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Land evaluation of malli-1 microwatershed for its suitability and sustainable crop plan using geospatial technologies

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Abstract
A study was undertaken to evaluate seven soil series belonging to Malli-1 micro watershed of Yedrami taluka, Kalaburagi district in North Eastern Dry Zone of Karnataka for sustainable land use planning. Seven soil series were tentatively identified and mapped into eight mapping units using GIS technique. Weighted mean of each soil property was calculated and soil-site characteristics of different soil mapping units were obtained. These soil-site characteristics data used to evaluate the land capability classification and soil-site suitability. Eight mapping units were grouped into land capability class III, IV and VI with limitations of erosion, texture and physico-chemical properties. Generally, Margutti (P-1) & (P-2) series were moderately (S2) suitable for sorghum, marginally (S3) suitable for greengram and currently not suitable (N1) for all other crops. Bhimanahalli and Gutti series of the study area was moderately (S2) and marginally suitable (S3) for pulses and cereals crops and currently not suitable (N1) for all other horticultural crops. Novinihala series was moderately (S2) and marginally suitable (S3) for pulses and cereals crops except bengalgram and currently not suitable (N1) for all horticultural crops. Rajhnal, Mahagoan and Gutti series were moderately (S2) suitable for greengram and sorghum, marginally (S3) suitable for pigeonpea, bengalgram, guava, sapota and currently not suitable (N1) for mango.

Keywords: Soil Series, mapping unit, Soil-site characteristics, Land capability classification

Introduction
The demand for the sustainable management of soil resources is essential for food security, maintenance of environment and general well being of the people. Indiscriminate use of soil resources coupled with lack of management practices however, led to degradation echoing the concern of planners, researchers and farmers alike. It is essential to enhance the soil productivity to meet the future demand. Information on soil and related properties is obtained from soil resource inventory through characterization and soil classification. In the recent past, concept of village based holistic development has emerged as one of the potential approaches in rainfed areas, which can lead to higher productivity and sustainability in agricultural production. Different measures are adopted and executed carefully in different soils according to their capability. Keeping these considerations in view, land evaluation exercise was undertaken in the Malli-1 micro watershed of Yedrami taluka, Kalaburagi districtin North Eastern Dry Zone of Karnataka.

Material and Methods
Malli-1 microwatershed is located in Yedrami taluka of Kalaburagi district, Karnataka state and having total area of 537.18 hectares lies between 17˚35'57.431" and 17˚37'17.861" North latitude and 77˚58'33.611" and 77˚00'59.361" East longitude of 450 m above mean sea level (MSL). The average rainfall of this region is 724.9 mm with a large spatial and temporal variability.

The detailed soil survey was carried out using IRS and quick bird satellite at the scale of 1:8,000 and toposheet of 1:50,000 from SOI. The pedons were exposed and studied for their morphological properties following the procedure outlined (Soil Survey Staff, 1999) [6]. The physico-chemical properties (horizon-wise) were estimated following standard procedures. Seven soil series were tentatively identified in the study area and mapped into eight mapping units as phases of soil series (Figure 1). Weighted mean of each property was calculated and soil-site characteristics of different soil units were obtained.

These weighted average data of soil-site characteristics have been used to evaluate the land capability classification and soil-site suitability (FAO, 1983). Land capability map and soil- site suitability maps were prepared using Arc view 3.2a GIS software.

Results and Discussion

Land capability classification

Land capability classification is an interpretive grouping of soils mainly based on the inherent soil characteristics, external land features and environmental factors that limit the use of the land. Soil site characteristics of soil units are matched with the criteria for land capability classification (Sehgal, 1996) [4]. The land capability classification of mapping units and their extent in micro watershed was presented in Figure 2.

Based on soil properties (Table 1), the soils of Malli-1 micro watershed of Yedrami taluka, Kalaburagi district have been classified into three land capability classes for better land management, *i.e.,* III, IV and VI based on soil properties (Fig. 2). The Bhimanahalli and Novinihala series were classified into IVs which were marginally cultivable soils with severe limitation of soil depth. The soils of Margutti series was classified as VIs. Due to very severe soil depth limitation, these soil series were not ideal for agricultural crops. Whereas, Gutti, Rajhnal, Mahagoan and Dinsi series were grouped under land capability sub class IIIesf. It was moderately cultivable land due to limitations of erosion, texture and organic carbon content. Sharma *et al.,* (2004) [5] also published similar results.

