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Land Resource Inventory for Evaluation of Land Capability and Land Use Planning in Palakkad District of Kerala State using Remote Sensing and GIS Techniques

A. William Mariya Josheph*, R. L. Meena and V. S. Arya

Soil and Land Use Survey of India, IARI Building, New Delhi- 110 012

Abstract: Land resource inventory was carried out in Palakkad District using remote sensing, GIS and GPS technologies. IRS- ID, LISS-III Satellite imageries were used to delineate different soil units based on image characteristics and was correlated with the different landforms. A standard soil survey methodology was followed to prepare soil resources map of the area. The inherent soil properties as an internal attributes and topography, physiographic unit, slope and climate as an external land feature of each mapping unit were evaluated for their capability occuring. It was found that soils developed on valleys and pediplain covered an area of 45.7 per cent under agriculture and plantation crops and have been classified in Land capability class II and III. Soils of foothill slope and pediment constituting 5.7 per cent of the area were classified in class III and IV and covered by plantation and open scrub. Soils of hill side slope covered an area of 8.8 per cent and classified under class VI and VII with plantation and open scrub. Reserve Forest area which constitutes 29.1 per cent was not grouped as per capability classification criteria. The study indicated that Physical, chemical and biological phenomenon occur in natural habitat and conservation processes play a decisive role and should be considered for designing proper Land use planning aimed at the effective utilization of land according to their classes.

Keywords: *Soil unit, landform, soil classification, soil capability, remote sensing, GIS.*

Introduction

Soils are the foundation of agriculture, which in turn is the basic building block in the livelihoods of all people. Land is becoming increasingly scarce, and new land taken into cultivation is often marginal compared to what is removed by degradation or urbanization. Soil survey provides integrated data essential for land use planning and soil resource development. It helps in studying and recording properties of soil and its environment in the field as well as important soil characteristics in the laboratory. The data so obtained are utilized for the classification of soils under well defined units. The extent of occurrence of each unit is shown on a map of appropriate scale. The utility of the soil maps is further enhanced by the interpretation of mapped units for capability classes based on the intensity and type of hazards involved in land use. Soil resource inventory provides an insight into the potentialities and limitation of soil for its effective exploitation and interpretation for multifarious land uses. Remote sensing technology has been used successfully in studying the different aspects of soils in spatial and temporal domain. The remote sensing satellite data interpreted as a function of soil properties and soil units delineated with respect to image characteristics and correlated with landform (Shukla *et*

*Corresponding author: (Email: joshphilo@gmail.com)

al. 2009; Ardak *et al.* 2010). Relevant information's were also collected from Survey of India Toposheets.

Study area

The Palakkad district (76° 02' to 76° 54' E; 10° 21' to 11° 14' N) is covered by 14 number of Survey of India toposheets *viz.* 58 A/08, 58 A/12, 58 A/16, 58 B/01, 58 B/02, 58 B/05, 58 B/06, 58 B/07, B/09, 58 B/10, 58 B/11, 58 B/13, 58 B/14 and 58 B/15 on 1:50,000 scale. The district lies at the foot of the Western Ghats Region of India (Fig. 1) and occupy an area of 4,47,652 hectare. It is often called as the "Gateway of Kerala". The Sahya Ranges bordering the region and the 32 km long gap in the mountains causes a dominant influence on the climate of the region. This gap is known as "Palakkad Gap". Palakkad district has wet monsoon type of climate. Rainfall during South-west monsoon season contributes nearly 70 per cent of total rainfall of the year, followed by the north-east monsoon which contributes nearly 15 per cent and the balance of 15 per cent is received during the month of January to May as summer/pre-monsoon showers. The mean monthly maximum temperature ranges from 29.3 to 35.9**°**C and the minimum ranges from 20.7 to 24.7**°**C. The difference between the mean summer and mean winter temperature is < 2.20**°**C. The Palakkad district falls in the Agro-climatic Zone- XII (West Coast Plains & Ghat Region). The soil temperature regime of the area is Isohyperthermic and the moisture regime can be presumed as 'Udic'. The major land use/ land cover categories identified within the study area are: Agriculture, plantation, forest, water bodies, built-up lands or habitation, scrub land and waste land. Parvathy *et al.* (2014) attempted to study the change detection in land use/land cover using remote sensing in Palakkad district. The present study is aimed to survey the land/soil resources of district on 1:50,000 scale using geospactial techniques so that the land resources could be grouped into different land capability classes for sustainable planning as soil survey provides adequate information about soil-site characteristics (Jagdish Prasad *et al.* 2009).

