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Land resource inventory and its applications for watershed planning: A case study of Dabarabad sub-watershed of semi-arid region of Kalaburagi district, Karnataka, India

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Abstract
A case study was conducted to evaluate land resources of Dabarabad sub-watershed located in North eastern Dry Zone of Karnataka (Zone-2) in semi-arid region of Kalaburagi taluka and district under Sujala-III project, which is sponsored by the Watershed Development Department of Karnataka and funded by World Bank. The analysis and interpretation of the non-spatial and spatial database generated has given that majority of the area suffer from major constraints. In most of the areas, very shallow (<25 cm) to shallow depth (25-50 cm), very gently sloping (1-3%)with moderate erosion and alkalinity affected even up to 60-80% of thesub-watershed area followed by gravelly (15-35%), thus reducing the production potential and crop choices. The fertility status of soils revealed that majority of soils were low in organic carbon content (<0.5 %), medium (23-57 kg/ha) in phosphorus (P_2O_5) and high (>337 kg/ha) in potassium (K_2O). Most agricultural and horticultural crops can be grown in soils that are either marginally (S3) or moderately (S2) suited because the levels of zinc (<0.6 ppm) and iron (<2.5 ppm) are below the critical limit. The best management options (optimal land use plans) were determined by analyzing various management scenarios and integrating land resource data with remote sensing and GIS techniques.

Keywords: Soil depth, Soil fertility, land capability and land suitability

Introduction
Since the country's watersheds are declining due to improper conservation measures and improper natural resource utilization, site specific Land Resource Inventories have become increasingly important for farm-level planning of watersheds (Rajendra *et al*., 2015) [11] for agricultural planning and development, an inventory of natural resources is a prerequisite. The land resources in Karnataka state are under severe stress due to various forms of degradation. Further, land degradation has emerged as a serious problem and this has already affected about 38.0 lakh ha of cultivated area in the Karnataka state. Soil erosion alone has degraded about 35.0 lakh ha (Geetha *et al*., 2017) [3]. Almost all the uncultivated areas are facing various degrees of degradation, particularly soil erosion. Nutrient depletion and declining of productivity are common in both rainfed and irrigated areas. The degradation is continuing at an alarming rate and there appears to be no systematic effort among the stakeholders to contain this process. In recent times, aberrations of weather due to climate change phenomenon have added number of additional constraints and unpredictable situations to be tackled by farmers. The challenges before us are to increase the productivity per unit area to meet out the food grain demand of the increased population, but also to reduce or conserve natural resources in the state. The two major technologies that have emerged as the most effective means of generating trustworthy spatial data on a variety of natural resources are remote sensing and geographic information systems (GIS). Because of the significant advancements in space-borne remote sensing technology in terms of spatial, spectral, temporal, and radiometric resolutions, the number of applications for characterizing and mapping soils is growing quickly. The utilization of GIS and GPS gave the information integration and resource survey a new dimension. Different management scenarios can be processed by integrating RS with GPS and GIS, enabling the resource manager to evaluate multiple management options and generate the optimal and most appropriate option (Rajendra *et al*., 2018) [12]. Therefore, the purpose of this study was to gather site-specific data, offer crop choices specific to farms, develop soil and water conservation measures tailored to specific locations, and provide the

datasets and inputs required for the planning, execution, and oversight of all land-based developmental programs in order to create tools, packages, and thematic outputs.

Materials and Methods

Dabarabad sub-watershed of Kalaburagi district is located in between 76^0 44' – 17^0 22' North latitudes and 76^0 48' – 17^0 20' East longitudes, covering an area of about 4213.32 ha (Fig. 1) Physiographically, based on geology the area has been identified as granite and gneiss complex, belonging to Archaean period. The climate is semi-arid tract and is categorized as drought prone with total annual rainfall of 866 mm.

False Color Composites (FCC) of combined Cartosat-1 and LISS-IV satellite data (Fig. 2) were used in the survey in addition to the digitalized cadastral map (Natarajan and Dipak, 2010) [8]. Each physiographic unit was thoroughly traversed, and transects covering every physiographic unit found in the sub-watershed were chosen throughout the slope based on the variability of the soil as seen on the surface. In the selected transect, soil profiles were located at closely spaced interval to take care of any change in the land features like slope break, erosion, gravel, stones, saline/sodic *etc*. (Soil Survey Staff, 1958) [16]. The profiles were first studied and then described in detail for all their morphological as well as physical characteristics.

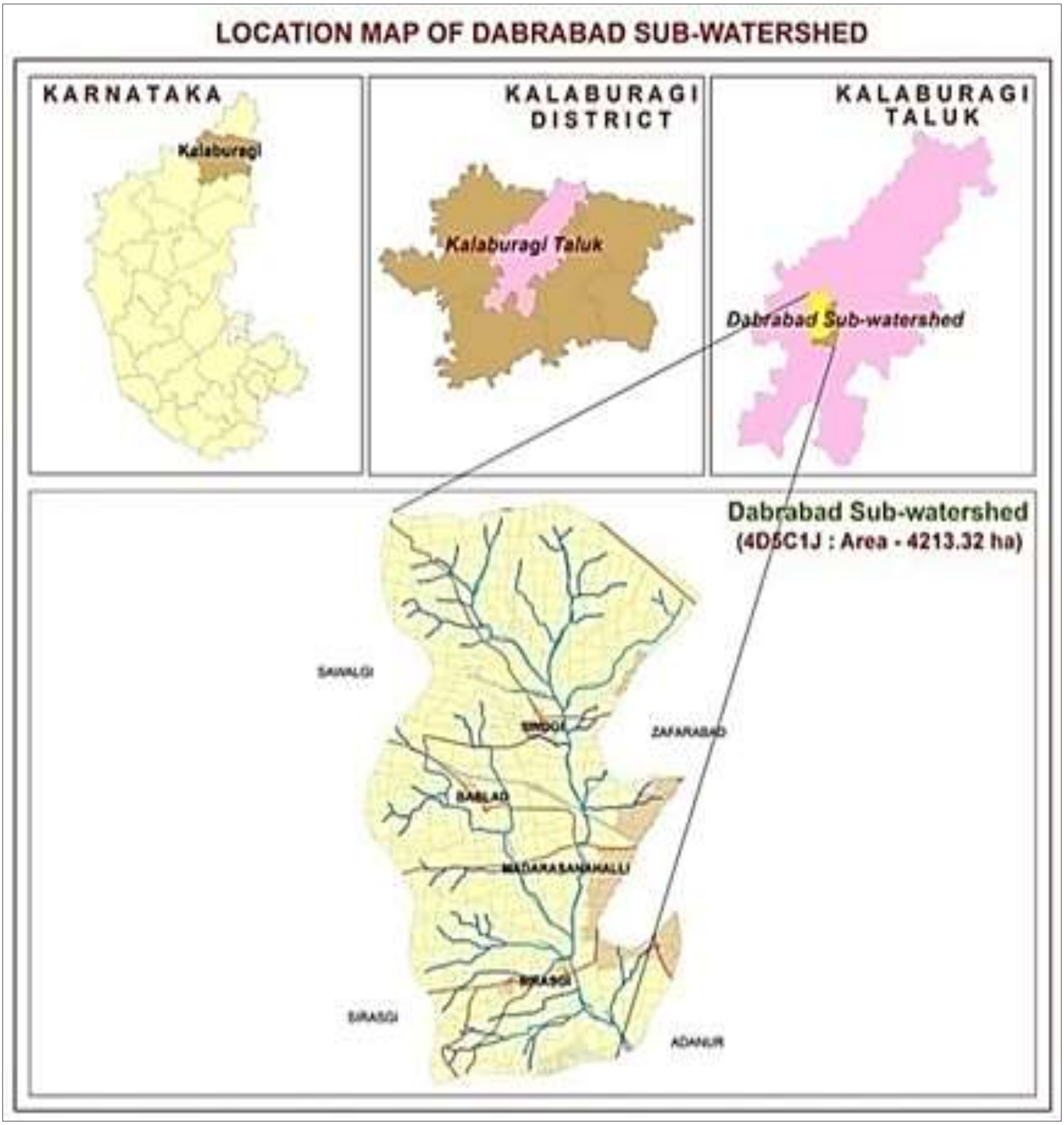

Fig 1: Location map of Dabarabad Subwatershed

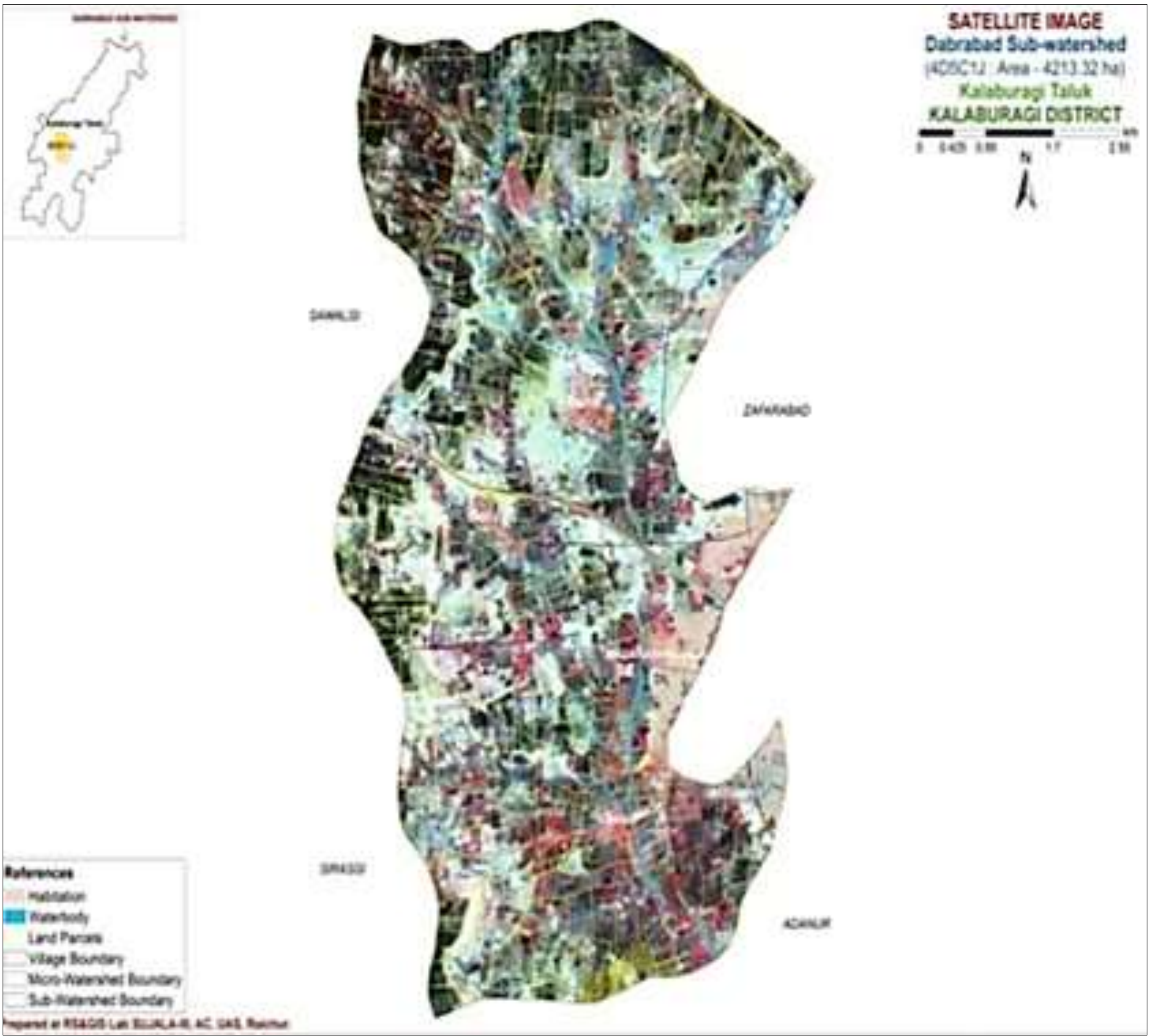

Fig 2: Satellite map of Dabarabad Subwatershed

Based on their properties, soils were divided, classified, and organized into different soil series up to the series level. Because it behaves consistently at every management level and has similar horizons and properties, this soil series is the most homogeneous unit. The soils were represented on the map as various soil series phases (Fig. 3). A soil map displays the area and spatial distribution of the various soil mapping units, or soil phases, that are classified under each soil series.

