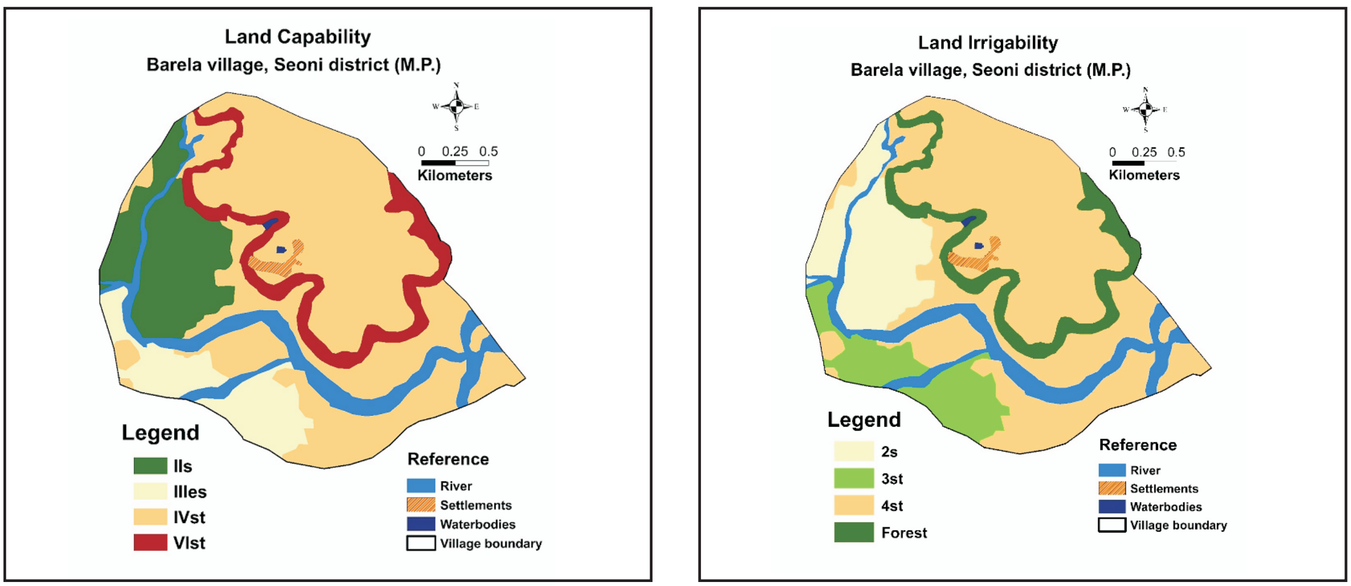

Fig. 3. Land capability (a), land irrigability (b) classification

The suitability evaluation for gram, soybean, maize and pegionpea (Table 5; Fig. 4) indicated that the soils of Barela-5 were highly suitable for growing pigeonpea and moderately suitable for gram, soybean and maize. The soils of Barela-4 are moderately suitable for gram, soybean, maize and pigeonpea. The soils of Barela-1, Barela-2 and Barela-3 are not suitable for these crops.

Table 5. Land capability, land irigability and suitability of soils for different crops

Soils	Land capability	Land irrigability	Gram	Soybean	Maize	Pigeonpea
Barela-1	IVst	4st	N1	N1	N1	N1
Barela-2	VIst	4st	N1	N1	N1	N1
Barela-3	IVst	4st	N1	N1	N1	N1
Barela-4	IIIes	3st	S2	S2	S2	S2
Barela-5	IIs	2s	S2	S2	S2	S1

