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Characterization and Evaluation of Soils of Singanallur Watershed Using Remote Sensing and GIS

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Abstract

Watershed is an ideal unit calling for multidisciplinary approach to the resources management for ensuring continuous benefit on sustainable basis. Land Resource mapping plays a vital role in resource management. A detailed soil survey is planned for the Singanallur micro watershed, Kollegal taluk, Chamaraj nagar district, Karnataka by using cadastral map overlaid on Cartosat-1(ortho corrected)+LISS IV image as a base to characterize and classify the land resources. Based on elevation and slope, three physiographic units were identified namely gently sloping lands (3–5%) very gently sloping lands (1–3%) and nearly level lands (0–1%). Soil profile study was carried out to identify the problems and potentials of the land resources. Based on morphological and physiochemical properties, six soil series were identified and the study area was delineated into 25 management units. Taxonomically, these soil series were grouped under Alfisols (*Typic Rhodoustalfs and Rhodic Paleustalfs*) and Inceptisols (*Typic Haplustepts*). The site evaluation of the soils showed that nearly 50% of the watershed area is highly suitable for ragi, maize, onion, turmeric and banana. More than 70% area is moderately to marginally suitable for red gram and groundnut due texture limitation. Different land use options and suitable interventions were suggested based on the potentials and limitations of the watershed area. This baseline data helps to monitor the different development programmes for enhancing the agricultural production.

Keywords: SHGs, market-led extension, marketing pattern, empowerment

1. Introduction

Soil resource information plays a key role in the management of natural resources and specifically in the agriculture sector. Indiscriminate use of resource coupled with lack of management has, however, led to degradation echoing the concern of planners, researchers and farmers alike (Sharma, 2006). Management of soil resources on scientific principle is essential to maintain the present level of soil productivity and to prevent soil degradation. Soil productivity is a function of the intrinsic properties of soil and thus influenced by countless characteristics. Unless we know the soils resources distribution and their dynamic situation, it is very difficult to practice scientific agriculture. All our recommendations in agricultural productions should be soil oriented, because any proven finding in agricultural improvement is applicable to such of those soils having similar characters where in experimentation was affected. For that we need to have farm level land resource data base which is the one help in evolving a rational, site-specific and viable land use options suitable for each and every farm. To achieve this, we need a detailed site-specific farm level database on various land resources for all the villages in a time bound manner. It will help to protect the valuable soil resources and also to stabilize the food production. Studies have been conducted by various workers about the utility of remote sensing in characterization of soil resources (Shukla et al., 2009; Indale et al., 2013). In a part of Basaltic terrain of Vidharbha region, Nagaraju et al. (2014) have generated a detailed soil map through the Physiography -soil relationship for preparation of action plan using Cartosat-1 merged IRS LISS IV data. To evaluate land suitability for various land use options there is a need of Detailed site-specific land resources inventory by identifying the inherent potentials and constraints of area. (Wani et al., 2002; Ghorbani and Kakeh Mami, 2013). Lalitha et al. (2016) suggested suitable scientific conservation measures based on problems and potentials and socio economic issues for better management of watershed in Muttala watershed Anantapur district. The present study aims to provide site specific database for the Singanallur watershed, Kollegal taluk, Chamrajnagar district of Karnataka, India. The land resource database was generated by using cadastral map of the watershed as base along with cartosat-1 imagery. The major objectives of the study is detailed Land Resources Inventory for Singanallur microwatershed for scientific integrated watershed planning.

2. Materials and Methods

2.1. Location and Extent

Singanallur micro watershed is located in Kollegal Taluk and Chamarajanagar District of Karnataka, India. (Figure 1). Detailed soil survey has been carried out in Singanallur micro watershed in the year 2015 having total area of 631 ha lies between 77°11′56.71′′–77°15′55.70′′East longitudes and 12°07′54.47′′–12°08′55.41′′ N latitudes. It is located 13 km east of Kollegal. The micro watershed is surrounded by village Singanallur on the north, Kongarahalli village on the south, village Doddainduvadi on the west and Bhoodhabalu village on the east.

