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Integrated Approach of Remote Sensing and Geographic Information System for a Case Study of Lime in Northern Dry Zone of Karnataka

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ABSTRACT

The soil and land resource inventory at village, as basic unit, are providing baseline data on soils, their constraints and potentials for crop production. Considering this fact, Ramtirth Tanda-4 Micro-watershed which is located in between 16^{0}57'0" to 16^{0}59'0" North latitudes and 75^{0}51'30" to 75^{0}53'0" East longitudes, covering an area of about 677.48 ha was selected for the case study. The database was generated by using cadastral map of the village as a base along with high resolution satellite imagery (IRS LISS IV and Cartosat-1). The soil series Babaleshwar (BBL), Halagani (HLG) and Jumanal (JML) were mapped into 6 mapping units using GIS techniques. The soil series Babaleshwar (clay soils, very deep (>150cm) and moderately eroded with 15-35% gravel), Halagani (clay soils, 100-150 cm deep with moderately eroded), Jumanal (clay soils, 100-150 cm deep, moderately eroded with 15-35% gravelliness). The baseline resource data are useful for deriving soil-landscape relationships in basaltic terrain at village and forms the basis for upgrading management packages for sustainable crop production at farm level. The capability maps generated from information collected through field work and topographical maps for Ramtirth Tanda-4 micro-watershed area shows that all the study area belong to arable lands and fit for cultivation. The assessment of Ramtirth Tanda-4 micro-watershed area for growing of horticultural crops like banana, grapes and pomegranate, onion, brinjal, chilli, tomato, papaya, sapota, guava, lime and ber. Crops such as mango, pomegranate, papaya, onion, banana, chilli, tomato, sapota and lime shows that the soils were moderately suitable (S2) with moderate to severe limitations of depth, texture and gravelliness. Mapping units were marginally (S3) to not suitable for ber, grapes, and guava with limitations of texture and gravelliness. Hence the study area could be potentially used for growing above mentioned horticulture crops. Thus, the data on crop-land suitability can help farmers and decision makers to develop new crop management systems along with enhancing land productivity.

Keywords: Land, Remote Sensing, Geographic Information System, Lime, Soil

INTRODUCTION

The Ramtirth Tanda-4 micro-watershed area cultivates some of the best jowar, wheat, pulses, sunflower, bajra, groundnut, linseed, sesame and cash crops like cotton, sugarcane, pomegranate and wine grapes and of course, the native *Kagzi lime*/lemon. Lemon especially the *Kagzi lime* is grown in over 12,000 hectares of land in this district with an average annual production of over 3 lakh MT. An evaluation of the suitability of land for alternative kinds of use requires a survey to define and map the land units together with the collection of descriptive data of land characteristics and resources (Prakash, 2003). Land resources inventory (LRI) provides information about morphological and physico-chemical characteristics of soils, its problems and potentials for best utilization under given set of agro-climatic conditions (Sharma *et al,* 2015). It produces maps of the specified location at larger scale with extent and distribution of various soil groups. However, village development is supposed to be more than a just soil and water management (Reddy *et al,* 2018; Bihare *et al,* 2022). It should be an integrated approach, which aims to improve rural livelihoods including human resource development, pasture development, agriculture development, livestock management and rural energy management. It should aim at the development of all resources for human in existing nature in one ecosystem (Bagherzadeh and Mansouri, 2011; Mendas and Delali 2012; Dengiz, 2013; Hamerlinck and Lieske, 2015).

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Fig. 1: Slope map of Ramtirth Tanda 4 micro-watershed