Table 1: Soil-site characteristics of Malli-1 micro watershed for land evaluation

Soil phases	Climate (c)				Land form characteristics			Physico-chemical characteristics (f)								
	Rainfall (mm)	Max. temp (°C)	Min. temp (°C)	RH (%)	Slope (l)	Erosion (e)	Drainage (w)	Depth (r) (cm)	Free $CaCO_3$ (%)	Texture (t)	pH (1:2.5) soil: water ratio	Ec dS m^{-1} (1:2.5) soil: water ratio	SOC (%)	CEC cmol (p^+) kg^{-1}	BS (%)	ESP (%)
Bhsimanahalli Series																
BHImB2g1	724.9	32.80	21.1	70.95	1-3	Moderate	Well	0-30	12.60	Clay	8.3	1.3	0.56	54.64	94.51	8.60
Novinihala Series																
NHAmB2g0	724.9	32.80	21.1	70.95	1-3	Moderate	Well	0-44	14.10	Clay	9.1	2.4	0.65	57.16	95.11	8.43
Margutti Series																
MGTmC2g1	724.9	32.80	21.1	70.95	3-5	Moderate	Well	0-25	11.38	Clay	8.2	1.2	0.39	39.25	92.35	9.30
Gutti Series																
GTTmB2g1	724.9	32.80	21.1	70.95	1-3	Moderate	Well	0-52	13.88	Clay	8.5	1.7	0.60	56.71	94.79	7.88
Margutti Series																
MGTfB2g1	724.9	32.80	21.1	70.95	1-3	Moderate	Well	0-25	10.43	Clay loam	8.1	1.1	0.34	36.99	91.88	8.76
Rajhnal Series																
RNLmB2g0	724.9	32.80	21.1	70.95	1-3	Moderate	Well	0-143	12.19	Clay	8.3	1.7	0.59	55.23	93.38	9.18
Mahagoan Series																
MANmB2g0	724.9	32.80	21.1	70.95	1-3	Moderate	Well	0-156	11.66	Clay	8.4	1.7	0.60	44.95	92.83	8.50
Dinsi Series																
DSImB2g0	724.9	32.80	21.1	70.95	1-3	Moderate	Well	0-69	11.38	Clay	8.3	1.2	0.51	40.49	92.57	6.94

Note: l- Slope, e- Erosion, w- Drainage, r- Rooting depth, $CaCO_3$- Calcium carbonate, t- Texture, pH- Pouviour of Hydrogene (power of hydrogen), SOC- Soil organic carbon, CEC- Cation exchange capacity, BS- Base saturation, ESP- Exchangeable sodium percentage, s- Physical characteristics, c- Climate and f- Chemical characteristic.

Soil-site suitability evaluation for crops

The optimum requirements of a crop are always region specific. Climate and soil-site parameters play significant role in maximizing the crop yields. The kind and degree of limitations were evaluated and soil properties from the study area (Table 1) were matched with soil site suitability criteria (Sehgal, 1996) [4].

The soil-site suitability assessment for pigeon pea revealed that 454 ha of study area was marginally suitable (S3f) due to marginal to severe limitations of soil depth and chemical constraints (ESP). The Bhimanahalli and Novinihala series were marginally suitable (S3f) for pigeon pea due to marginal limitations of exchangeable sodium percentage and soil depth. Similarly, Gutti, Rajhnal, Mahagoan and Dinsi series were marginally suitable (S3f) for pigeon pea due to marginal limitations of exchangeable sodium percentage. The 63 ha of study area represented by Margutti (P-1) & (P-2) series were currently not suitable (N1f) because of severe limitations of exchangeable sodium percentage and soil depth (Fig. 3). Similar works on soil-site suitability for pigeon pea carried out in 48A distributary of Malaprabha right bank command by Ravikumar *et al.* (2009) [3].