Materials and Methods

Satellite images of IRS- ID, LISS-III for the year 2006 were used to prepare soil maps of the study area on 1:50,000 scale. The soil mapping units were delineated by interpreting the satellite data based on image characteristics like tone, texture, parcelling, pattern, shape, size, colour, and association. The topographic features (*i.e.* surface elevation, slope, aspect, relief) and major physiographic units were extracted from Survey of India Toposheets. The origin of soil deposits were extracted from geological map of the district sourced from Geological Survey of India (GSI). The data extracted from both the sheets were converted into defined soil units and were verified by ground truthing through field observations. A semi-detailed survey was carried out throughout the study area in order to achieve more information of the soil patterns, landforms and soil characteristics of landscape. Selected soil profiles were taken to represent delineated soil mapping units. The morphological description of these profiles were recorded in field according to the guidelines of Soil Survey Manual developed by Soil and Land Use Survey of India organisation (AIS&LUS 1970). The collected soil samples from the selected profiles were analysed for their basic physico-chemical properties.

The Comprehensive System of Soil Classification was followed to classify the different soils of the district to correlate the physiographic and taxonomic units. Soils of the district were classified under orders Alfisols, Entisols, Inceptisols, Mollisols, Oxisols, Ultisols and Vertisols. Recently Jagdish Prasad *et al.* (2021) have reported occurance of shrink-swell soils in Palakkad district of Kerala. The data obtained as raster was converted into vector using GIS software; the spatial data was generated using ArcMap to create different theme maps. The spatial data was analysed for interpreting capability class of soils based on their characteristics and limitations to evaluate their present and future potentialities. The soil capability map was generated for planners to be used as a vital input to prepare a strategic planning for effective and efficient decision making.

Results and Discussion

Based on the Satellite data, Survey of India Toposheets and field survey, the physiography of the district was identified and delineated. The results indicated that the major physiographic units in the study area were undifferentiated hills side-slope (41 per cent) followed by lower pediplains, upper pediplains, pediments, foot hill slope and valleys. Paddy is the major crop of area and grown in autumn, winter and summer seasons in lowland and part of high land area is under in contour farming. Other field crops like cotton, groundnut, sugarcane, some vegetables *etc.* grown in rainy season. The pattern also reveals of the agricultural land use greatly influenced by the location of water bodies. The highest concentration of agricultural land use in midland of the district is seen in tehsils of Alathur, Chittur, Palakkad, Pattambi, Ottappalam and some part of Mannarkad as well as mixed plantations are also with dominance of coconut, rubber, arecanut and mango. The tea, coffee and cardamom are planted in south-east hilly terrain part of the district. The soil map and soil mapping units described in fig.2

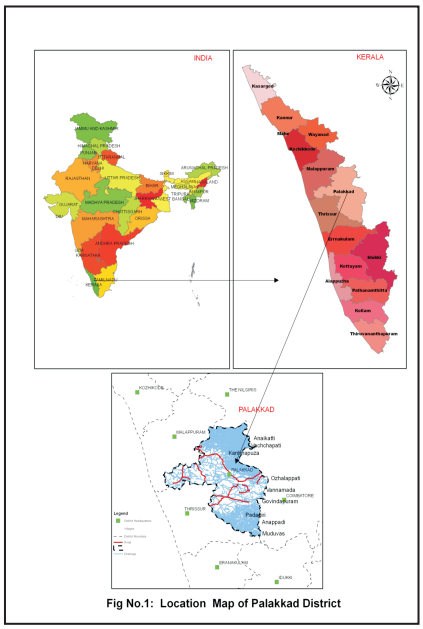

Fig. 1.

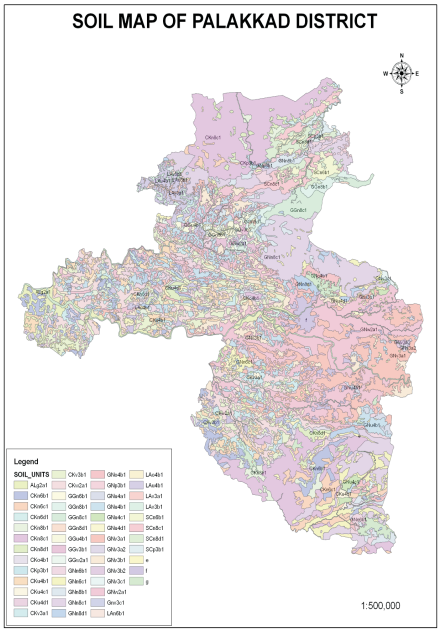

Fig. 2.