2.2. Climate

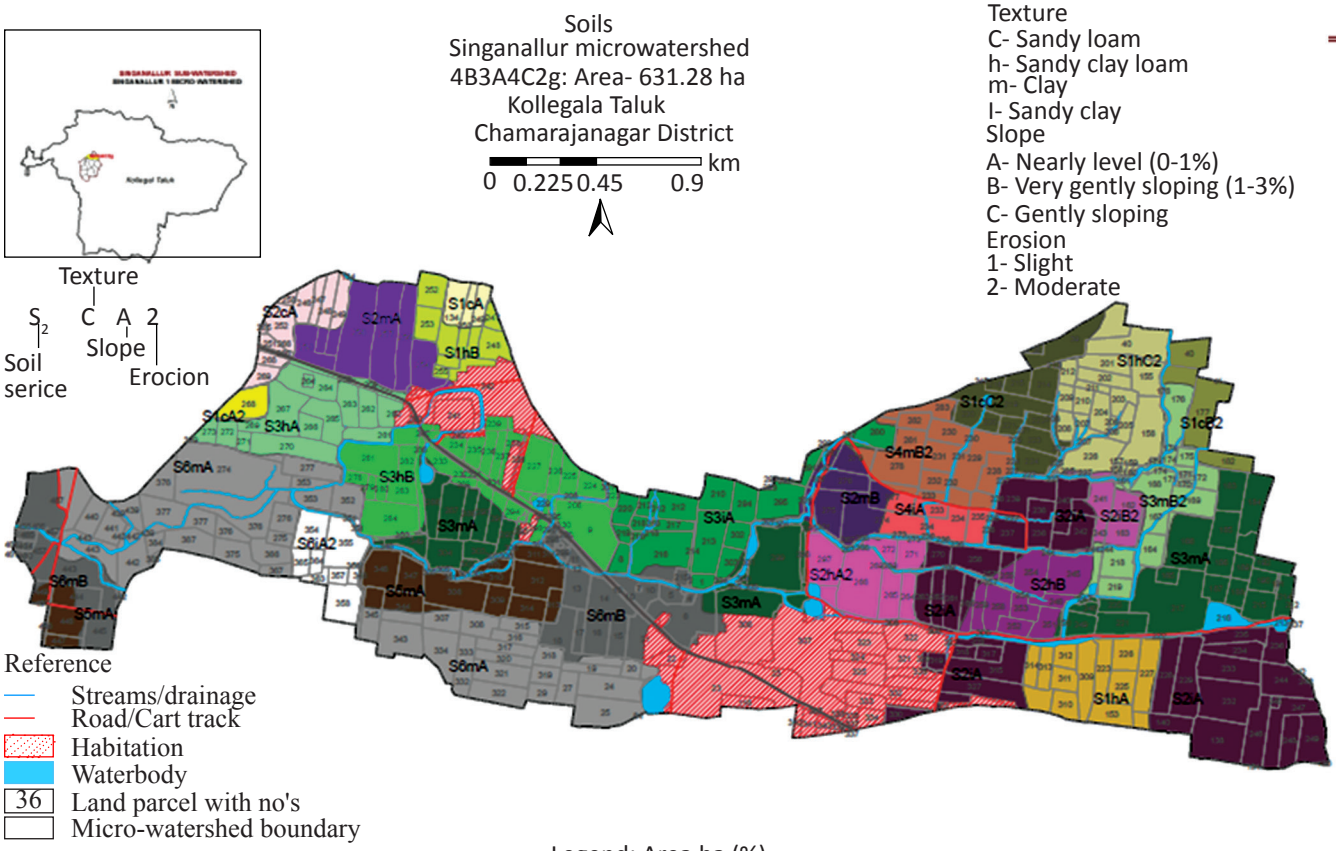
The climate of the study area is tropical monsoon type, with the mean maximum temperature in the district is 28.4 °C and the mean minimum temperature is 22.4 °C. mean annual air temperature of 24 °C and mean annual rainfall of 801.4 mm (1980–2011), growing period commence from last week of May and continues up to end of October. The availability of moisture is a limiting factor for crop production, which in turn is determined by climate and soil type. Major Geological formation observed in this micro-watershed is granite gneiss.