Green gram requires more rainfall compared to other crops.Soil reaction, depth, texture, exchangeable sodium percentage showed a considerable impact on yield of green gram. The suitability of study area varied from moderately (S2cf) (245 ha) to marginally suitable (S3f) (272 ha) for green gram. The Bhimanahalli, Novinihala and Margutti (P-1) & (P-2) series were marginally suitable (S3f) because of marginal limitations of soil depth. While Gutti, Rajhnal, Mahagoan and Dinsi series were moderately suitable (S2cf) for green gram due to moderate limitations of rainfall, texture, free calcium carbonate and soil depth (Fig. 4). Similar works on soil-site suitability for sapota carried out in Karekal-1 micro watershed by Vidyavathi *et al.* (2017) [7].

The suitability of the study area showed that most of the soils were marginally suitable (S3f) (375 ha) for bengal gram. The Bhimanahalli series was marginally suitable (S3f) due to marginal limitations of soil depth and soil reaction. Similarly Gutti, Rajhnal, Mahagoan and Dinsi series were marginally suitable (S3f) due to marginal limitations of soil reaction. Novinihala and Margutti (P-1) & (P-2) series were currently not suitable (N1f) (142 ha) for bengal gram because of severe limitation of soil reaction and very severe limitation soil depth, respectively (Fig. 5) Ravikumar *et al.* (2009) [3]. The Bhimanahalli, Margutti (P-2), Gutti, Rajhnal, Mahagoan and

Dinsi series were moderately suitable (S2ef) (410 ha) for sorgum because of moderate limitations of erosion, soil depth and soil reaction. While, Margutti (P-1) series was moderately suitable (S2elf) (29 ha) due to limitations of erosion, slope, depth, pH and fertility constraints. Novinihala series was marginally suitable (S3f) (79 ha) for sorghum due to severe limitations of soil (Fig. 6). The suitability of the study area showed that most of the soils were moderately suitable (S2) for sorghum.

Mango tree require more depth and neutral soil reaction for its better growth and development. The suitability of study area showed that 517 ha of study area were currently not suitable (N1f) for growing of mango. The Bhimanahalli, Novinihala, Margutti (P-1) & (P-2), Gutti and Dinsi series were currently not suitable (N1f) due to severe limitations of rooting depth and soil chemical characteristics. Similarly, the Rajhnal and Mahagoan series were currently not suitable (N1f) for growing of mango due to severe limitations of calcium carbonate (Fig. 7) Rajesh *et al.* (2018) [2].

The suitability of the study area showed that 245 ha of study area was marginally suitable (S3cf) and 272 ha was currently not suitable (N1f) for growing of sapota. The Bhimanahalli, Novinihala and Margutti (P-1) & (P-2) series were currently not suitable (N1f) for growing of sapota due to severe limitations of rooting depth and soil reaction. Whereas, Gutti, Rajhnal, Mahagoan and Dinsi series were marginally suitable (S3cf) due to marginal limitations of soil physico-chemical characteristics, climate and rooting depth (Fig. 8). The suitability of study area showed that 245 ha of the study area was marginally suitable (S3) and 272 ha was currently not suitable (N1f) for growing of guava. The Bhimanahalli, Novinihala and Margutti (P-1) & (P-2) series were currently not suitable (N1f) due to severe limitations of rooting depth and soil reaction. Whereas, Gutti, Rajhnal, Mahagoan and Dinsi series were marginally suitable (S3cf) due to marginal limitations of climate, soil physico-chemical characteristics and rooting depth (Fig. 9) Vidyavathi *et al.* (2017) [7].