For each soil series, representative master profiles were used to gather soil samples for laboratory examination of their physical and chemical characteristics (Sarma *et al*., 1987) [15]. The fertility status of surface soil samples (0–20 cm) that were taken at 320 m grid intervals was examined in the laboratory.

As phases of soil series, six soil series were tentatively identified in the study area and mapped into 27 mapping units (Fig. 3). Each property weighted mean was calculated and different soil units soil-site characteristics were obtained as shown in Table 1. These weighted average data have been used to evaluate the classification of land capability and soil-site suitability (FAO, 1983) [2]. Land capability map and soil-site suitability maps were prepared using Arc view 3.2a GIS software.

Table 1: Soil-site characteristics of Dabarabad sub-watershed for land evaluation

Sl. No.	Soil Series	Depth (cm)	Colour	Texture	Slope (%)	Erosion	Drainage	Gravels (%)	Calcareousness
1	Bhimanahalli (BHI)	25-50	10YR 4/3, 4/2	gc, gcl	1-5	Moderate	Moderately Well Drained	15-35	-
2	Gutti(GTT)	50-75	10YR 3/2, 7.5YR 3/3	gc	1-3	Moderate	Moderately Well Drained	15-35	-
3	Kalamandaragi (KGI)	25-50	10YR 3/2, 4/2 7.5YR 3/4	gc	1-3	Moderate	Moderately Well Drained	15-35	-
4	Mahagaon (MAN)	>150	10YR 3/2	gc, gcl	1-3	Moderate	Moderately Well Drained	<15	-
5	Margutti (MGT)	0-25	10YR 3/3, 4/3 7.5YR 4/3	gc	1-5	Moderate to severe	Moderately Well Drained	15-35	-
6	Rajanala (RNL)	100-150	10YR 3/2, 4/2	c	1-5	Moderate	Moderately Well Drained	15-35	-

Note:-gc-gravelly clay, gcl-gravelly clay loam, c- clay

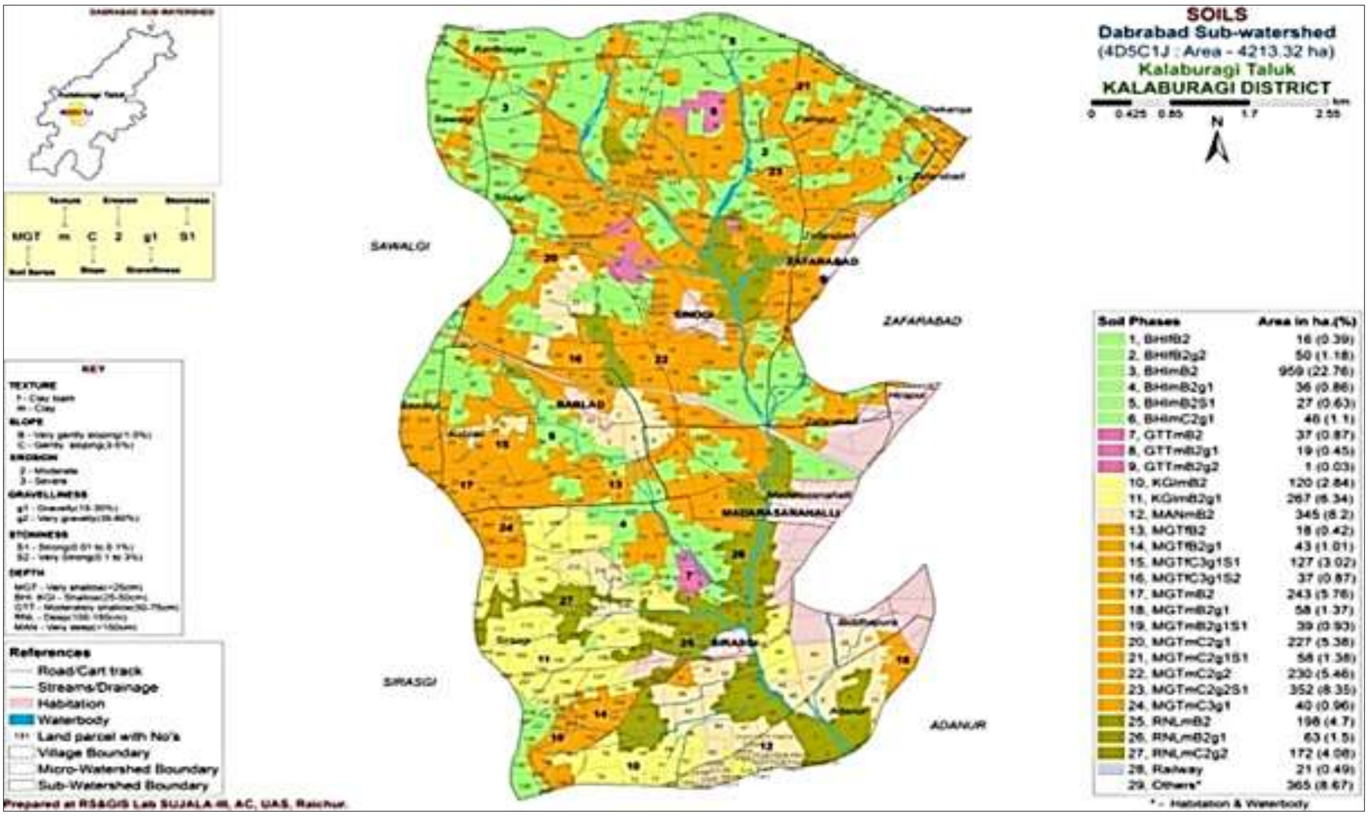

Fig 3: Soil phase map of Dabarabad Subwatershed

Result and Discussion

Soil Depth

Soil depth generally refers to the depth of the soil occurring above the parent material. About 37.42 percent area covered by shallow (25-50 cm) to moderately shallow (50-75 cm) soils, whereas very shallow (< 25 cm) soils occupied in an area of 34.91 percent and remaining area of 14.49 percent comprised of deep (100-150 cm) to very deep (>150 cm) soils (Fig. 4). The shallowness of soils is due to more erosion (e2) and slow weathering process as explained by Kumar and Naidu (2012) [5].

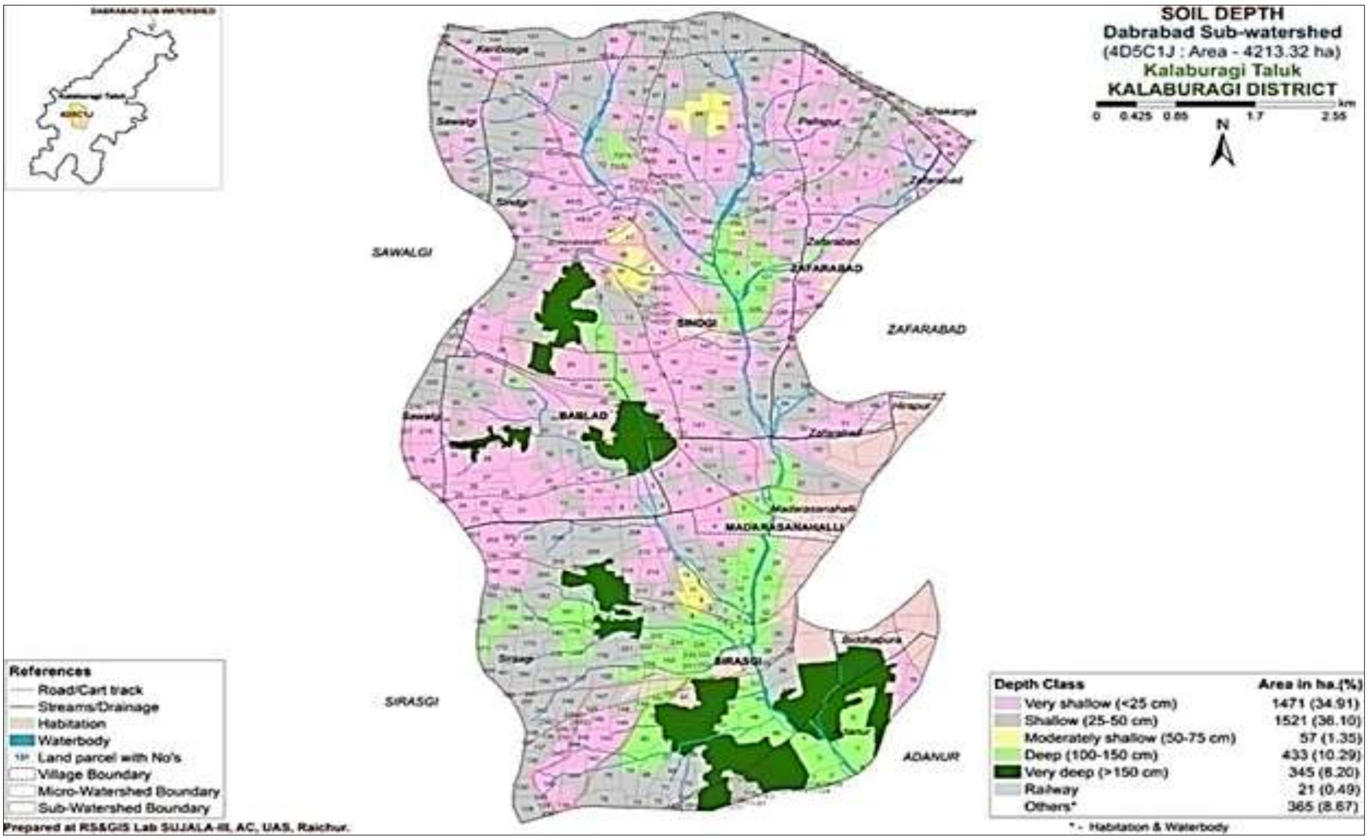

Fig 4: Soil depth map of Dabarabad Subwatershed

Soil Surface texture

An area of 83.96 percent has soils that are clay textured at the surface and clay loam soils occupy in an area of about 6.88 percent (Fig. 5). The heavier textures of the soils are due to less erosion, less slope and good managements by the farmers (Vedadri and Naidu, 2018) [21].