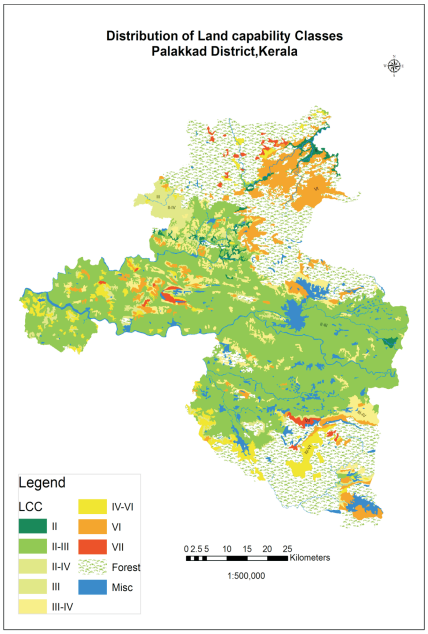

Fig. 3.

Land capability assessment

The capability classification is an interpretive classification based on effects of combination of climate, morphological characteristics and physico-chemical properties associated with land features like physiography, slope, land use / land cover, sodicity, calcareousness, erosion hazards *etc.* The land capability classification for the soils of the district has been interpreted as per standard classification criteria. The areal extent under different capability classes is given in table 1.

Based on topography, slope, erosion susceptibility and improved crop management practices, the soils developed on valleys, upper and lower pediplains have been classified into class II, III and between II and III and covers an area of 1.2, 3.6 and 40.9 per cent, respectively with present land use of agriculture and plantation crops. The detail description of mapping unit for LCC is given below.

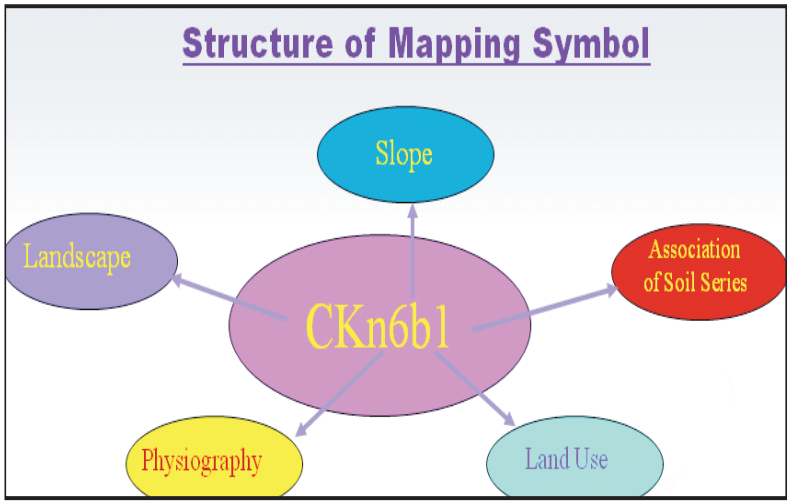

Table 1. Distribution of mapping units under different Land Capability Classes

S. No.	Land Capability Class	Mapping Units	Area (ha)	Percentage
1	II	GGw2a1,GNp3b1,GNv3a2,GNv3b2,SCp3b1	5402	1.2
2	III	CKo4b1,GGu4b1,LAo4b1,LAu4b1	16158	3.6
3	II-III	ALg2a1,CKp3b1,CKu4b1,CKv3a1,CKv3b1,CKw2a1, GGv3b1,GNv3a1,GNv3b1,GNw2a1	182954	40.9
4	II-IV	LAv3a1,LAv3b1	4221	0.9
5	III-IV	GNo4b1,GNu4a1,GNu4b1,GNu4d1	25572	5.7
6	IV-VI	CKn6b1,CKn8b1,LAn6b1	17774	4.0
7	VI	GGn8b1,GNn6b1,GNn8b1, CKn6d1,SCn6b1,	24771	5.54
8	VII	CKn8d1, SCn8d1, GGn8d1, GNn8d1	14850	3.33
9	Not assign	(CKn6c1,CKn8c1,CKu4c1,GGn6c1,GGn8c1, GNn6c1,GNn8c1,GNu4c1,GNv3c1,SCn8c1) Reserved Forest	130325	29.1
10	e	Rockout crop	5624	1.26
11	f	Habitation	7602	1.70
12	g	Water body	12399	2.77
Grand Total			**447652**	**100**