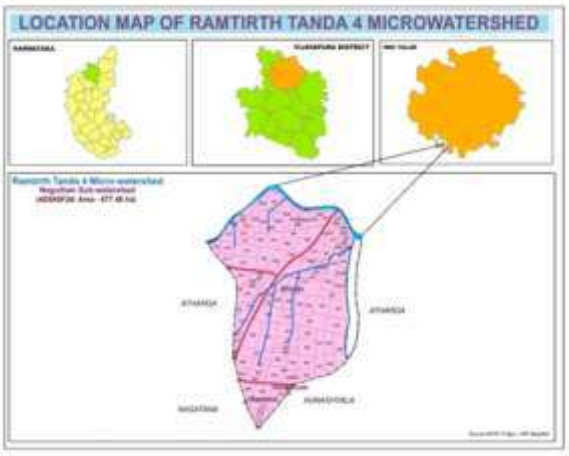

Fig. 2: Location map of Ramtirth Tanda 4 micro-watershed

Fig: Land Suitability for Major Crops

Fig 3: Land Suitability for Lime

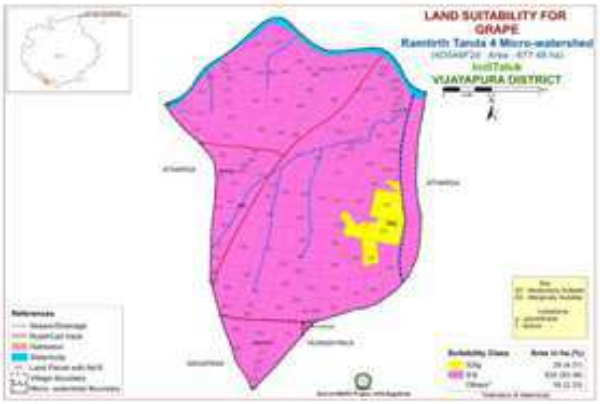

Fig 4: Land Suitability for Grape

Fig 5: Land Suitability for Guava

Fig 6: Land Suitability for Sapota

Various projects have been initiated by National Bureau of Soil Survey and Land Use Planning, Nagpur on land resource inventorization for farm planning in different agro-ecological regions of India (NBSS&LUP, Annual report 2011-12). The aim of this case study is to understand the way of integration of land resource data with village or Taluka development programmes for better utilization (Girma *et al,* 2015). The village-based evaluation of land resources for land use planning and their sustainable use is very important for intensive agriculture. Providing reliable and accurate information on land resources is the key for

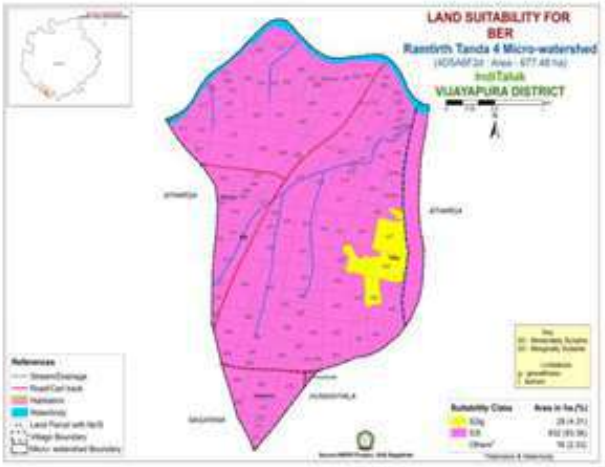

Fig 7: Land Suitability for Ber

Fig 8 (a): Land Suitability for Pomegranate

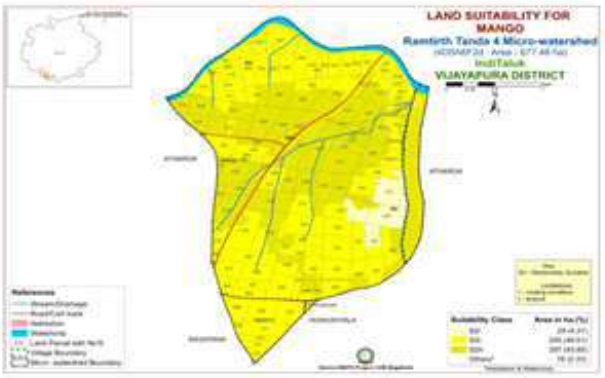

Fig 8 (b): Land Suitability for Banana

Fig 8 (c): Land Suitability for Papaya

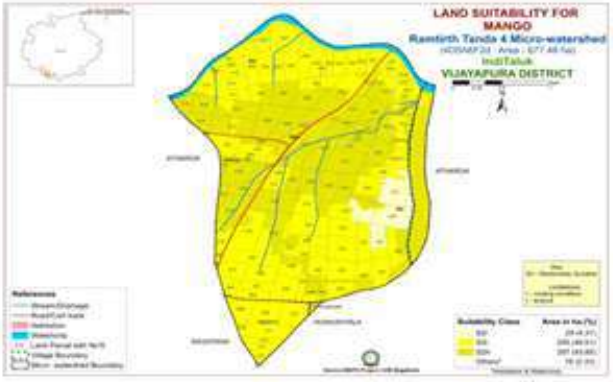

Fig 8 (d): Land suitability for Mango

Fig 9: Land Suitability for Brinjal, Chilli, Tomato

taking right decision at right time for right agro-technology transfer in farmer's field (Dengiz *et al,* 2010). Keeping this in view, we have selected Ramtirth tanda-4 mws in Vijayapura district of northern Karnataka for the case study.