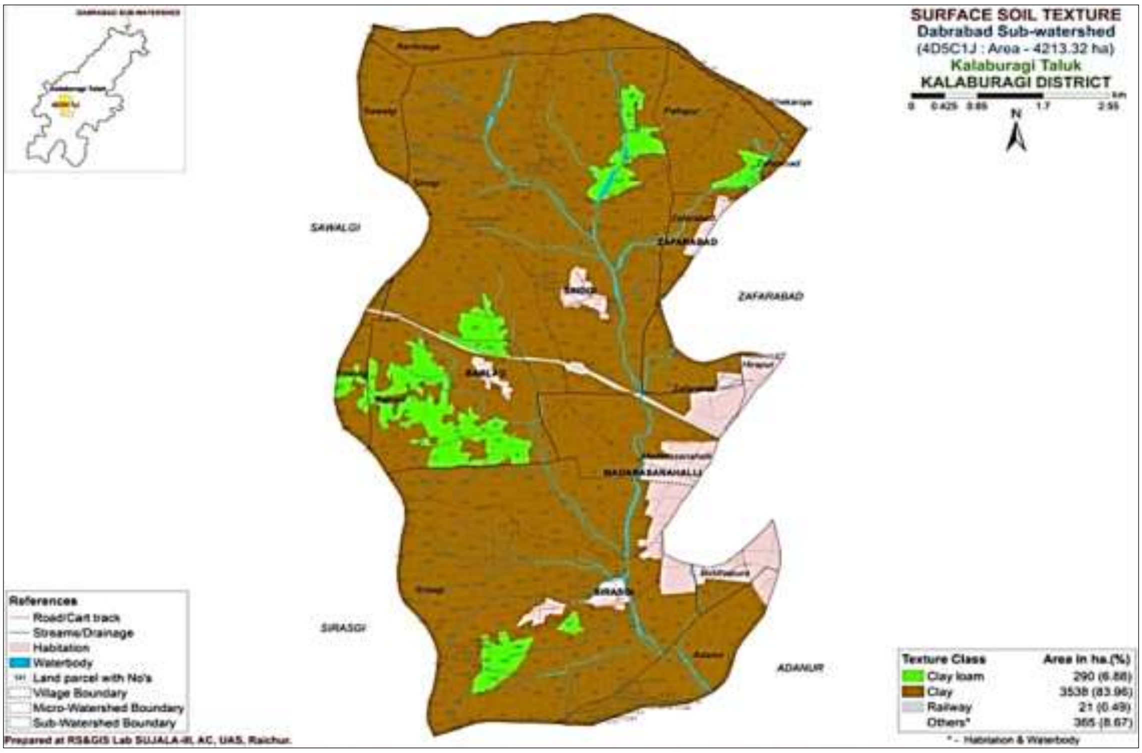

Fig 5: Surface texture of Dabarabad Subwatershed

Soil Gravelliness

Gravel refers rock fragments present in the soil having >2 mm and 75 mm diameter. In study area about 19.10 percent has soils that are very gravelly (35-60 %), 25.17 percent has gravelly (15-35 %) and non-gravelly (<15%) soils cover in an area of about 46.58 percent(Fig. 6). This is mainly due to differential weathering of rocks.

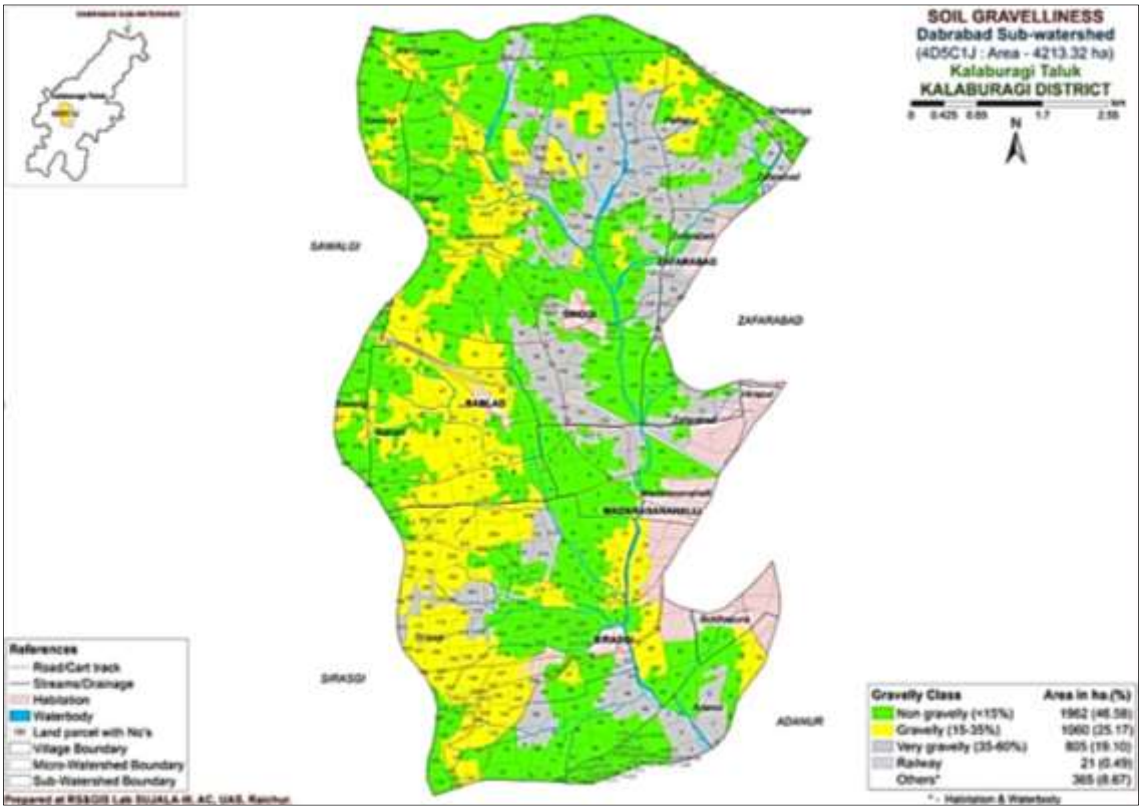

Fig 6: Soil Gravellinessmap of Dabarabad Subwatershed

Soil Slope

Slope plays an important role in the formation of soils, controls the process of erosion and alters the overall use of the land. Two slope classes were found in the Dabarabad sub-watershed. Major area of about 60.24 percent falls under very gently sloping (1-3 % slope) lands, whereas gently sloping (3-5 % slope) lands occupy in an area of 30.61 percent (Fig. 7). This is mainly due to physiography of the land (land form, texture, relief factor *etc.*) as concluded by Rajendra *et al*. (2018) [12].

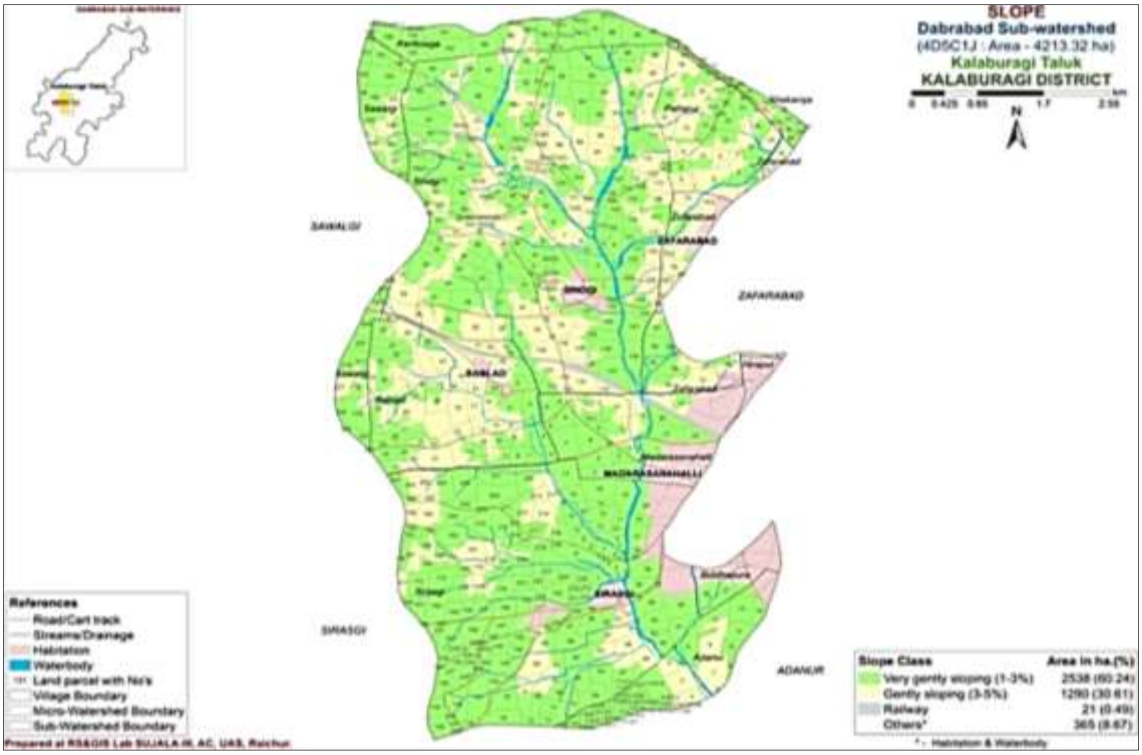

Fig 7: Soil slope map of Dabarabad Sub watershed

Soil Erosion

Soil erosion is the process involving detachment and transport of soil particles by raindrop impact. Soils that are severe eroded (e3 class) cover in an area of about 4.85 percent whereas moderate eroded (e2 class) soils cover a major area of about 86.00 percent (Fig. 8). The prevalence of gentle slopes in the uplands favors easy detachment and removal of soil particles from the surface.

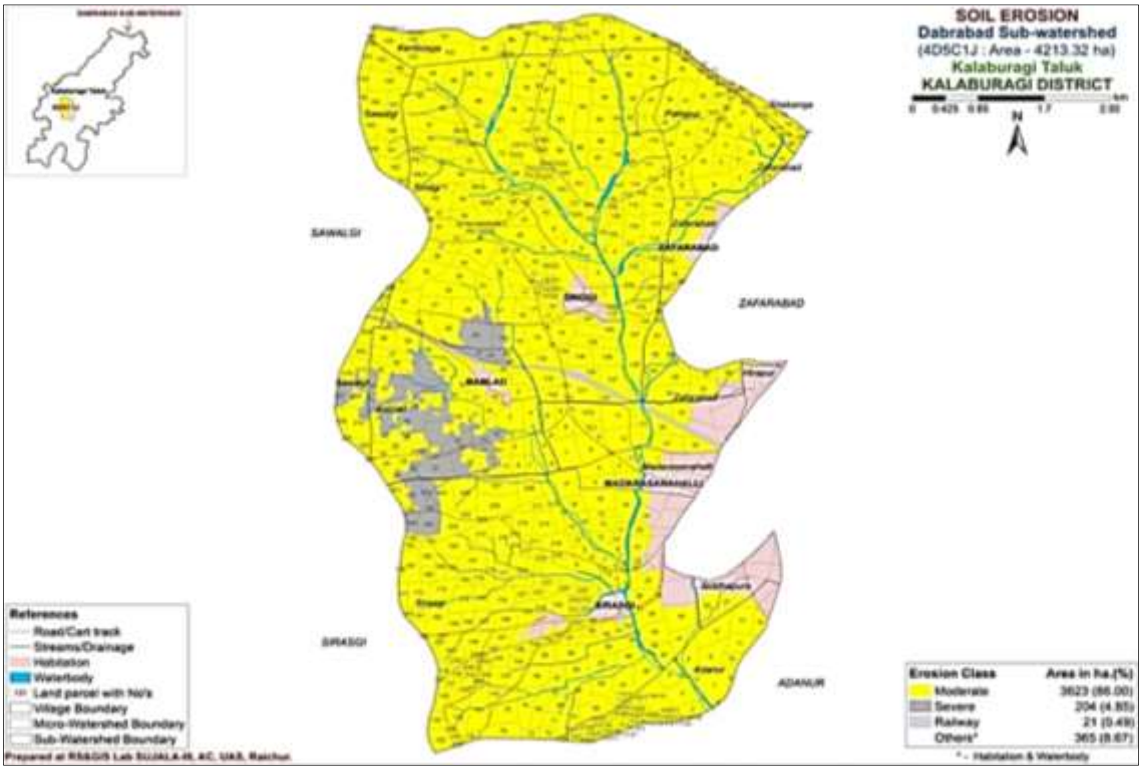

Fig 8: Soil erosion map of Dabarabad Sub watershed

Soil Fertility

Soil fertility data obtained from the soil testing laboratory has been assessed and individual maps for all the nutrients for the Dabarabad sub-watershed have been prepared by using the Kriging method under GIS. The details are discussed below.