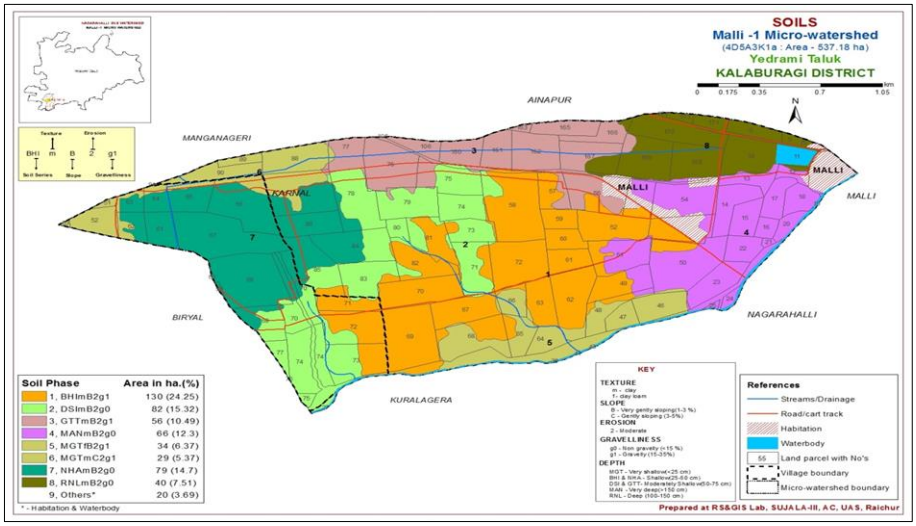

Fig 1: Soil phase map of Malli-1 micro watershed

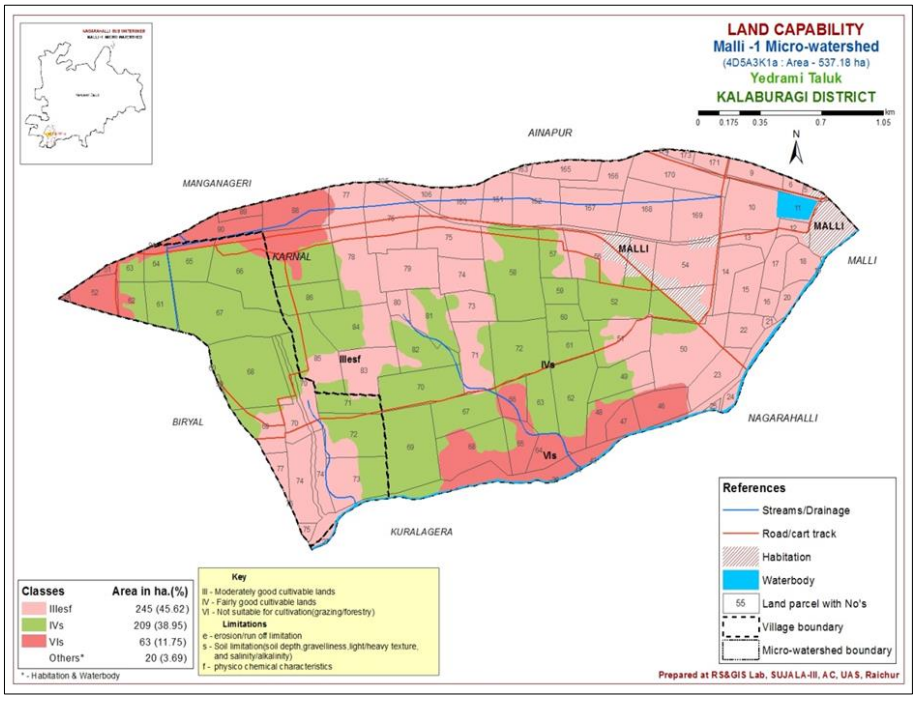

Fig 2: Land capability classification of soils in Malli-1 micro watershed

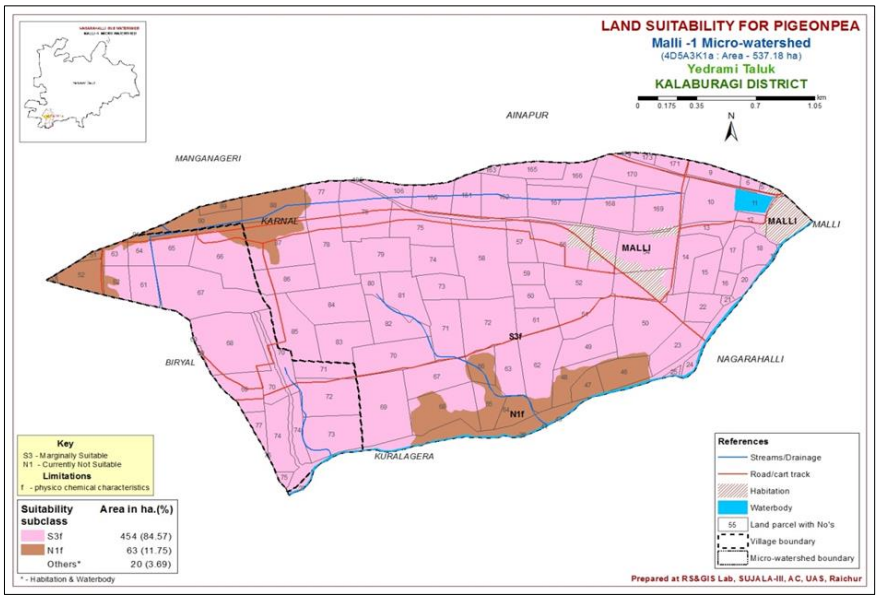

Fig 3: Soil-site suitability for pigeon pea in Malli-1 micro watershed

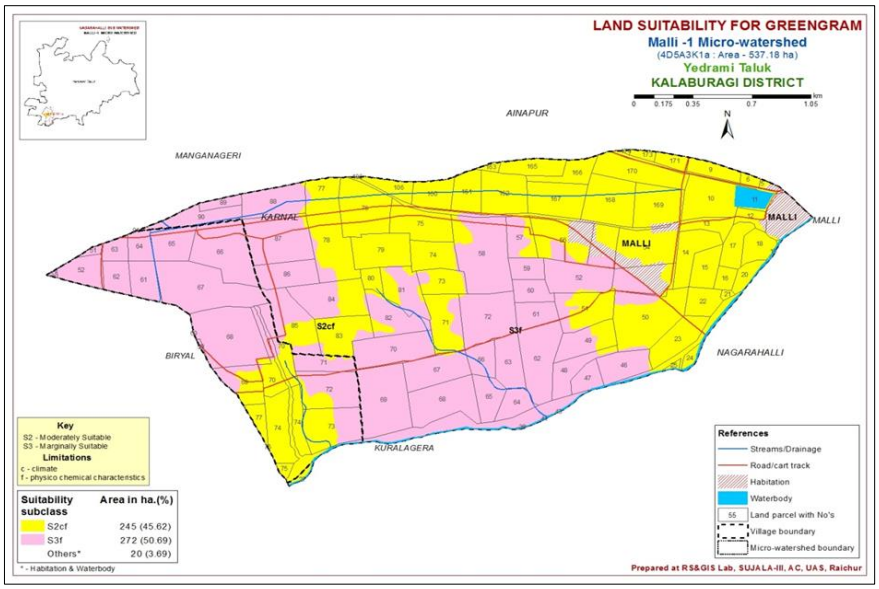

Fig 4: Soil-site suitability for green gram in Malli-1 micro watershed

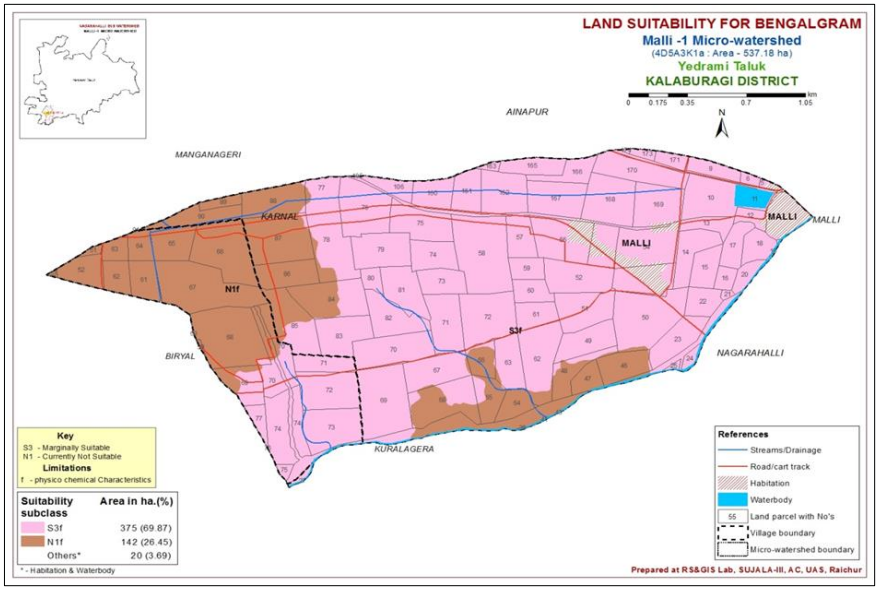

Fig 5: Soil-site suitability for bengal gram in Malli-1 micro watershed

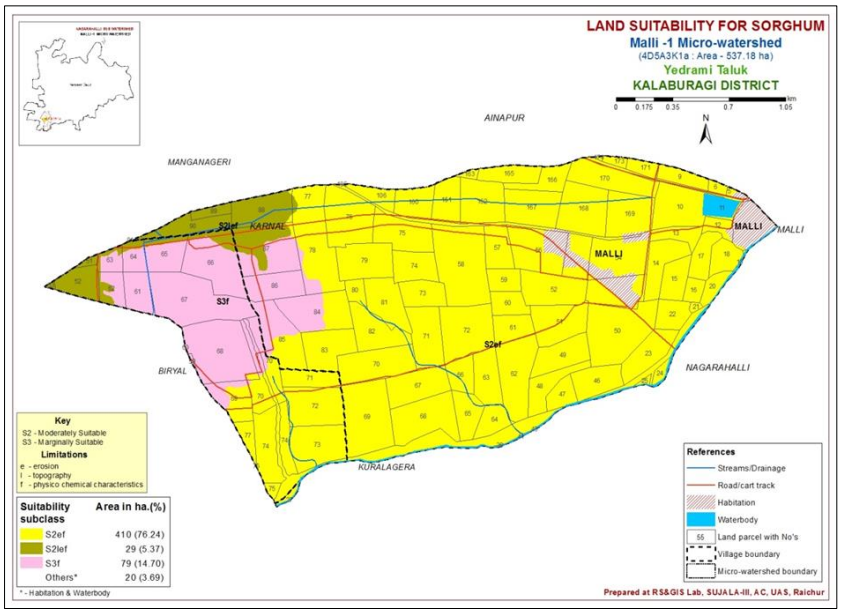