2.3. Base map and image interpretation

Remote sensing data products from Cartosat-1(ortho corrected) at the same scale shall be used in conjunction with the cadastral maps to identify the landforms and other surface features. Imageries helped in the identification and delineation of boundaries between hills, uplands and lowlands, water bodies, forest and vegetated areas, roads, habitations and other cultural features of the area. Visual interpretation of FCC imagery of IRS-IC LISS IV+Cartosat-1 (ortho corrected) merged data on 1:8000 scale was carried out to identify the physiographic units in the watershed.

2.4. Soil mapping

Rapid traversing of the entire watershed area was undertaken in order to check the physiographic units. Correction of physiographic units was done wherever necessary. Transects were delineated in such a way that each transect should



Legend: Area ha (%)

S_1cA	3.32 (0.53)	S_1hB	9.15 (1.45)	S_2IA	67.76 (10.74)	S_3hB	36.15 (5.73)	S_4mB_2	19.36 (3.07)
S_1cA_2	2.52. (0.4)	S_1hC_2	25.58 (4.05)	S_2IB2	5.78 (0.92)	S_3IA	26.2 (4.15)	S_5mA^2	24.24 (3.84)
S_1cB_2	8.04 (1.27)	S_2cA	9.3 (1.47)	S_2mA	18.3 (2.9)	S_3mA	60.3 (9.55)	S_5IA_2	10.91 (1.73)
S_1cC_2	16.5 (2.61)	S_2hA_2	15.06 (2.39)	S_2mB	10.69 (1.69)	S_3mB_2	18.31 (2.9)	S_6mA	78.88 (12.5)
S_1hA	18.64 (2.95)	S_2hB	14.93 (2.37)	S_3hA	20.89 (3.31)	S_4IA	7.31 (1.16)	S_6mB	36.67 (5.81)
								Others	66.38 (10.51)

Figure 1: Distribution of soil phases or management units in Singanallur watershed, Kollegal Taluk

cut across three physiographic unit. In each physiographic unit, profiles were studied to establish relationship between physiography and soils depending on slope element or length of slope (Table 1). Based on the soil characteristics, six soil series were identified and mapped with their bases (AIS and LUS, 1971). Soil samples collected from typifying pedons were