The soil analysis of the Dabarabad sub-watershed for soil reaction (pH) showed that major area of about 82.08 percent has moderately alkaline (pH 7.8-8.4) followed by 5.17 percent slightly alkaline (pH 7.3-7.8) and 3.59 percent has strongly alkaline (8.4-9.0) in reaction (Fig. 9) and entire area of Dabarabad subwatershed is non saline (Fig. 10). The soil alkalinity is due to presence of sodium carbonate and increase in exchangeable bases brought by runoff water in these soils and also due to higher temperature results in accumulation of salts in the surface layers. These results were in line with the findings of Rajendra *et al.* (2018) [12] and Ram *et al*. (2010) [13]. Major area of about 89.97 percent of the sub-watershed is low (< 0.5 %) in percent soil organic carbon content followed by 0.88 percent medium (0.5-0.75 %) (Fig. 11). This is due to depletion of soil organic carbon due to continuous removal by crops (Rao *et al*., 2008) [14] and also this probably was due to intense cultivation of crops without fully replenishing it with external organic inputs as explained by Walia and Rao (1996) [22] in soils of Bundelkhand region of Uttara Pradesh. Most of the soils were medium (23-57 kg/ha) in available phosphorus content with an area of 60.86 percent followed by 29.99 percent low (<23 kg/ha) (Fig. 12) due to the precipitation of added phosphorous as iron and aluminum phosphate of low solubility. This might be due to the granitic parent material and presence of small amounts of phosphate bearing minerals (Gupta, 1965) [4] and (Mahendra *et al*., 2015) [6]. Majority of the soils were high (>337 kg/ha) in available potassium content in an area of 61.02 percent followed by 29.82 percent is medium (144-337 kg/ha) (Fig. 13). This is due to presence of potassium bearing minerals and rocks in the study area (Tawande *et al*., 1976) [18], Maximum area of about 83.87 percent is low (<10 ppm) in available sulphur followed by4.72 percent medium (10-20 ppm) and 2.26 percent high (>20 ppm) in available sulphur (Fig. 14). This is due to less addition of sulphur to soils and more removal by plants (Balanagoudar, 1989) [1].

Among the micronutrients available zinc content was deficient (<0.6 ppm) in most of the study area which accounts for90 percent and sufficient (>0.6ppm) in 0.85 percent (Fig. 15). Available iron content was deficient (<2.5 ppm) in 83.62 percent and sufficient (> 2.5 ppm) in an area of 7.23 percent (Table. 2). The zinc deficient was attributed to the alkaline soil condition which might occur due to high precipitation of hydroxides and carbonates as concluded by Thangasamy *et al*. (2005) [21]. The Copper and manganese contents were sufficient in entire area (Fig. 16& 17), higher available manganese content in soils originated from granite genesis parent material with semi- arid climate (Srikanth *et al*., 2008) [17]. Available boron content was low (<0.5 ppm) in majority of the area of 90.37 percent and medium (<0.5-1.0 ppm) in 0.47 percent (Fig. 18).