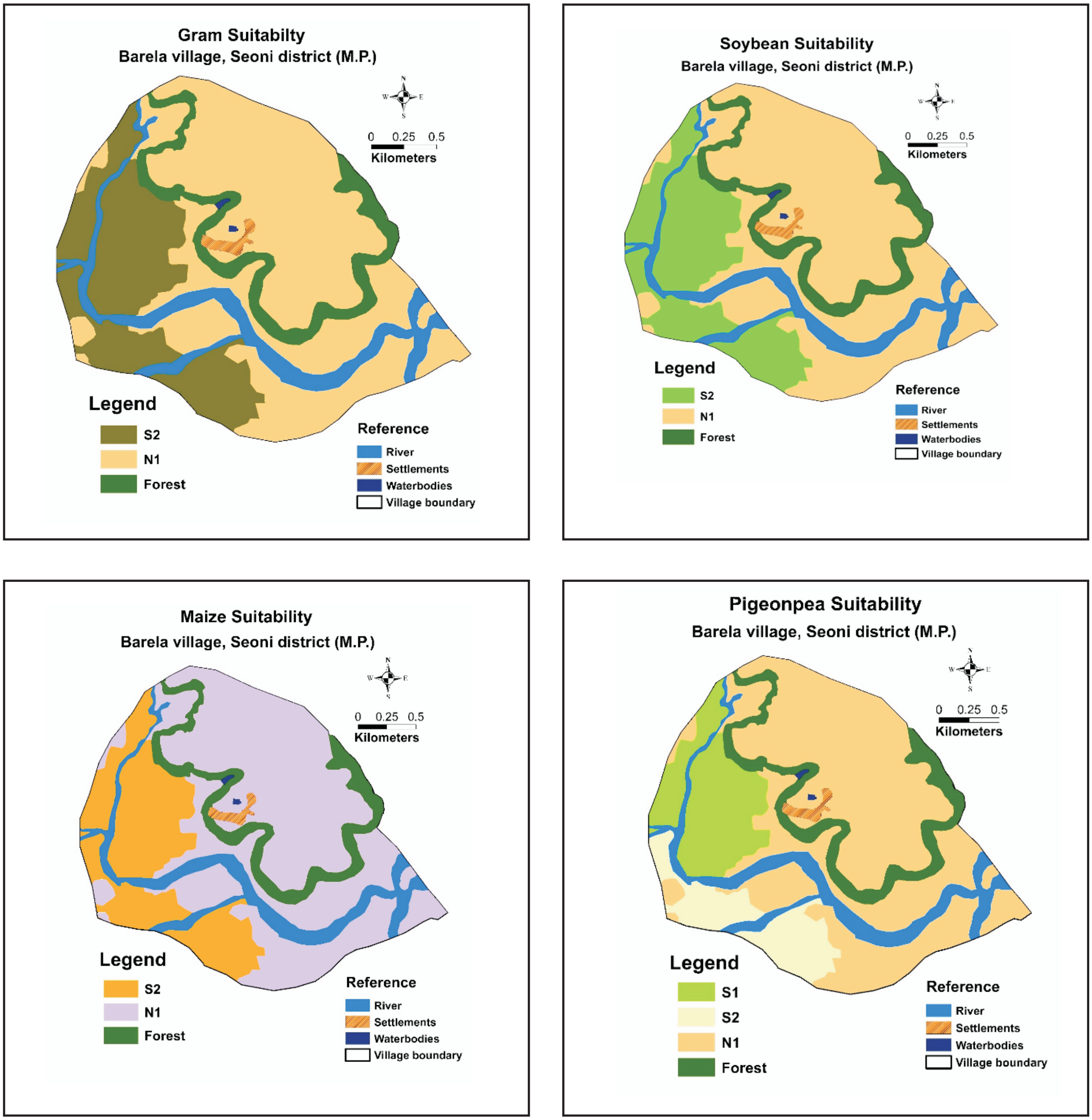

Fig. 4. Suitability of soils for a) gram b) soybean c) maize d) pigeonpea cultivation

Land resources management

The integration of landform, soil, present land use and slope maps under GIS environment has brought out the thirteen composite land units which lead to identify the areas for resource development and conservation. The suggested land use plan with suitable interventions includes agri-horticulture, agro-forestry, silvipasture and intensive cultivation.

The plateau with very shallow soils under single crop (Barela-1) has fairly good cultivated lands with severe limitations due to soil depth, slope and erosion. The soils also have very severe limitations of soil depth and texture for sustained use under irrigation. The soils of Barela-1 are low in available N and available P and very high in available K. The soils are poor in soil productivity and severely eroded without any soil and water conservation measures. To improve the productivity in cultivated land units under single crop and wasteland, agri-horticulture with goosebery, guava, custard apple and drum stick may be adopted under integrated nutrient management and suitable soil and water conservation measures like contour bunding, gully plugging and water harvesting structures.

The escarpments having moderately deep soils (Barela-2) is under degraded forest and occur on strongly (10-15%) and steeply sloping (15-25%) lands with severe erosion with poor soil productivity. The area is suggested for afforestation and agroforestry with suitable tree species like gooseberry, guava, and custard apple to improve the productivity of these land units. Staggered contour trenches needs to be taken up to reduce the run-off and soil loss.

The very shallow and deep soils (Barela-3, Barela-4) associated with pediments are under single and double crop. The mapping units with shallow soils have fairly good cultivated lands with severe limitations due to soil depth, slope and erosion and also possess very severe limitations of soil depth and texture for sustained use under irrigation. The soils of Barela-3 are low in available N, high in available P, very high in available K and deficient in available Zn. The mapping units with soils of Barela-4 are low in available N, high in available P, very high in available K and deficient in available Zn. The soils are moderately eroded due to lack of soil and water conservation measures. The soils of Barela-4 are moderately suitable of maize, pigeonpea, gram and soybean. Proper field bunding, gully plugging and contour bunding is needed to conserve soil and water. Agri-horticulture interventions like goose berry, guava, custard apple and drum stick and silvipasture systems with multi-purpose trees under integrated nutrient management needs be taken up in these land units to improve the productivity.

The very deep soils of alluvial plain (Barela-5) have moderate limitations for sustained use under irrigation. The soils are medium in available N, moderately high in available P, very high in available K and deficient in DTPA- Zn. The productivity of these soils may be improved by adopting integrated nutrient management and agronomic measures such as crop rotation with legumes, mixed cropping and vegetable cultivation.

Conclusions

Five major landform units *viz.* plateau top, escarpment, isolated mound, pediment and alluvial plain and five major land use/land cover *viz*. cultivated land, wasteland, degraded forest, habitation and water bodies were identified using high-resolution satellite data. Five slope classes namely very gently sloping (1-3%), gently sloping (3-5%), moderately sloping (5-10%), strongly sloping (10-15%) and moderately step to steep sloping (15-25%) lands have been identified. Five soil series (Barela-1, Barela-2, Barela-3, Barela-4 and Barela-5) were tentatively identified and mapped as soil series at 1:10000 scales. Soils are shallow to very deep (shrink-swell soils) and have clay to clay loam texture. The soils are moderately well drained to well drain with moderate to severe erosion. The village has well to fairly good cultivable lands and minor to moderate limitations for sustained use under irrigation. The soil-site suitability evaluation indicated that soils are highly suitable to not suitable for growing pigeonpea, maize, gram and soybean with various interventions and soil and water conservation measures have been suggested to for better management of land resources in Barela village of Seoni district Madhya Pradesh.

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