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Delineation of Land Management Units for Alternate Land Use Options: A Case Study of Bishalgarh Block in Sepahijala District of Tripura

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ABSTRACT

Planning and management of land resources are integral part of any developmental programme related to agriculture. GIS based land resource inventory with satellite imagery is considered as most effective tool for soil resource mapping. In the present study, we attempted to delineate the land management unit (LMU) based on problems and potentials of soils and in each LMU the present land-use and suggested land-use option is given for the block for land use planning.

INTRODUCTION

Reliable and timely information on natural resources is very much essential for formulation of a land use plan. The soil resource maps serve as a base for monitoring changes in soil quality with respect to erosion and deposition, inundation and natural calamity. Soil maps have become valuable tools for natural resource management. Adequate knowledge about the distribution and properties of soils is a key issue to support sustainable land management, which, among others, includes erosion control, fertility management, crop choice, and possibilities for irrigation.

Detailed soil information in 1:10,000 scale is required for many environmental modeling and land management applications, and also highly useful for developing watershed and village level sustainable agricultural land use planning (LUP) in India (Saxena and Prasad 2008). Remote sensing has become an indispensable scientific tool for mapping and monitoring of natural resources (Kasturirangan *et al.* 1996) and frequently used in the characterization of the soil resources (Srivastava and Saxena 2004) for planning. GIS has emerged as a powerful tool for spatial analysis of natural resources and data base management. A large scale mapping using latest and fine resolution imageries and thereby generate unique and detailed land mapping units (Srivastava and Saxena 2004) without compromising any geomorphic information.

The concept of land management unit (LMU) is on the unique characteristics of a land parcel under similar biophysical (climate, physiography, soil, land use and eco-system) and socio-economic environments. The concept may be used for alternate land use options at block level in a site specific mode (Reza *et al.* 2017a, 2017b, 2019a). Successful agricultural

technology implementation depends upon crop planning based on need based soil resource inventory which can respond similar soil and input management practices. Such models are highly accepted by the state agricultural and allied line departments for implementation of LUP at regional and local levels.

STUDY AREA

The study was carried out in Bishalgarh block of Sepahijala district, Tripura, India (23°36′51″–23°45′02″ N, 91°08′58″–91°23′00″ E) covering an area of 170.51 km^2 (Fig. 1). The area is characterized by humid subtropical climate with annual mean maximum temperature is 36ºC and annual mean minimum temperature is 7ºC. Mean annual rainfall is 2340 mm and about 85% of rainfall is from south-west monsoon. Geomorphologically, the study area represents undulating topography (3–25% slope). The rocks are sandstone, siltstone and shale grading into clay. These rock types are repeated as layers one above the other. Depending on their characters and the presence of fossils, these sedimentary rock sequences are divided into Surma group (the oldest), Tipam group and the Dupitila group (the youngest). Two major landforms namely, valley land (*lungas*) and high lands (*tillas*) are common in the study area. The *lungas* is well suited for common agricultural crops like rice, pigeon pea, black gram, green gram, cowpea whereas *tillas* are fit for plantation crops like rubber and tea. Sugarcane, potato, groundnut, ginger and turmeric are also cultivated on the *tilla* and *lunga* lands.