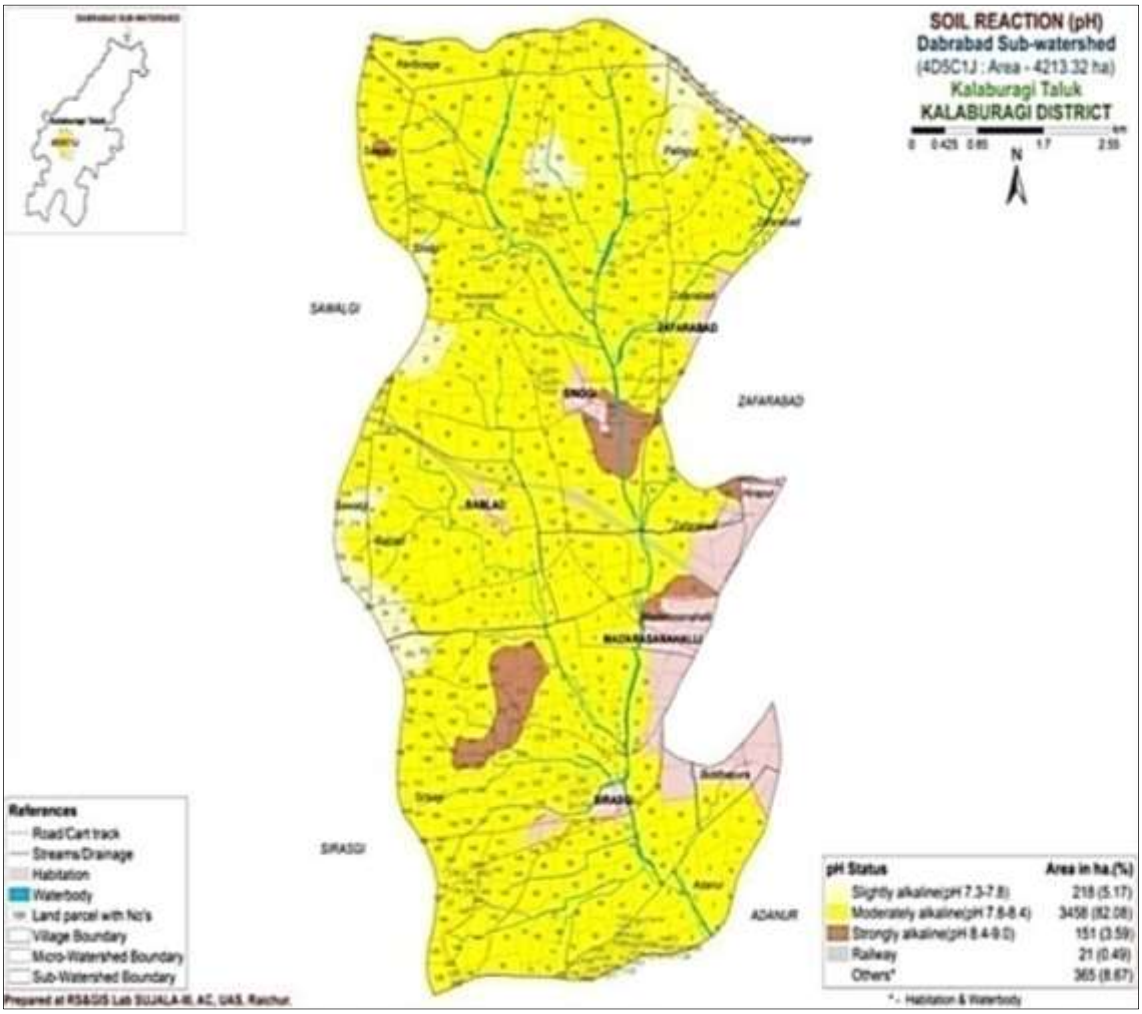

Fig 9: Soil reaction map of Dabarabad SWS

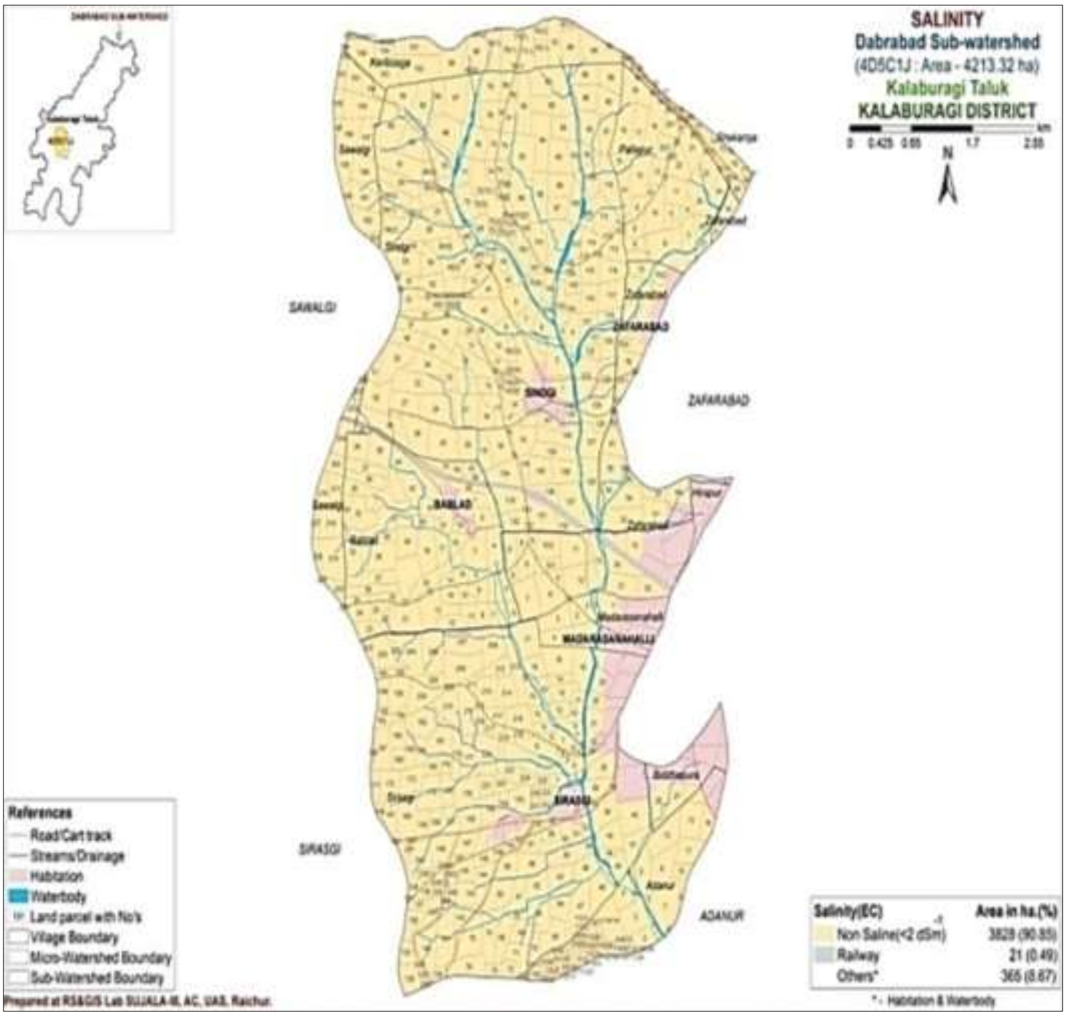

Fig 10: Soil salinity map of Dabarabad SWS

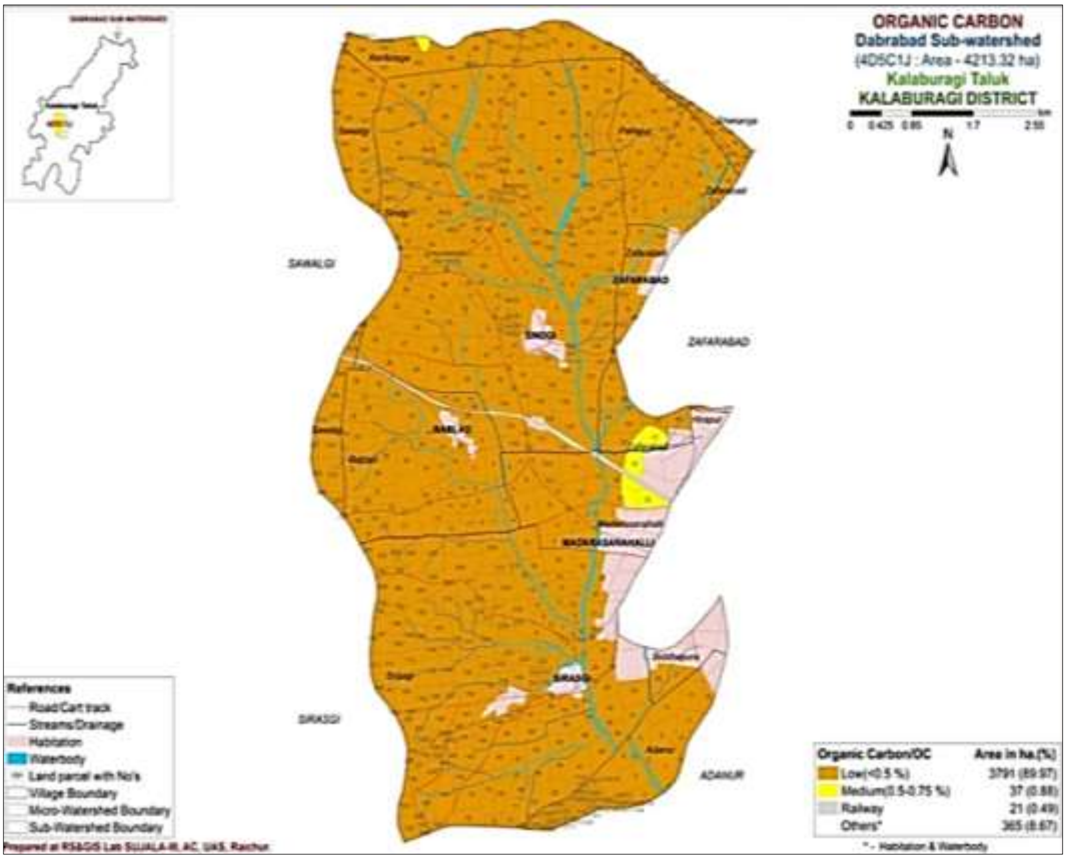

Fig 11: Soil organic carbon map of Dabarabad SWS

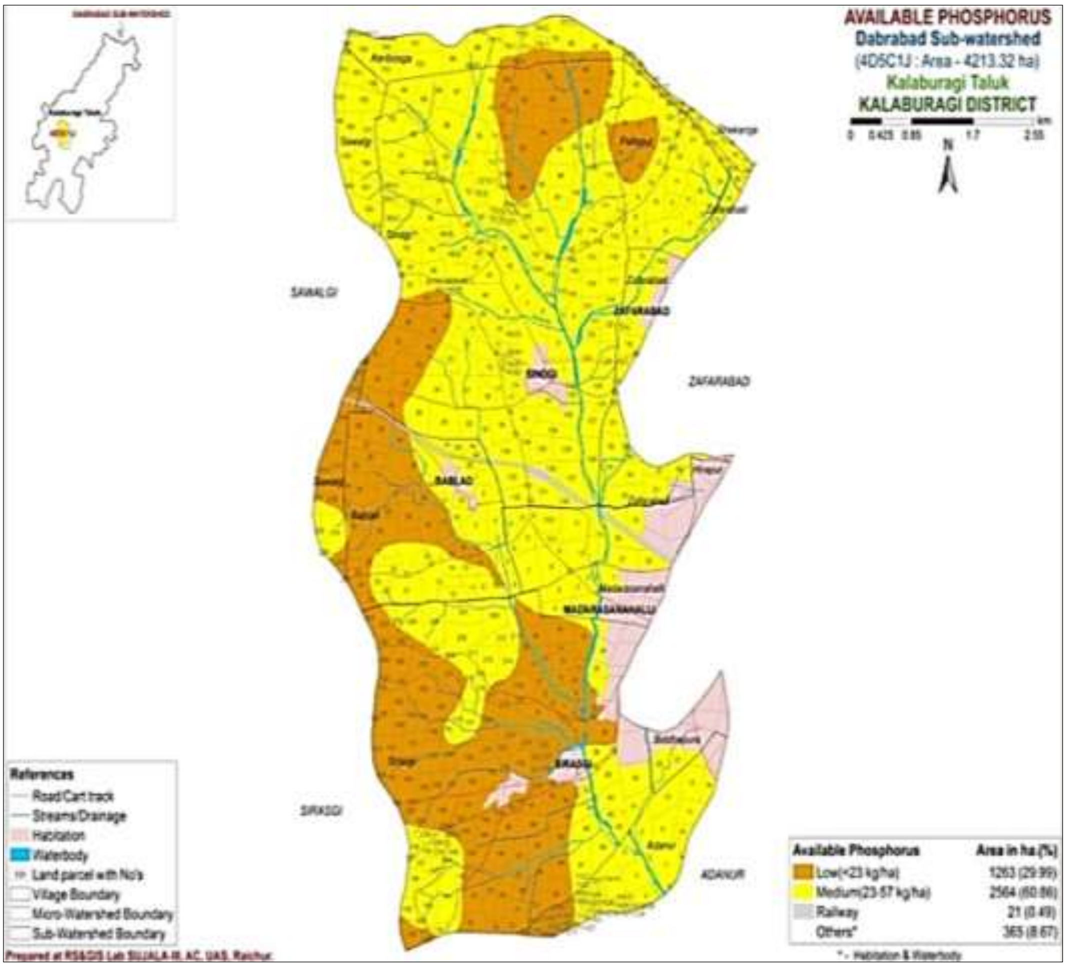

Fig 12: Available Phosphorus map of Dabarabad SWS

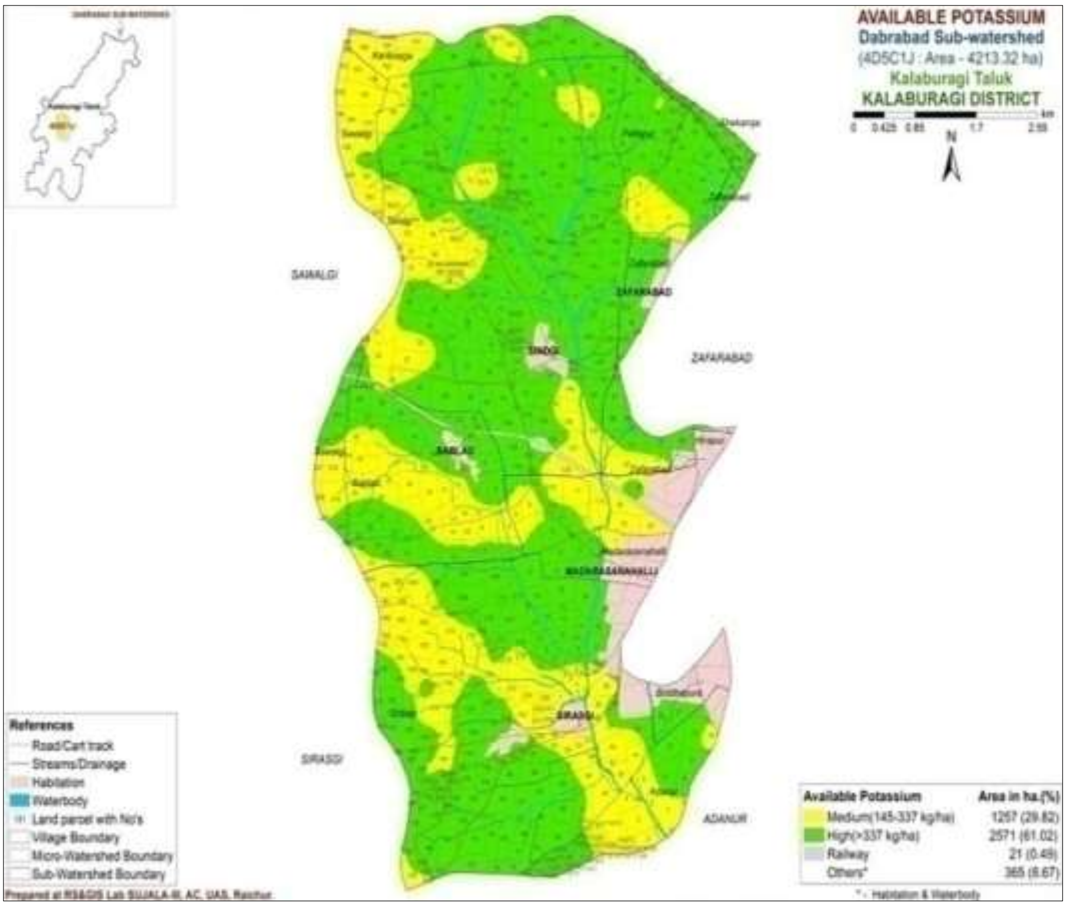

Fig 13: Available Potassium map of Dabarabad SWS

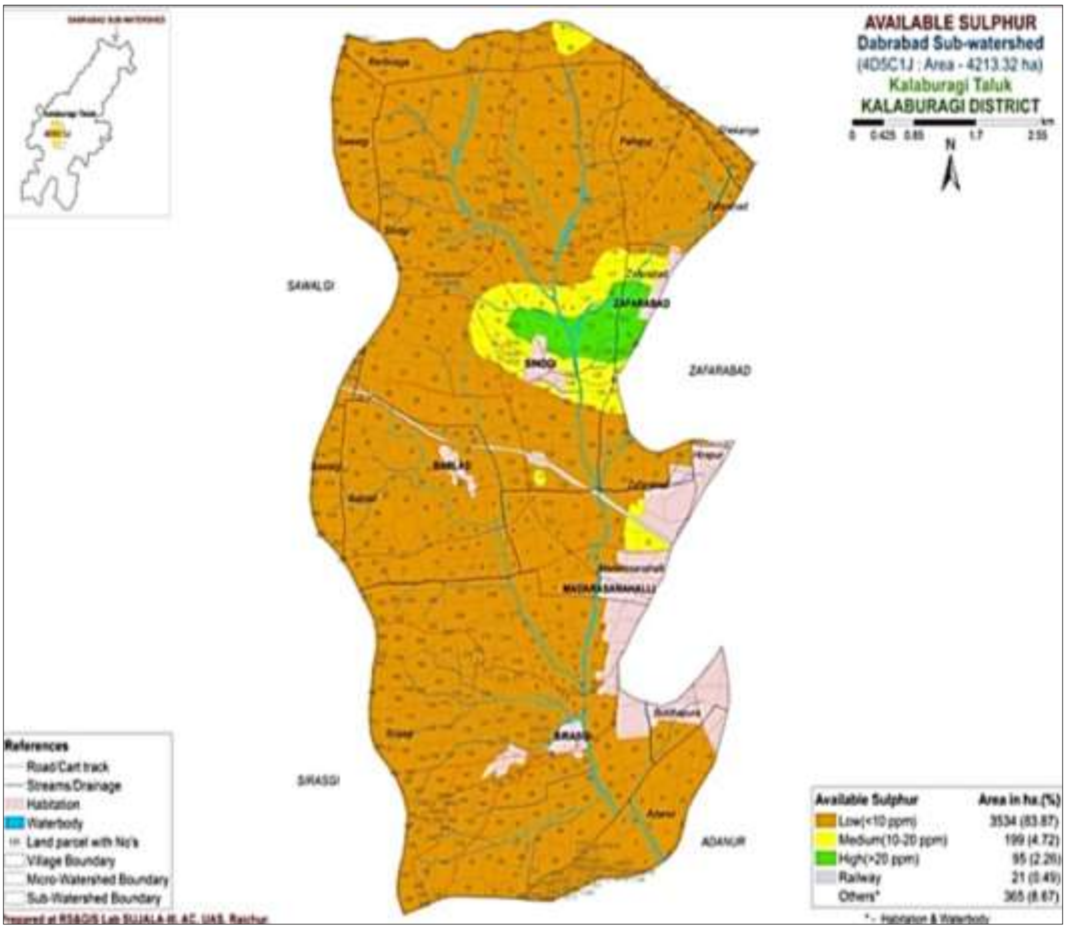

Fig 14: Available Sulphur map of Dabarabad SWS

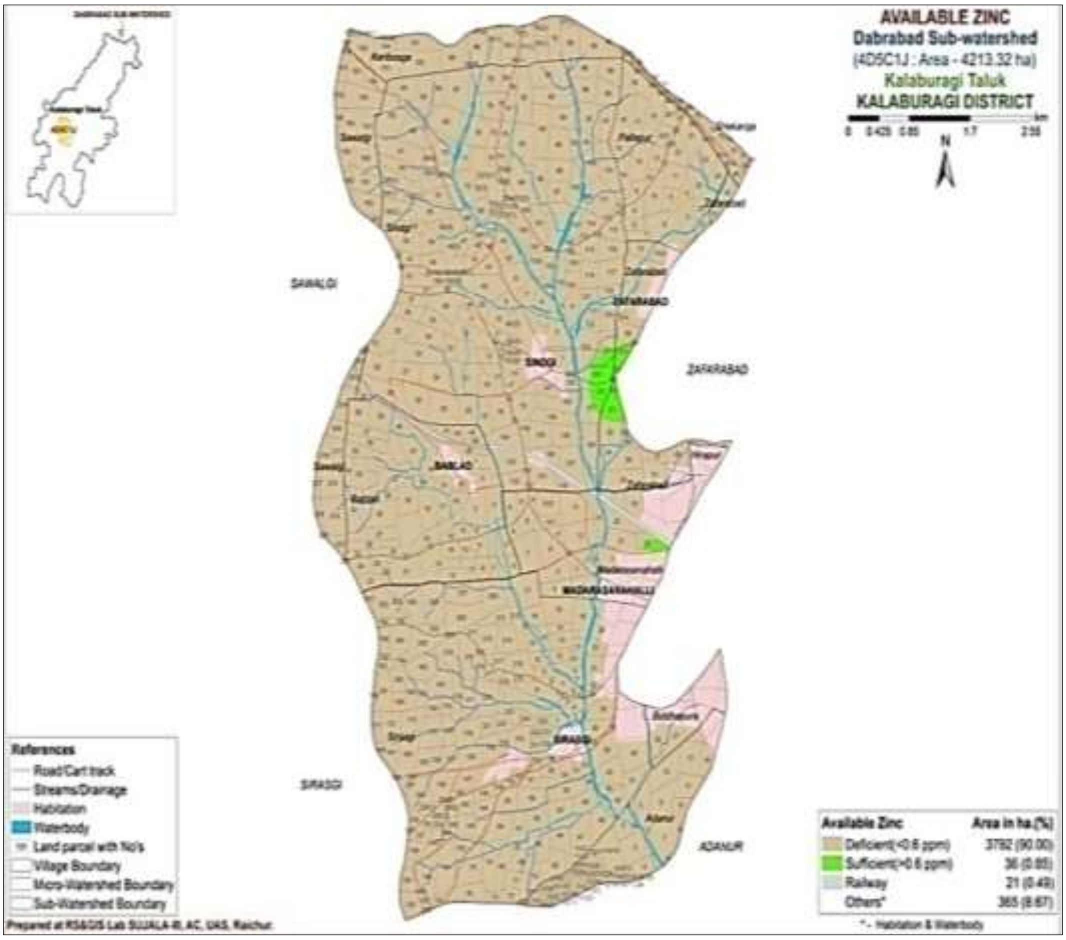

Fig 15: Available zinc map of Dabarabad SWS

Fig 16: Available Copper map of Dabarabad SWS

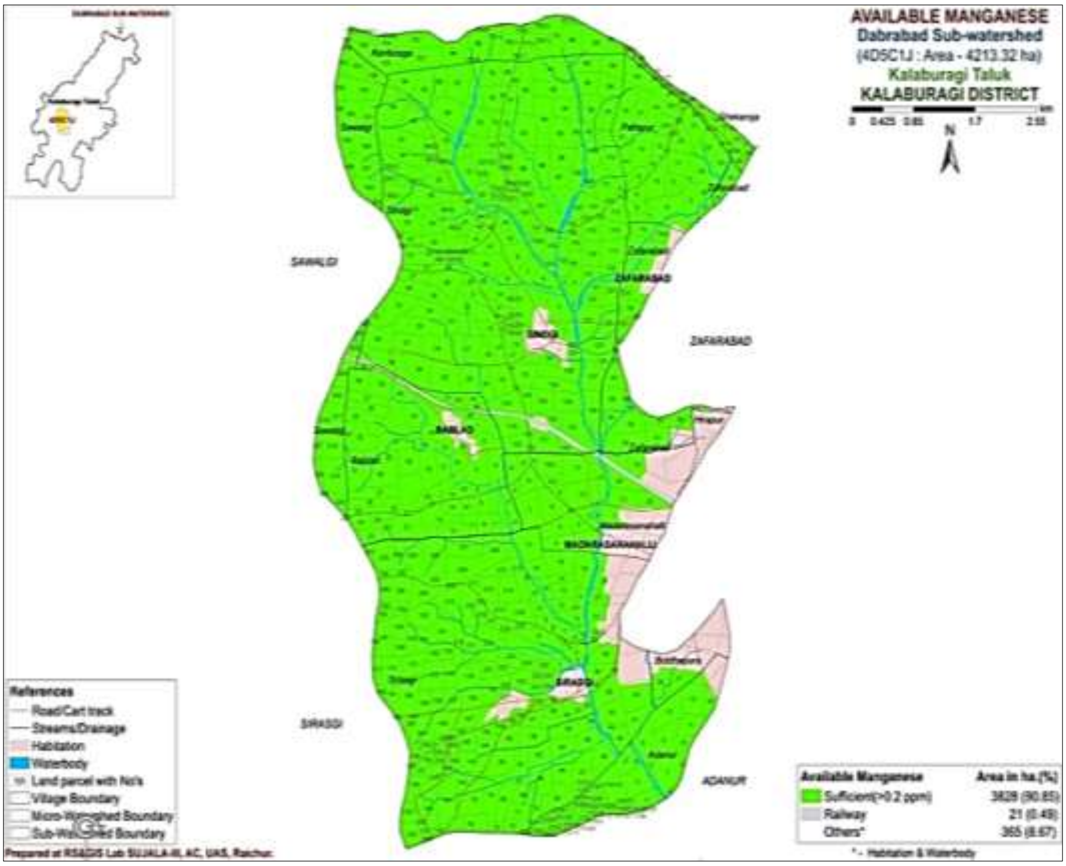

Fig 17: Available Manganese map of Dabarabad SWS

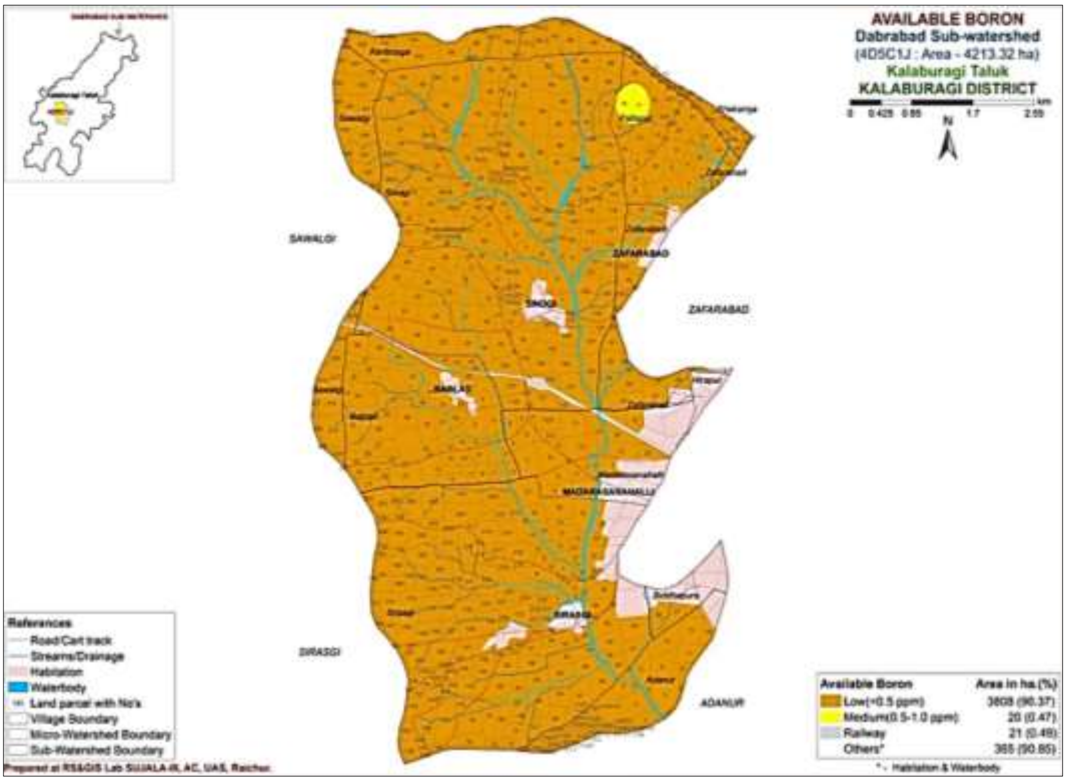

Fig 18: Available Boron map of Dabarabad SWS

Land Capability Classification

The criteria for classifying land capability are aligned with the soil site characteristics of soil units (Table 1) (Rajendra *et al*., 2021) [9, 10]. The mapping units, land capability classification and their extent in watershed is given in (Fig.19). The 27 soil mapping units found in the Dabarabad sub-watershed are divided into three land capability subclasses according to dominating limitations within each land capability class and two land capability classes based on soil characteristics, external land features, and environmental factors. An area of about 90.81 percent in the sub-watershed is marginally to moderately suitable for agriculture with limitation of slope, erosion, texture, soil depth limitations and soil and 9.16 percent is not suitable for agriculture. Similar findings were obtained by Rajendra *et al*. (2021) [9, 10] in soils of Yaadhalli-1 micro watershed of Yadagir district.