Soils of foothill slope and pediments were classified between III and IV due to moderately sloping topography with 5.7 per cent area and covered with plantation and open scrub whereas the soils on upper pediplain on lateritic landscape categories falls under II to IV because of soils having root zone limitation. Soils of hill side slope were classified under VI, VII with 5.5 and 3.3 per cent areal extent, respectively and covered with plantation and open scrub. The soils of Reserve Forest area occupied 29.1 per cent of the total area of the district. The land capability classification map is presented as figure 3 and the abbreviation codes used in soil map are given in table 2 and 3.

Land use capability

Land capability classification is primarily supportive to the planning of large area and it augments land use planning, *e.g.* balance the need for agricultural land against urban development or forest land against agriculture or pasture development. In doing this, the land capability classification has made an important contribution to the development of land use planning and management. The land capability-wise dominant soil units have been grouped into seven land capability classes suitable for agriculture, forest, pasture, recreation and rehabilitation (Fig. 3). In the district, it was observed that about 43 per cent of land is suitable for agriculture while 13.3 % suited for plantation/pasture remaining 8.9 % per cent area is classified as suitable for pasture/forest plantation and other purposes.

The cultivated land in the area having (capability class II, III) are divided into two main categories as (i) Paddy lands and (ii) land under other crops including horticulture crops. The important crops can be grown in district are rice, pulses, coconut, tapioca, vegetables and fruits. The main crops are grown in all the villages are cereals-paddy, cash crops-sugarcane and banana. Productivity is high for a wide range of field crops adapted to the area. Local/regional infrastructure to support intensive forms of agriculture is present. Slopes are level to gently inclined. Soils are deep to very deep. The land is capable of sustaining regular cultivation; however, conservation tillage practices may be adopted. The soil profile is either moderately well drained or imperfectly drained. Erosion hazard is low to moderate, so soil conservation measures may be adopted to control the intensity of erosion hazard. Any soil physical and chemical constraints are capable of being economically overcome for a wide range of field crops. Class III and IV lands have moderate levels of social, economic or physical limitations, restricting the extent of arable agriculture. Further erosion hazard, land slope may limit the intensity for cultivation and productivity of soils and crops and thus soil conservation or drainage works may be required. The land capability class VI having very steep sloping land with high relief are suitable only for forest tree, plantation crop and spices.

Table 2. Abbreviations used in soil map for various mapping units.

		Geology		**Physiography**		**Landuse**
1	AL	Alluvium	w	Lower pediplains	a	Agriculture
2	CK	Charnockite	v	Upper pediplains	b	Plantation
3	GN	Gneiss	u	Pediments	c	Forestry
4	GG	Granite Gneiss	g	Stream banks	d	Open scrub
5	LA	Laterite	p	Narrow hill valleys	e	Barren land
6	SC	Schist	o	Foot hill slopes	f	Built up area
7	1/2	Soil series association	n	Undifferentiated hills side slope	g	Water bodies

Table 3. Different slope classes and their codes

Slope Percent	Slope Class	Slope Description	Slope Code
0 to 1 %	A	Nearly level (0-1%)	1
0 to 3%	AB	Nearly level to Very gentle slope (1-5%)	2
1 to 5%	BC	Very gentle to Very gentle slope (1 -5%)	3
3 to 10%	CD	Gentle to Moderate slope (3 -5%)	4
5 to 15%	DE	Moderate slope to Strong slope (5 -15%)	5
10 to 25%	EF	Stron g slope to Moderately steep slope (10-25%)	6
15 to 33%	FG	Moderate steep slope to Steep slope (15 -33%)	7
33 to50%	HI	Steep slope to Very steep slope (25 -50%)	8

Conclusion

The findings indicated that based on land capability classification nearly two third of the area is suitable for agriculture and plantation. A massive soil and water conservation programmes are the need of hour to combat natural calamities. Besides these, judicious allotment of land for different land uses, may help in restoration of land resources for prospective planning.

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