Fig 6: Soil-site suitability for sorghum in Malli-1 micro watershed

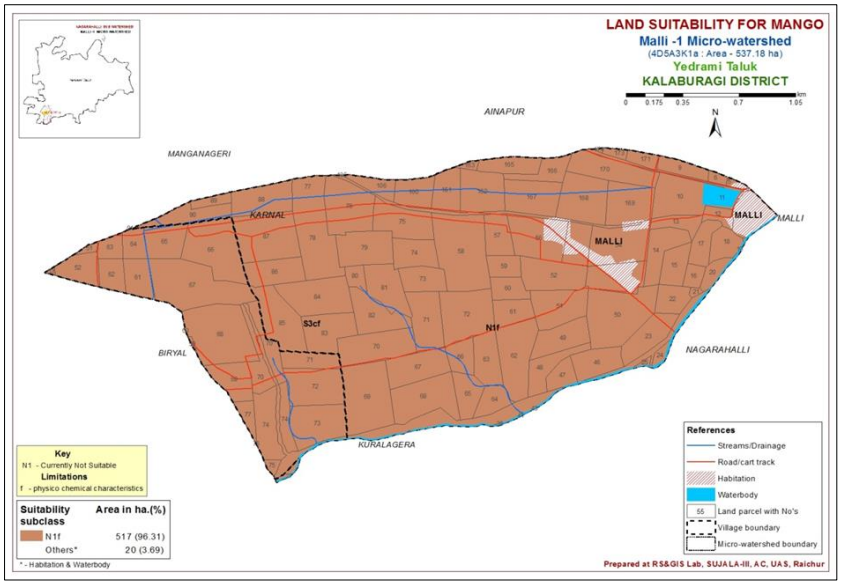

Fig 7: Soil-site suitability for mango in Malli-1 micro watershed

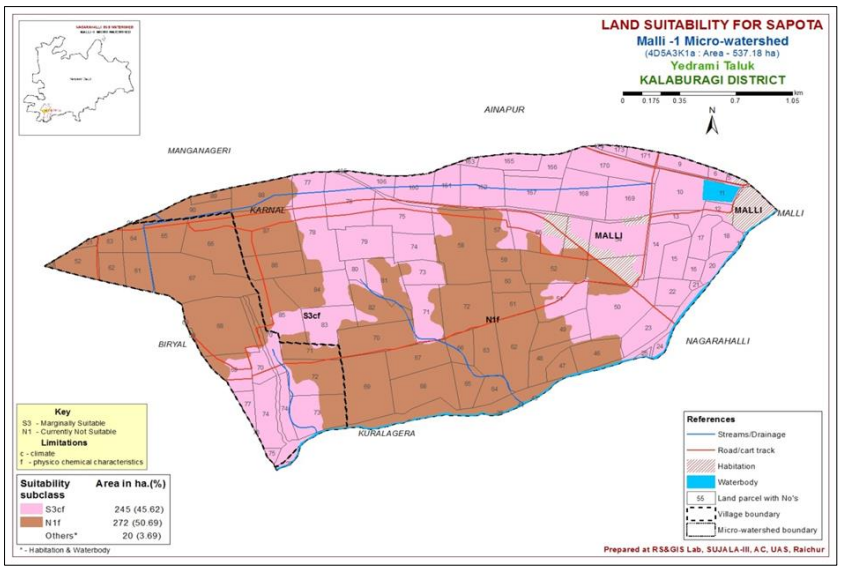

Fig 8: Soil-site suitability for sapota in Malli-1 micro watershed

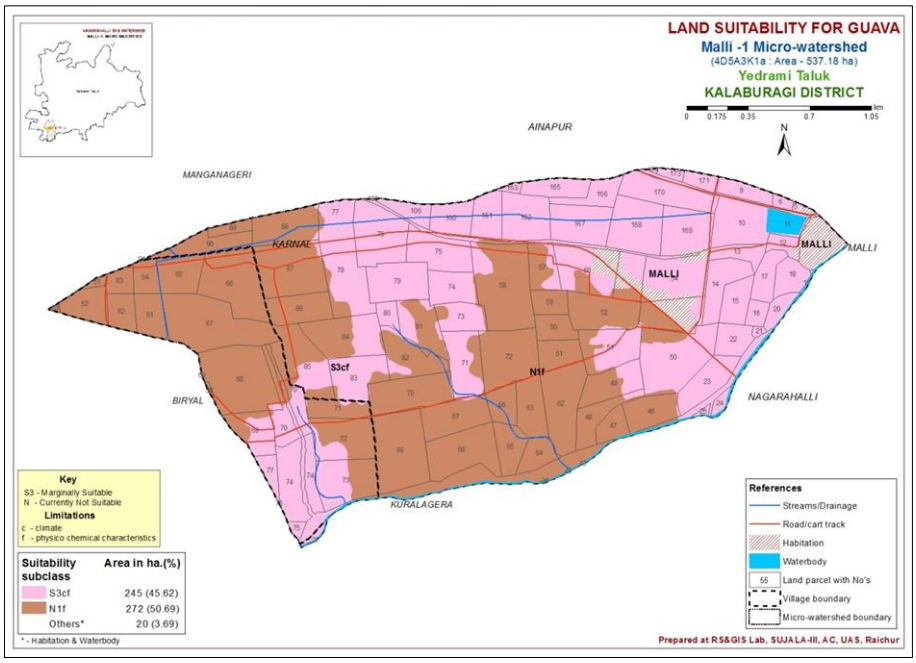

Fig 9: Soil-site suitability for guava in Malli-1 micro watershed

Conclusion

Seven soil series were identified in the study area. Land capability classification was carried out for the study area based on the inherent soil characteristics, external land features and environmental factors. In the land capability map, different sub classes were identified *viz.*, IIIesf (Gutti, Rajhnal, Mahagoan and Dinsi series), IVs (Bhimanahalli and Novinihala series) and VIs [Margutti (P-1) & (P-2) series] have been differentiated and mapped.The soils from the study area were matched with the soil suitability criteria for a few important crops like pigeon pea, green gram, bengal gram, sorghum, mango, guava and sapota. Margutti (P-1) & (P-2) series were moderately (S2) suitable for sorghum, marginally (S3) suitable for greengram and currently not suitable (N1) for all other crops. Bhimanahalli and Gutti series of the study area was moderately (S2) and marginally suitable (S3) for pulses and cereals crops and currently not suitable (N1) for all horticultural crops. Novinihala series was moderately (S2) and marginally suitable (S3) for pulses and cereals crops except bengalgram and currently not suitable (N1) for all horticultural crops. Rajhnal, Mahagoan and Gutti series were moderately (S2) suitable for greengram and sorghum, marginally (S3) suitable for pigeonpea, bengalgram, guava and sapota and currently not suitable (N1) for mango.

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