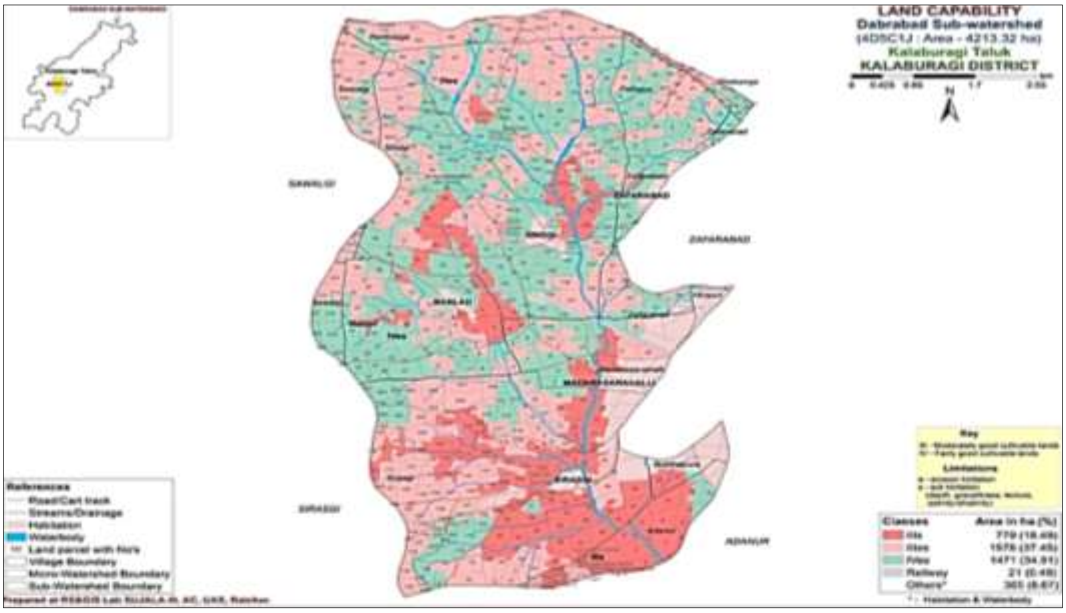

Fig 19: Land Capability Classification in Dabarabad sub-watershed

Land Suitability for Major Crops

By using the process described in FAO (1983) [2], the characteristics of the soil site from the study area were matched with land suitability criteria for different crops. The crop requirements were matched with the soil and land characteristics to arrive at the crop suitability. Using the above criteria, the soil map units were evaluated and land suitability maps for major annual (Redgram and Sorghum) and perennial (Mango and guava) crops were generated.

Land Suitability for Sorghum (*Sorghum bicolor*) and Redgram (*Cajanus cajan* L.)

Sorghum is a medium to long duration crop and redgram is long duration crop with deep root system. The soil-site properties from the study area were matched with land suitability criteria and land suitability maps for growing sorghum (Fig. 20) and redgram (Fig. 21) were generated. Maximum area of about 1521 ha (36.10 %) was marginally suitable (Class S3), an area of 836 ha (19.83 %) is moderately suitable (S2) due to slight limitation of topography and remaining area of 1471 ha (34.91 %) is currently not suitable (N1) for sorghum and redgram production due to severe limitations of rooting depth and topography. Similar results were obtained by Geetha *et al*. (2017) [3] in soils of Giddadapalya Microwatershed of Tumkur District.