Table 1: Morphological characteristics of soils of singanallur microwatershed

Pedon no. & horizons	Depth (cm)	colour	Texture	Structure			consistency				effevescences
				s	g	T					
Singanallur-1-Fine-skeletal, isohyperthermic Rhodic Haplustalfs											
Ap	0–16	7.5YR 4/4	scl	m	2	Sbk	sh	fr	ss	sp	-
Bt1	16–40	2.5YR3/6	sc	m	2	Sbk	sh	fr	ss	sp	-
Bt2	40–60	2.5YR3/6	sc	m	2	sbk	sh	fr	ss	sp	-
Singanallur -2 Fine, , isohyperthermic kandic Paleustalfs											
Ap	0–12	2.5YR3/6	scl	C	2	sbk	H	fr	vs	vp	-
Bt1	12–30	2.5YR3/6	sc	C	2	sbk	H	fr	vs	vp	-
Bt2	30–54	2.5YR3/6	c	C	2	sbk	H	fr	vs	vp	-
Bt3	54–80	2.5YR3/4	sc	C	2	sbk	H	fr	vs	vp	-
Bt4	80–107	2.5YR4/6	sc	c	2	sbk	H	fr	vs	vp	-
Bt5	107–135	2.5YR5/6	sc								
Singanallur -3 Fine, mixed, isohyperthermic Rhodic Paleustalfs											
Ap	0–20	5YR4/4	cl	m	2	sbk	sh	fr	ms	mp	-
Bt1	20–49	2.5YR3/4	c	m	2	sbk	sh	fr	ms	mp	-
Bt2	49–91	2.5YR3/4	c	m	2	sbk	sh	fr	ms	mp	-
Bt3	91–136	2.5YR3/4	c	m	2	sbk	sh	fr	ms	mp	-
Bt4	136–172	2.5YR3/4	sc	m	2	sbk	sh	fr	ms	mp	-
Singanallur -4 Fine, mixed, isohyperthermic ultic/typic/Paleustalfs											
Ap	0–20	5YR3/3	c								
Bw1	20–56	5YR3/3	c	m	2	sbk	sh	fr	ms	mp	-
Bw2	56–93	5YR43/3	c	m	2	sbk	sh	fr	ms	mp	-
Bw3	93–140	5YR3/4	cl	m	2	sbk	sh	fr	ms	mp	-
Bw4	140–178	5YR3/2	c	m	2	sbk	sh	fr	ms	mp	-
Singanallur -5 Fine, mixed, isohyperthermic Typic Haplustepts											
Ap	0–16	5YR4/4	c	m	2	sbk	sh	fr		mp	-
Bw1	16–49	5YR3/4	c	m	2	sbk	sh	fr		mp	-
Bw2	49–88	10YR4/2	c	m	2	sbk	sh	fr		mp	-
Bw3	88–117	10YR3/2	c	m	2	sbk	sh	fr		mp	-
Bw4	117–148	10YR3/2	c								
Bw5	148–117	10YR3/2	c								
Singanallur -6 Fine, mixed, calcareous, isohyperthermic Typic Haplustepts											
Ap	0–17	10YR 4/2	c	m	1	sbk	sh	fi		po	-
Bw1	17–153	10YR 3/2	c	m	2	sbk	sh	fr		mp	VS
Bw2	53-85	10YR3/2	c	m	2	sbk	sh	fr		mp	VS
Bw3	85–120	10YR 4/4	c	m	2	sbk	sh	fr		mp	VS
Bw4	120–159	10YR 4/4	c	m	2	sbk	sh	fr		mp	VS

analysed for physical and chemical properties as per standard procedure (Klute, 1986). The soils were classified as per USDA Soil Taxonomy (Soil Survey Staff, 2010).

2.5. Land suitability evaluation

The land suitability for growing different field crops was evaluated by matching the crop requirement s with soil–site characteristics of watershed (Naidu et al., 2006). The soils were grouped into S_1 (highly suitable), S_2 (moderately suitable), S_3 (marginally suitable) N1-Currently not suitable and N2-Permanently not Suitable as per FAO guideline (FAO 1976) considering the soil-site limitations (Table 2).

Table 2: suitability of different soil series of Singanallur watershed for different crops

series	R	G	T	O	T	B	S
Singanallur -1	S_2rg	S_2rg	S_2rg	S_2rg	S_2rg	S_3rg	S_3rg
Singanallur -2	S_1	S_2t	S_1	S_1	S_1	S_1	S_1
Singanallur -3	S_1	S_2t	S_1	S_1	S_1	S_1	S_1
Singanallur -4	S_1	S_2t	S_1	S_1	S_1	S_1	S_1
Singanallur -5	S_2tn	S_3t	S3n	S_3n	S2t	S_1	S_1
Singanallur -6	S_2t	S_3t	S_3n	S_3n	S_2t	S_1	S_1

R: Ragi; G: Ground nut; T: Turmeric; O: Onion; T: Tomato; B: Banana; S: Sugarcane