MATERIALS AND METHODS

This study was conducted in Ramtirth Tanda-4 microwatershed of Northern Dry Zone which is located in between $16^0$57'0" to $16^0$59'0" North latitudes and $75^0$51'30" to $75^0$53'0" East longitudes, covering an area of about 677.48 ha. Northern Dry Zone extends over entire Koppal, Vijayapur, Bagalkot and Bellary district and five taluks of Belgaum, two of Raichur, one of Dharwad and Davanagere and four of Gadag. The total geographical area of the zone is about 4.78 M ha. Most of the zone is at an elevation of 450-800 m from mean se level, but some area is between 800 and 900 m from mean sea level. Average annual rainfall of the

Table 1: Mapping unit description

Sr. No.	Mapping unit	Mapping Unit Description	Area in ha. (%)
1	BBLmB2	Very deep (>150 cm), clay soils developed on very gently sloping (1 -3%), with moderately eroded	201 (29.6)
2	BBLmB3	Very deep (>150 cm), clay soils developed on very gently sloping (1-3%), severely eroded	135 (19.91)
3	HLGmB2g1	Deep (100-150 cm), clay soils developed on very gently sloping (1-3%), moderately eroded with gravelly (15-35%)	92 (13.54)
4	JMLiB2g1	Deep (100 -150 cm), sandy clay soils developed on very gently sloping (1 -3%), moderately eroded with gravelly (15-35%)	29 (4.31)
5	JMLmB2	Deep (100-150 cm), clay soils developed on very gently sloping (1-3%), moderately eroded	155 (22.91)
6	JMLmB2g1	Deep (100-150 cm), clay soils developed on very gently sloping (1-3%), moderately eroded with gravelly (15-35%)	50 (7.39)
7	Others	Habitation and Waterbody	16 (2.33)
		Total	**677.48(100)**

Table 2: Grouping of Soil-site suitability characteristics of soil mapping units of Ramatirth Tanda-4 micro-watershed

Mapping unit	Grape	Lime	Pomegranate	Sapota	Guava	Banana	Ber	Papaya	Mango	Onion	Vegetables (Solanaceous)
BBLmB2	S3t	S2t	S2t	S2t	S3t	S2t	S3t	S2t	S2t	S2t	S2t
BBLmB3	S3t	S2t	S2t	S2t	S3t	S2tg	S3t	S2tg	S2t	S2tg	S2tg
HLGmB2g1	S3t	S2t	S2t	S2rt	S3t	S2t	S3t	S2t	S2rt	S2t	S2t
JMLiB2g1	S3t	S3t	S3t	S2rt	S3t	S2tg	S3t	S2tg	S2rt	S2tg	S2tg
JMLmB2	S3rtg	S3rt	S3rt	S3rt	S3rt	S3rt	S3rt	S3rt	S3rt	S3rt	S2rtg
JMLmB2g1	S3rt	S3rt	S3rt	S3rt	S3rt	S3rt	S3rt	S3rt	S3rt	S3rt	S2rtl

zone ranges from 464.5 to 785.7 mm. The soils are medium to deep black clay in major areas with sandy loams in remaining areas. The main cropping season is *Kharif*. Sorghum, maize, bajra, red gram groundnut, green gram, cotton, sugarcane, wheat, chick pea and horticultural crop like grape, lime, pomegranate and vegetables like chilli, onion, brinjal and cucurbits are the important crops of the zone. A cadastral map of the village was used as the base and integrated with high-resolution satellite imagery (IRS LISS IV and Cartosat-1) to generate a spatial database. Soil survey and field investigations were carried out to identify soil series and their characteristics. Using GIS techniques, the soils were classified into mapping units, and their physical and morphological properties such as depth, texture, erosion, and gravelliness were assessed. Land capability and suitability analysis for various horticultural crops was performed by integrating field data with topographical maps.