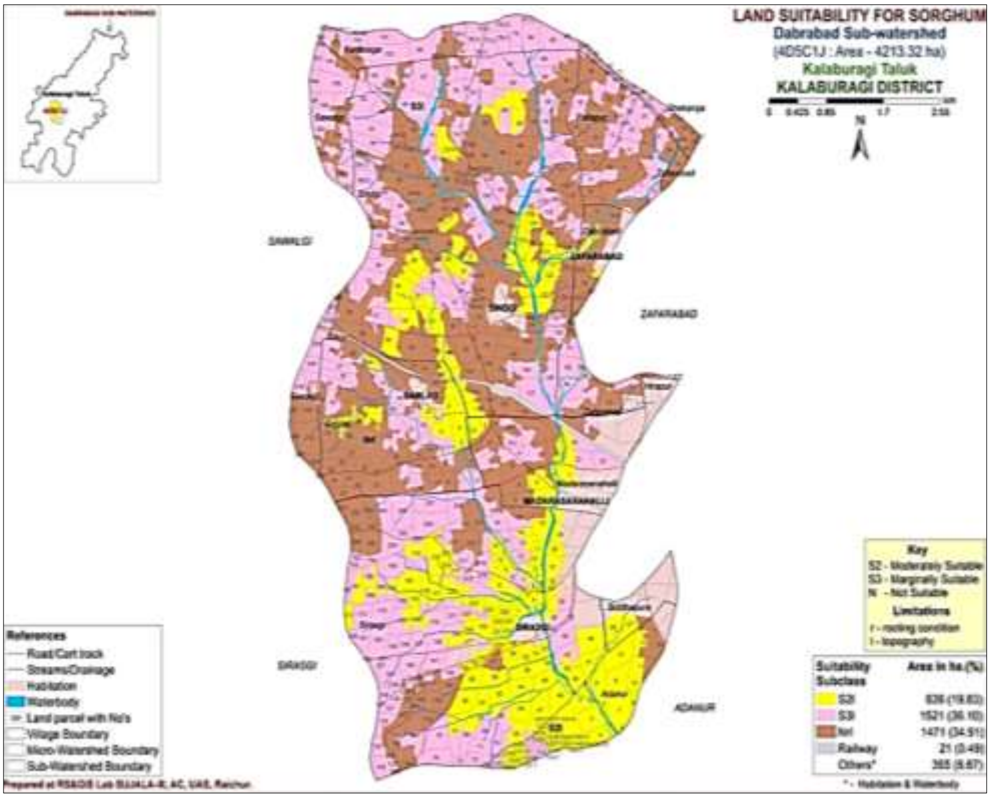

Fig 20: Crop suitability map of Sorghum

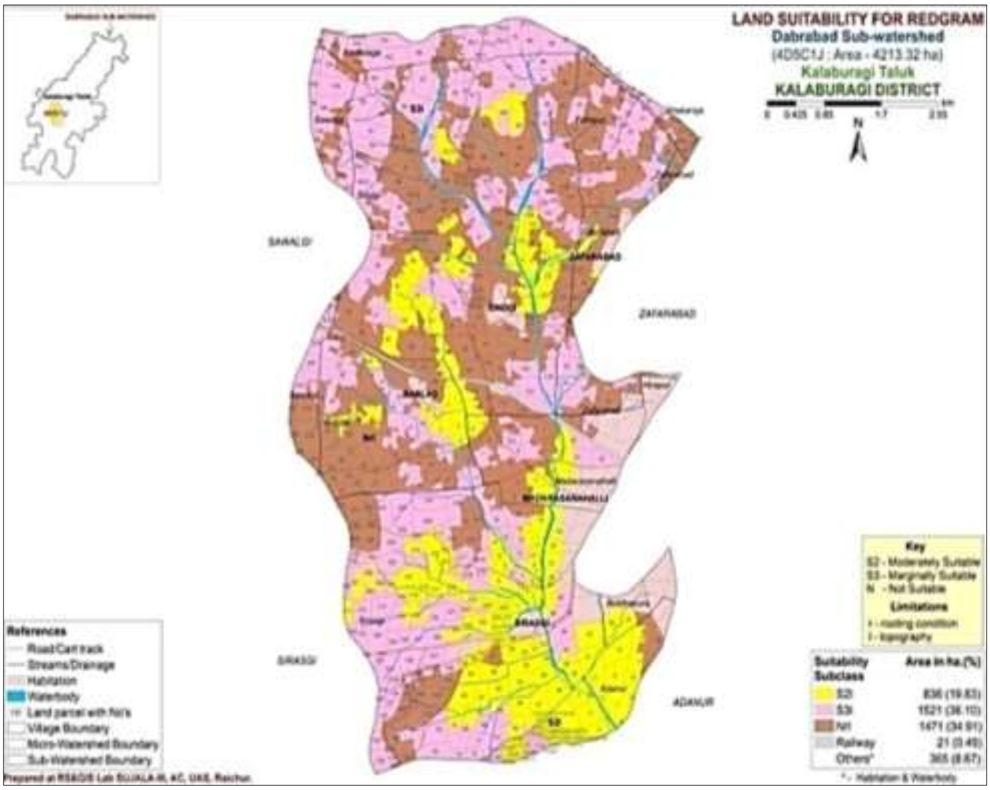

Fig 21: Crop suitability map of Redgram

Land Suitability for Mango (*Mangifera indica* L.) and Guava (*Psidium guajava* L.)

According to Rajendra *et al*. (2021) [9, 10] assessment of the Dabarabad sub-watershed's suitability for mango and guava, an area (Fig. 22 & 23) of about 836 ha (19.83%) was moderately suitable due to a slight texture limitation, and the remaining area of about 2992 ha (71.01%) was currently not suitable due to severe rooting conditions, texture, and topography limitations.

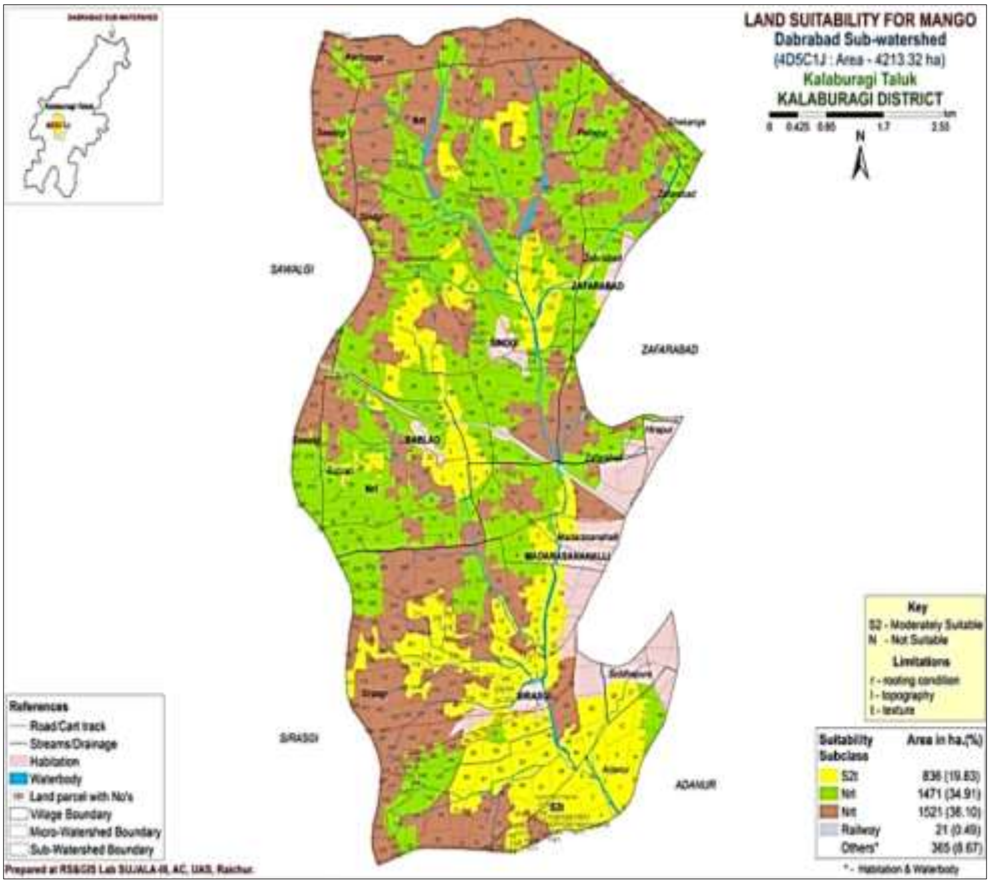

Fig 22: Crop suitability map of Mango

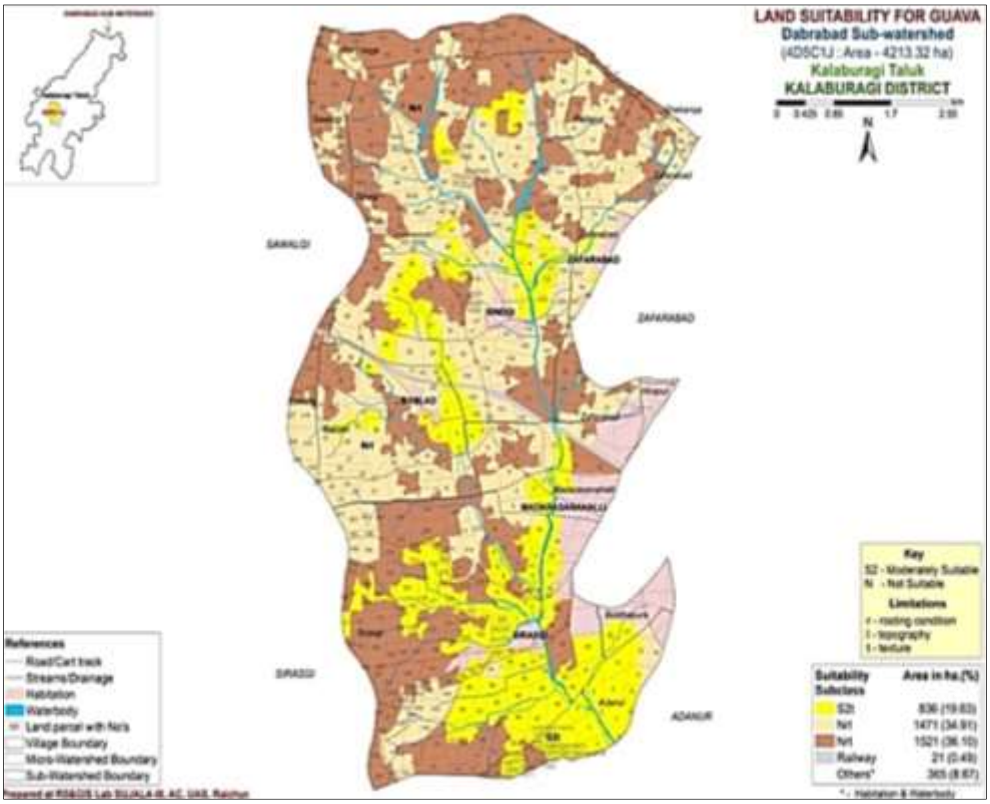

Fig 23: Crop suitability map of Guava

Soil and Water Conservation Plan

For preparing soil and water conservation plan for Dabarabad sub-watershed, the appropriate conservation structures best suited for each of the land parcel/ survey number are selected based on the slope percent, severity of erosion, amount of rainfall, land use and soil type. The different kinds of conservation structures recommended are Graded/Strengthening of bunds, Trench cum Bunds (TCB), Trench cum Bunds / Strengthening and Crescent Bunds.