3. Results and Discussion

3.1. Soils of gently sloping lands

The soils are moderately shallow, somewhat excessively drained to well drained, non-calcareous with gravelly sandy clay and gravelly clayey texture. The gravel content is high and ranges from 35 to 75%. This soil occurs in the northern part of watershed. The thickness of A horizon varies from 10 to 19 cm. Its colour is in 7.5YR, and 2.5YR hues with value 3 to 5 and chroma 4 to 6. The surface soils are light textured and vary from sandy loam to sandy clay loam with 5 to 15% gravel. The thickness of B horizon ranges from 10 to 83 cm. Its colour is 2.5YR, hues with value 3 to 4 and chroma 3 to 6. Its texture is sandy clay to clay with 15 to 75% gravel. The medium sub-angular blocky structure. Soil erosion is slight to sever, which is the major constraint. The indiscriminate cutting of trees accelerates the detachment and removal of the soil cover from uplands. The contour bounding and check dams were recommended to conserve the soil and water. Soils are taxonomically classified Fine, skeletal kandic, isohyperthermic family of *Rhodic Paleustalfs*.

3.2. Soils of very gently sloping lands

This physiography unit is situated in the east and western part of the watershed. Deep to very deep in depth texture varies from sandy clay loam to clay pH is slightly acidic to neutral. Its colour is in 7.5YR, and 2.5YR hues with value 3 to 5 and chroma 4 to 6. Nearly 40% of the area is fallow due to scarcity of water in this area. These soils are highly suitable for field and horticultural crops. Horticultural crops such as mango pomegranate tamarind custard apple citrus fruits crops are recommended based on soil, climate and rainfall distribution. Soils are taxonomically classified Fine, mixed, isohyperthermic family of *Typic Rhodoustalfs* and *Typic Paleustalfs.*

3.3. Soils of nearly level lands

This physiography unit is situated in the southern part of the watershed. These soils formed over granite-gneiss parent material by the action of water and gravity with an elevation of 668 m above MSL (Mean Sea Level). These soils are very deep (>150) slightly alkaline to strongly alkaline pH (7.5 to 8.5). Dark reddish brown (5YR3/4) dark yellowish brown (10YR4/4) with clay texture. These soils are cultivated to banana and vegetable crops (tomato, onion, turmeric and cabbage). Soils are taxonomically classified Fine mixed calcareous isohyperthermic *Typic Haplustepts*.

3.4. Land suitability evaluation

Six series were identified in the watershed were evaluated for their suitability for growing field and horticultural crops of the regions. Soils of Singanallur-3 and Singanallur-4 were highly suitable for growing all most all crops like ragi, maize, redgram, banana, onion turmeric and moderately suitable for growing ground nut due to the limitation of texture. Soils of gently sloping lands are moderately to marginally suitable for these crops due limitation of depth and gravelliness. Nearly level soils are moderately suitable for ragi and maize, ground nut, onion, turmeric due nutrient availability (Figure 2&3).

In the whole study area, about 297 ha (47%) is highly suitable for maize and ragi. about 41% areas is moderately suitable for maize due to main limitations are calcareous soils, rooting depth, texture and gravelliness in moderately suitable areas. (Figure 2). The suitability assessment for groundnut in the Singanallur showed that nearly 47% area is moderately suitable. The main constraints are eroded soils, texture and gravelliness in moderately suitable areas. The non parametric approach revealed Soil A is non-suitable for all the three crops due to shallow depth. Soil B, C&D are also non suitable for mango due to depth constraint (Whiley, 1984). Soil E, F and G are moderately suitable for groundnut and pigeon-pea because of low organic carbon and heavy soil texture (Gajendragiri, 2002). In 42% of the areas groundnut is marginally suitable. Soils in nearly 52% area of the watershed highly suitable for the Onion and turmeric termeric (Table 1) and Nearly 76% of the area is highly suitable for banana and sugar cane cultivation in singanallur micro watershed due 60 cm deep soil and having good internal drainage.