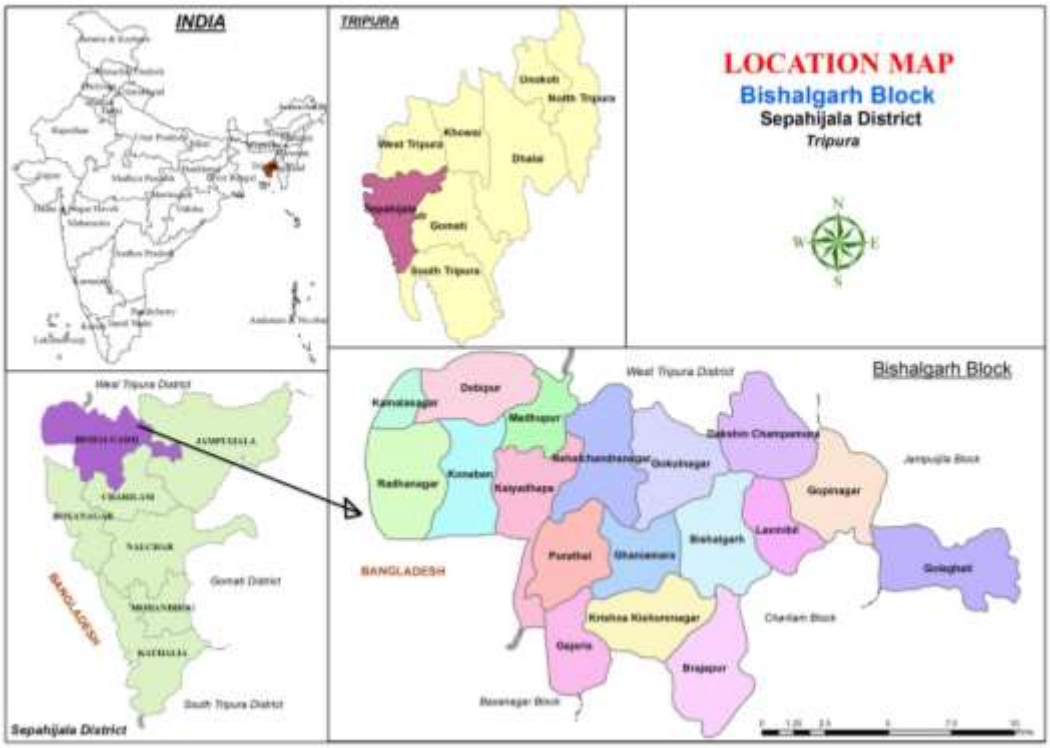

Fig. 1. Location map of Bishalgarh block

METHODOLOGY

Survey of India toposheets and Indian Remote-Sensing Satellite (IRS)-R2 LISS-IV data were used in this study. Delineation of land use/land cover and landform analysis were carried out by onscreen visual interpretation of IRS-R2 LISS-IV data in ArcGIS software. The landform,

slope, and land-use/land-cover layers were integrated in ArcGIS to generate landscape ecological unit (LEU) map. The LEU units are relatively homogeneous in terms of the main factors of soil formation and typical predictors of soil characteristics. The LEU map was used as a base map for conducting soil survey. To check the accuracy of the base map, ground truth verification was done. The area was traversed for identification of different landform units, slope, and present land-use/land-cover classes, and correlated with image interpretation units. The boundaries of LEU units were verified and corrected wherever necessary. Soil survey was conducted and representative soil profiles were selected for laboratory analysis after doing soil correlation. Soil samples were air dried in the laboratory at room temperature, ground using a wooden pestle and mortar, screened through a 2 mm sieve, labelled properly, and stored in polythene bags for further analysis. Analysis of soil physical and chemical characteristics was carried out as per standard procedures. Besides soil map other thematic maps like soil reaction (pH), soil fertility, soil erosion and drainage were integrated in ArcGIS to prepared LMU map.

LMU BASED ALTERNATE LAND USE OPTIONS

The low productivity of agricultural crops in the block is the combined effect of problems of the soils, water and climate. Major soil problems are soil acidity, soil erosion, light soil texture, low fertility status (Reza *et al.* 2018, 2019b, 2019c). Besides these, natural disasters like heavy rains and overflow of water causing severe flood and/or water-logging and damage to rice and other crops. Based on major problems like soil reaction (pH), soil erosion, and drainage a LMU map (Fig. 2) of the block was prepared. The description of constraints for crop production in each unit along with area is given in Table 1.