RESULTS AND DISCUSSION

Slope: The analysis of the micro watershed revealed that 97.67 per cent of the area falls under very gently sloping category (1-3%) (Fig. 1).

Soil map and soil mapping units

A soil map is designed to show the distribution of soil types or other soil mapping units in relation to other prominent physical and cultural features of the earth's surface. In the identification of soil mapping units of the study area, soil series, soil texture, soil depth, slope, erosion and gravelliness were used as input parameters. Our study area is grouped into three series namely, Babaleshwar (BBL), Halagani (HLG) and Jumanal (JML) series. Babaleshwar series covers 336 ha (49.51%) of the study area and they are very deep, clay soils developed on very gently sloping (1-3%) with moderate erosion. Halangeni series which covers 92 ha (13.54%) area are deep clay soils with

moderate erosion. Jumanal series covers 184 ha (27.22%) and are classified as deep clay soils developed on gently sloping (1-3%) with moderately erosion (Table 1). These were mapped into six mapping units at different phases of soil series with the help of Arc View Interface of ArcGIS 10.8.2 GIS software (Figure 2). The mapping legend is presented as HLGmB2g1, First three capital letters represents the name of the series (HLG-Halagani), followed by small alphabetic letter represents surface texture (m-clay) and next capital letter indicates slope (B-1 to 3%) of the land and next numerical indicates erosion status (2-moderately eroded) and g1(15-35 %)indicates gravelliness class *i.e.,* gravelly (Suryawanshi *et al,* 2005; Mishra *et al,* 2006; Mishra and Babu, 2009; Silpa and Nowshaja, 2016). Legend design and the kinds of mapping units for the study area were determined by the procedure and kind of survey as indicated in LRI Field guide, REWARD project (ICAR-NBBSS & LUP, 2018).

Soil-site suitability evaluation

Based on the criteria and degree of limitation, the overall suitability for lime showed that (Table 2), the soils of BBL and HLG series are moderately suitable (S2) due to minor limitations of texture and gravelliness, whereas, JML series soils are marginally suitable (S3) for lime cultivation. Nearly, 632 ha (93.36 %) area under marginally suitable (S2t) and 29 ha (4.31 %) area under highly suitable (S1) class (Fig. 3) for cultivation of lime. The crop suitability map of grape depicts that 632 ha (93.36%) area is classified as marginally suitable (Fig 4), the soils of BBL, HLG and JML are marginally suitable (S3) for grape cultivation. The suitability evaluation (Table 2) for guava showed that soils of BBL, HLG and JML series are marginally suitable (S3), due to minor limitations of texture and gravelliness and majority of the area *i.e.,* 632 ha (93.36%) area falls under marginally suitable (S3) and 29 ha (4.31%) of watershed area falls under moderately suitable (S2) class (Fig 5). The overall suitability class for pomegranate, sapota, banana, papaya, mango and onion showed that the soils of BBL, HLG and JML series are moderately suitable (S2) and marginally suitable (S3). Soils are marginally suitable for growing of pomegranate, sapota, banana, papaya, mango and onion with limitations of texture, gravelliness and depth (Table 2) (Fig. 8a, b, c & d). The crop suitability criteria for ber showed that soils of BBL, HLG and JML are marginally suitable (S3) (Fig 7). Out of total micro watershed area 491 ha (72.42 %) is moderately suitable (S2) at BBL, HLG and JML mapping units and marginally suitable with limitations like gravelliness, topography, rooting condition and texture suitable for cultivation of solanaceous vegetables (Brinjal, Chilli and Tomato) in Ramtirth Tanda-4 micro watershed (Fig 9).

CONCLUSION

The capability maps generated from information collected through field work and topographical maps for Ramtirth Tanda-4 micro-watershed area shows that all the study area belong to arable lands and fit for cultivation. The assessment of Ramtirth Tanda-4 micro-watershed area for growing of horticultural crops like banana, ber, grapes, guava, lime, mango, papaya, pomegranate and sapota shows that the soils were moderately suitable (S2) to marginally suitable (S3) with moderate to severe limitations of depth, texture and gravelliness. Mapping units were marginally (S3) to moderately suitable (S2) for onion and solanaceous vegetables with limitations of texture and gravelliness. Hence the study area could be potentially used for growing above mentioned horticulture crops. Thus, the data on crop-land suitability can help farmers and decision makers to develop new crop management systems along with enhancing land productivity.

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