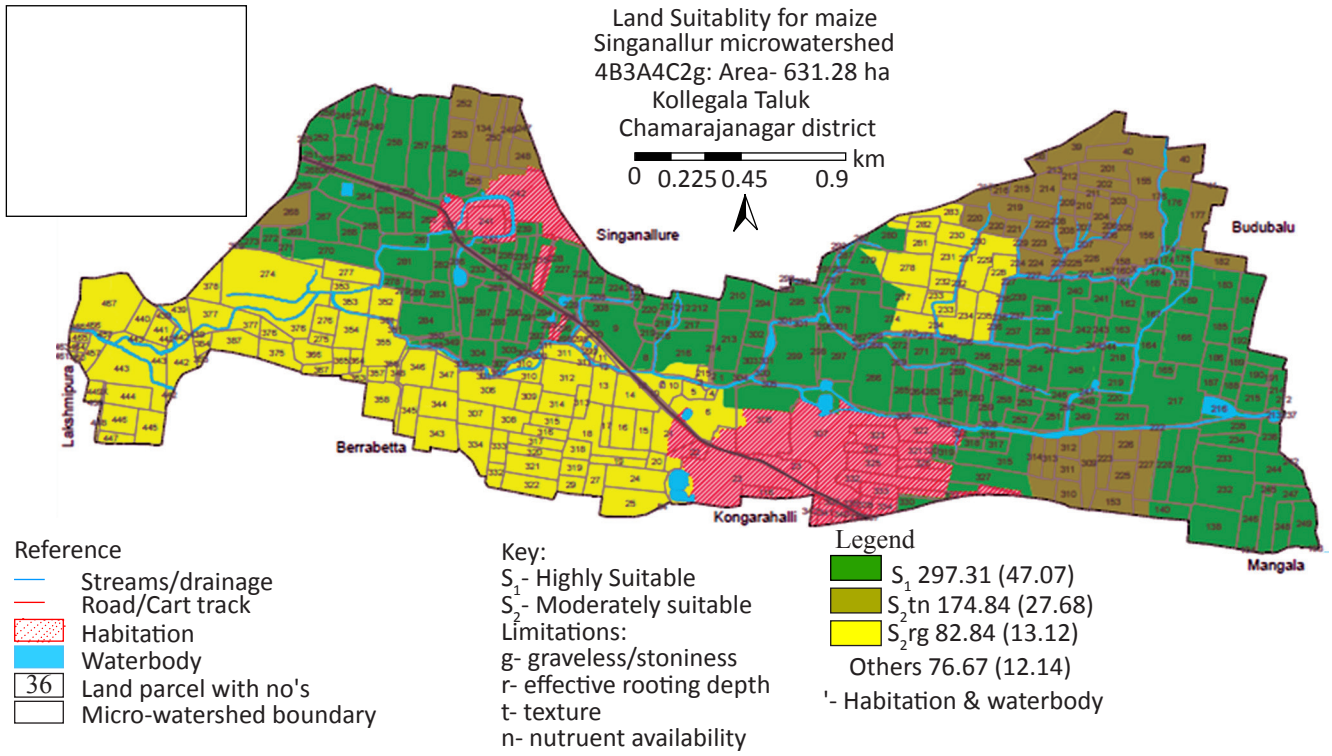


Figure 2: Land suitability map for maize

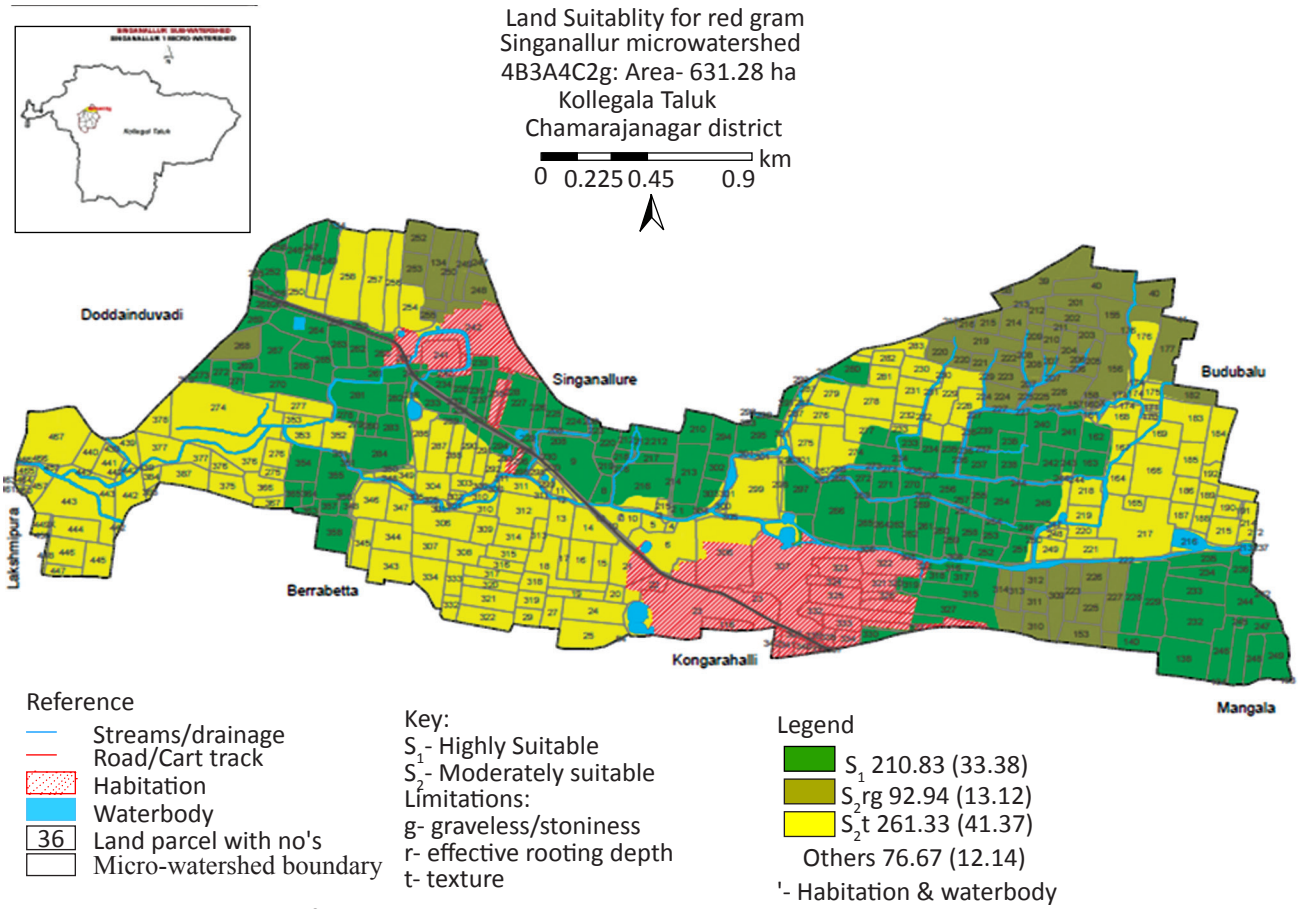


Figure 3: Land suitability map for Redgram

4. Conclusion

Characterization of soils of Singanallur micro-watershed reveals that the soils were granite-gneiss parent material by colluvium-alluvial origin. Contour bunding and check bunds are necessary for soil conservation. Gently sloping lands are deep to very deep be suitable for horticultural crops with minimum irrigation contour bunding are required in moderate erosion areas. Study area is highly suitable for maize, ragi, onion turmeric banana and sugarcane crops due to soils having good internal drainage depth and texture, and Soils of nearly level lands has 20% area have calcareousness not suitable for citrus crops.

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