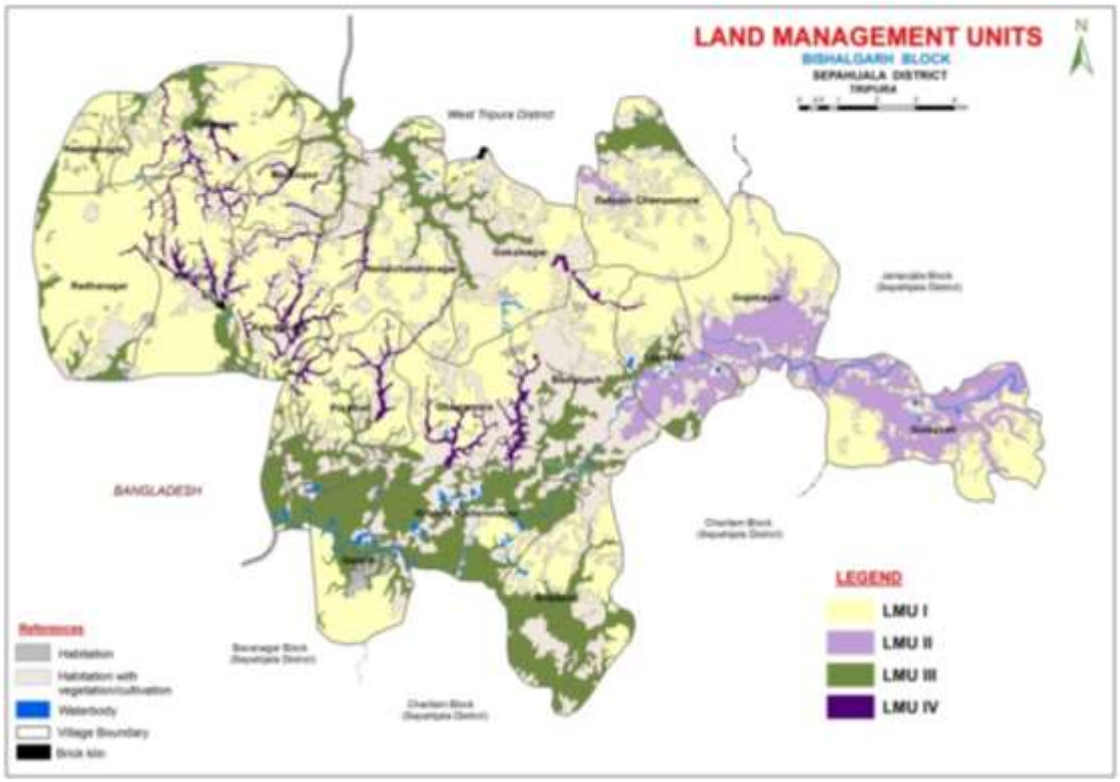

Fig. 2. Land management units map of Bishalgarh block

Table 1. Land management units based on problems and potentials of soils

LMU	Series	Description	Area (ha)	TGA (%)
I	Nehalchandranagar, Radhanagar, Gokulnagar (*Typic Hapludults*)	Very deep, excessive to well drained, very strongly acidic, sandy loam to silty clay loam soils, moderate to severe erosion	8344	48.94
II	Laxmibil (*Typic Endoaqualfs*)	Very deep, moderate to well drained, very strongly acidic, silty clay loam soils, slight erosion	1075	6.31
III	Krishnakishorenagar (*Fluvaquentic Dystrudepts*)	Deep, somewhat to poorly drained, strongly acidic, sandy clay loam to sandy clay soils, slight to moderate erosion	2625	15.40
IV	Ghaniamara, Debipur (*Aeric Endoaqualfs* and *Typic Endoaquents*)	Deep to very deep, somewhat to poorly drained, strongly acidic, clay loam to sandy clay loam soils, slight to moderate erosion	438	2.57
Miscellaneous (habitation / river / water body)			4568	26.79
Total area			**17051**	**100.00**

In the block, four land management units were delineated based on problems and potentials of soil. In each LMU the present land-use and alternate land-use option is given in Table 2 for the block.

Table 2. Present and suggested land-use of the block

LMU	Present land-use	Suggested Land-use options
I	Rubber plantation	➢ Rubber plantation with application of recommended dose of NPK fertilizer in two equal splits. ➢ Inter-cropping with pineapple, ginger and turmeric for first three years. **Managements:** • Amelioration of soil acidity with application of 200–250 kg lime / ha in furrows. • Use of biofertilizers particularly phosphate solubilizing micro-organisms. • Use of manures to reduce the adverse effect of soil acidity (particularly high Al) and increase of soil fertility. • Use of specific management practices like mulching, ridge and furrow system, etc. which can help in conserving soil moisture for rabi crop.

II	Kharif paddy / fallow	➢ Paddy / maize – mustard / lentil / pea / groundnut. ➢ Summer green gram can also be included where paddy cultivation is problematic due to water scarcity. **Managements:** • Green manuring of Dhaincha can be included after medium duration HYV of paddy. • Raised bed furrow irrigation method for maize cultivation. • Zero tillage or minimum tillage for mustard / lentil cultivation.
III	Paddy – mustard / pea / lentil / winter vegetables / groundnut / paddy / fallow	➢ No change, prefer medium duration HYV paddy varieties. **Managements:** • Timely land preparation, sowing & transplanting. • Rain water harvesting by 30 cm high bunding. • Utilization of waters for irrigation from nearby beels, ponds, rivers, natural depressions etc. • SRI technology should be properly adopted. • Timely weeding, at critical growth stages and short duration drought tolerant crops should be grown.
IV	Paddy – lentil / pea / fallow	➢ No change. Preference should be given to medium duration paddy varieties. **Managements:** • Adopt SRI paddy cultivation. • Adopt zero or minimum tillage in case of lentil and pea. • Use paddy transplant machine for timely quick sowing.

CONCLUSION

Results of the investigation revealed that application of latest fine resolution imageries was good enough to delineate the problems and potential of an study area at a high accuracy level so that each mapping unit are comprehensibly representative. The concept of land management unit further accelerates the investigation towards management interventions. This investigation showed that similar management practices can be used in similar agro-climatic and physiographic regions in other parts of the country.

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