A map (Fig. 24) showing soil and water conservation plan with different kinds of structures recommended has been prepared which shows the spatial distribution and extent of area. Maximum area of about 3538 ha (83.96 %) requires graded bunding and about 290 ha (6.68 %) area needs trench cum bunding. The conservation plan prepared may be presented to all the stakeholders including farmers and after including their suggestions, the conservation plan for the sub watershed may be finalized in a participatory approach (Natarajan *et al.*, 2015) [7].

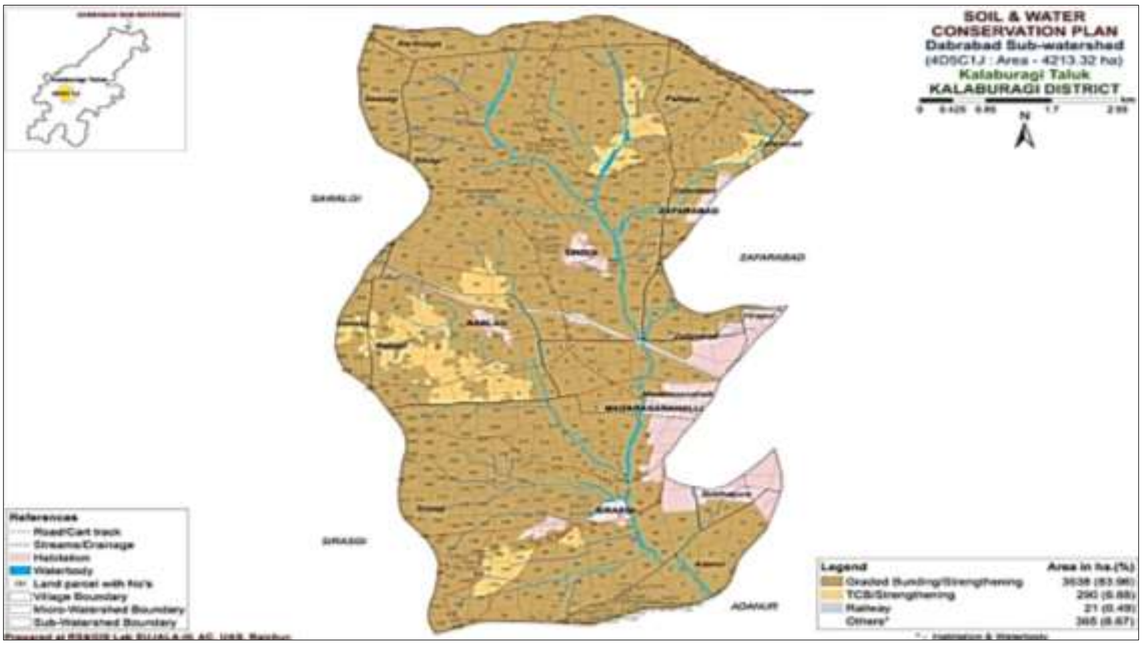

Fig 24: Soil and Water Conservation map of Dabarabad sub-watershed

Proposed Crop Plan for Dabarabad Sub watershed

Following an evaluation of the land's suitability for the main crops, a proposed crop plan was created using the soil phase database created under LRI, which was then used to identify LMUs according to management requirements. One or more than one soil site characteristic having influence on the management have been chosen for identification and delineation of LMU's. The five identified LMU's by considering only the moderately and marginally (Class S2 and S3) suitable lands for each of the crop. The resultant proposed crop plan is presented in Table 3 and Fig. 25.

Table 3: Proposed Crop Plan for Dabarabad sub watershed

Proposed Land Use Class	Soil Map Units	Survey Number	Field Crops	Horticulture Crops	Suitable Interventions
LMU-1	MGTfC3g1S1 MGTfC3g1S2 MGTmC3g1	Bablad: 34, 32, 28, 27, 29, 27, 25, 21, 20, 13, 14, 10, 12, 22, 23, 41, 42, 43, 44. Sawalgi: 227, 218. Sindgi: 25, 20 Sirasgi: 202, 203, 195, 196.	Sole crop; Sorghum, Bajra, Foxtail millet, Greengram, Maize, Sun flower,	Tamarind, Custard apple, Amla, Ber, and Aonla Veg: Brinjal, Chilli, Onion, Tomato, cury leaf, Green leaf Flowers-Gaillardia, Bhendi, marigold,lilly, Chrysanthemum,	Wider and deep size pits, Drip irrigation systems with suitable soil and water conservation measures (Trench cum bunding (TCB)/graded bund, Cultivation of crops on raised bunds with mulch and drip irrigation. Land and soil manage needs with crescent bunds.
LMU-2	MGTfB2 MGTfB2g1 MGTmB2 MGTmB2g1 MGTmB2g1S1 MGTmC2g1 MGTmC2g1S1 MGTmC2g2 MGTmC2g2S1	Keribosga: 108, 103, 88, 88(A). Sawalgi: 154, 157, 158, 160, 161, 162. Sindgi: 80, 82, 75, 66, 65, 62, 70, 49(2), 49(4), 49(1), 59(2), 58(1), 57, 56, 49(5), 49(3), 47, 48, 41, 46, 45, 73(6), 73(4), 73(7), 73(5), 99, 98, 97, 96, 93, 94, 92, 83, 75, 90, 91, 94, 93, 99, 111, 113, 108, 119, 120, 124, 126, 140, 141, 139, 127. Zafarabad: 57, 51, 52, 15, 49, 73, 74/2, 70/4, 78, 69, 70/1, 63, 62 Pallapur: 18, 17, 19, 20/1, 15, 13, 14, 9, 10, 5, 4, 25, 6, 7, 8, 2. Shekaroja: 73, 72, 57/2, 88, 87/4, 69, 67, 70, 71. Madarasanahalli: 9, 8, 7, 6, 12, 5, 4, 11, 13, 10/2. Bablad: 24, 26, 25, 11, 8, 10, 12, 9, 5, 1, 45, 39	Sole crop; Bajra, Sorghum, Foxtail millet, Redgram, Greengram, Maize, Sun flower,	Tamarind, Custard apple, Ber, Amla and Aonla Vegetables: Brinjal, Onion, Tomato, Chilli, Bhendi, cury leaf, Green leaf Flowers-Gaillardia, marigold, lilly, Chrysanthemum,	Wider and deep sized pits, Drip irrigation systems with suitable soil and water conservation, Cultivation of different crops on raised bunds with mulch and drip systems. Land and soil manage needs with crescent bunds. Non-agril. land: "Staggered trenching"' "Continuous staggered trenches" Bunding through surface scraping. Zing terracing: leveling.

		Sirasgi: 201, 196, 212, 213, 215, 214, 17, 18, 57, 144, 145, 143, 240, 244, 239, 245, 142, 238(1), 238(2), 139, 242, 140, 245. Adanur: 16			
LMU-3	BHIfB2 BHIfB2g2 BHImB2 BHImB2g1 BHImB2S1 BHImC2g1 KGImB2 KGImB2g1	Keribosga: 104, 101, 102, 89, 77(1), 66, 65, 63, 62, 61. Shekaroja: 83, 85/1, 82, 85/2, 77, 85/3, 76, 75, 74, 87/1, 87/3. Pallapur: 16, 21, 22, 20/2, 12, 11, 3, 26, 27, 9. Zafarabad: 61, 55, 56, 54, 57, 49, 15. Madarasanahalli: 20, 21, 22, 10/1, 6, 12, 11, 8, 7. Adanur: 1 08, 109, 111/19, 115, 111/18. Sirasgi: 70, 71, 73, 72, 76, 75, 68, 69, 66, 111/1, 128, 130, 136, 137, 138. Bablad: 38, 37, 36, 35, 33, 47, 49, 50, 51, 16, 17, 18, 9, 13, 6. Sawalgi: 216, 217, 205, 204, 203, 163, 149, 150, 155, 151, 152, 153, 156.	Sole crop; Sorghum, Bajra, Foxtail millet, Redgram, Greengram, Cotton, Maize, Sunflower, blackgram, bengalgram, groundnut , maize	Guava, Sapota, Jamun, Lime, Tamarind, Musambi, Custard apple, Amla, pomegranate, Jackfruit, Vegetables: Onion, Tomato, Brinjal, Chilli, Bhendi, Green leaf, cury leaf, Tomato, Flowers-Gaillardia, marigold, Chrysanthemum, lilly	Laser land leveling to 2% slope to reduce soil erosion and facilitate uniform distribution of applied nutrients and soil moisture. Drip irrigation system with suitable water and soil conservation measures. Cultivation of crops on raised beds with mulch materials and drip systems.
LMU-4	GTTmB2 GTTmB2g1 GTTmB2g2	Sindgi: 95, 41, 40, 39, 9, 10, 105. Sirasgi: 15, 12, 9.	Sole crop; Sorghum, Bajra, Foxtail millet, Redgram, Greengram, Cotton, Maize, Sunflower, blackgram, bengalgram, maize, ground nut.	Fruit crops: Guava, Sapota, Jamun, Lime, Musambi, Custard apple, Tamarind, Jackfruit, Amla, pomegranate, Mango Vegetables: Solanaceous, Cucurbits, Drumstick and curry leaf, Onion, Tomato, Chilli, Bhendi, Brinjal, Green leaf, cury leaf, Tomato, Flowers- marigold, Chrysanthemum, lilly, Gaillardia	Application of FYM, Biofertilizers and micronutrients, Cultivation of crops on raised beds with mulches and drip irrigation. Drip irrigation system with suitable water and soil conservation measures. Graded bunds and strengthening of different field bunds
LMU-5	MANmB2 RNLmB2 RNLmB2g1 RNLmC2g2	Sindgi: 73, 73(1), 73(3), 106, 103, 104, 121, 5, 4, 3, 1, 34, 35, 33, 24, 26, 21, 23, 38, 19. Bablad: 44, 2, 4, 3, 31, 29, 30 Madarasanahalli: 13, 20, 1, 2, 3, 8, 9. Sirasgi: 171, 187, 184, 183, 179, 175, 220, 223, 224, 226, 230, 233, 232, 231, 1, 2, 3, 7, 6, 9, 10, 11, 25, 24, 19, 59, 56, 50, 63, 64, 62, 60, 74, 67. Biddhapura: 28, 27 Adanur: 13, 12, 11, 10, 5, 6, 3, 4, 7, 2, 114/14, 112/1, 114/12, 114/13, 126, 115, 111/18, 111/2, 110/2, 110/11, 126.	Sole crop; Sorghum, Bajra, Foxtail millet, Red gram, Green gram, Cotton, Maize, Sun flower, black gram, bengal gram, maize, ground nut.	Fruit crops: Guava, Sapota, Jamun, Lime, Musambi, Custard apple, Tamarind, Jackfruit, Amla, pomegranate, Mango Vegetables:Solanaceous, Cucurbits, Drumstick and curry, Onion, Tomato, Chilli, Bhendi, Brinjal, Green leaf, cury leaf, Tomato, Flowers- Gaillardia, lilly, marigold, Chrysanthemum	Use of short duration varieties, sowing across the slope, drip irrigation and mulching is recommended Cultivation on raised beds with different mulches and various drip irrigation system. Drip irrigation with suitable water and soil conservation measures. Different dgaded bunds and strengthening of field bunds

Conclusion

The various soil types, their spatial distribution and extent, classification, characteristics, and use-potentials are displayed on an appropriate and suitable base map through the Land Resource Inventory (LRI) database, which is available as atlases, maps, and tables. It displays issues and possible regions, along with their geographical distribution and kinds of restrictions. It indicates the regions that need reclamation and conservation of water and soil. This provides information on zones that are suitable for growing major annual crops and, with some restrictions, perennial crops. Additionally, it aids in determining which regions have adequate or insufficient amounts of micro and major nutrients, making it easier to prepare soil health cards for each land parcel or survey number. Lastly, the Land Resource Inventory database aids in the creation of sub watershed optimal land use plans that support both sustainable production growth and the restoration of the ecological balance. The data handling system will be useful in protecting the health of natural resources by helping to make decisions about land use and giving farmers proactive advice in real time.

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