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GIS based LRI study approach for identification of bench mark soil series and major crop suitability planning of Baisnabakhol-Hinjalachua micro-watershed of Deogarh district to mitigate climate change impact

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Abstract

A comprehensive GIS-based Land Resource Inventory (LRI) study was conducted for the Baisnabakhol-Hinjalachua micro-watershed in Deogarh district to evaluate soil resources and crop suitability for sustainable land use planning under changing climatic conditions. The study involved a detailed soil survey of 800 ha, encompassing 20 soil profiles and 70 grid samples, which were analysed for physical, chemical, and nutrient characteristics. Seven soil series comprising 15 mapping units were identified, with the Reamal-V series occupying the largest area. Crop suitability assessments using FAO and ICAR-NBSS&LUP guidelines revealed that paddy, maize, and blackgram were moderately suitable across nearly half the area. Additionally, three benchmark soil phases were delineated based on arability, crop diversification potential, and biophysical attributes. The integration of GIS with LRI proved effective in generating critical information for crop planning and natural resource management, contributing to adaptive strategies for climate change mitigation.

Keywords: GIS, Land Resource Inventory, soil series, crop suitability, benchmark soil, climate change mitigation.

Introduction

Land use planning involves a systematic evaluation of the potential of land and water, as well as considering alternative land use options and the economic and social conditions. The main objective is to choose and implement the most suitable land use options that will effectively meet the needs of the population while also ensuring the preservation of resources for the future. (Hegde. *et al.*, 2019) [3].In the present investigation a detailed survey was conducted in Baisnabakhol-Hinjalachua micro-watershed which comes under Reamal sub-watershed.

Based on the results of the soil survey, soils were classified into series, phases followed by crop suitability. Total 20 soil profiles and 70 grid soil samples were examined for crop suitability plan.

The study area

General Information

Baisnabakhol-Hinjalachua micro-watershed (under Reamal SWS Cluster, Reamal block, Deogarh District) occupies an area of about 800 ha and has been spread across Baisnabakhol, Ratakhandi, Kantabahala, Brahmanipali, Hinjalachua villages.

Current Land Use-Land Covers

Current land use-land cover map depicted that lion's share of the MWS has occupancy of scrub land (54.37% of TGA) followed by forest cover (29.38% of TGA), arable lands (agriculture) (15.0.3% of TGA). About 0.31% of TGA was under habitation, whereas, 0.37% of TGA was under waste lands. Only 0.11% of TGA was under orchard plantation.

Methodology

Field study

A detailed soil survey study was conducted in the Baisnabakhol-Hinjalachua micro-watershed by selecting the profile points on transect lines with references to topography and landscape pattern. A total of 20 no. of soil profiles are studied for crop and land suitability classification.

Soil Analysis

Soil samples collected from the field study area subjected to chemical analysis for macro and micro nutrients with other soil physical and chemical analysis for crop and land suitability class.

GIS intervention

Terrain mapping units (TMUs) were created using the satellite imagery and the 5 m contour map, and the profile points selected on transect lines with references to the topographical conditions (Hilltop to valley) in the region. Soil series, soil phases, crop, land suitability categorisation, and soil nutrient maps were developed following the final examination of pedological and laboratory data.

Results and Discussion

Soil Resources

Soil is a slowly renewing, dynamic natural resource that affects the eventual viability of any agricultural system. Water flow, water quality, land usage, and vegetation productivity are all linked to soil. Soils supply food, fodder, and fuel to support fundamental human and animal requirements (Schoonover and Crim, 2015, Fekadu *et al.*, 2018) [4, 2].

Baisnabakhol-Hinjalachua MWS consist of 7 soil series with 15 phases as soil mapping units based on important soil series differentiating criteria *viz.*, geology, landforms, major land use, soil depth, horizon sequence, soil texture of the control section, soil matrix colour sequence and any other diagnostic properties like presence of redoximorphic features, cutans, cracks, etc. It has been found that Reamal-V series (Shallow soil, excessively well drained, moderately steep sloping, extensively gravelly, weakly acidic soils with sandy loam surface texture) occurring on severely eroded plains of derived from Eastern Ghat Super Group (Charnockite) encompasses highest area occupancy (42.38%) followed by Reamal-N series (deep soil, excessively well drained, moderately gravelly, weakly acidic soils with sandy loam surface texture) occurring on slightly eroded plains of derived from Eastern Ghat Super Group (Khondalite), (31.95% of TGA) and Reamal-P series (Very deep soil, excessively well drained, moderately gravelly, weakly acidic soils with sandy loam surface texture) occurring on slightly eroded plains of derived from Eastern Ghat Super Group (Khondalite) (15.15%).

Crop Suitability Plan of Baisnabakhol-Hinjalachua MWS

The land evaluation criteria for rain-fed and irrigated agriculture include detailed methods. The suitability tables which are based on the overall capability index (Hegde *et al.*, 2019) [3], were used to assess the soil's appropriateness for each crop while taking constraints into the account. The categories were as follows: highly suitable (S1), moderately suitable (S2), marginally suitable (S3), and not suitable (N). Based on field and laboratory soil investigations, sustainable fertility and soil management have been proposed as ways to maximise land potential.

Land suitability assessment of crop has been performed using FAO module [1] followed by revised NBSS&LUP guidelines and criteria table for crop suitability plan developed by ICAR-NBSS&LUPO, Regional Centre, Kolkata. It was observed that Paddy, Maize, Blackgram, covering 49.44% of TGA each of the MWS under moderate suitability class across various landform situations. Groundnut and Mustard were moderately suitable in 40.33%, and 47.74% of TGA, whereas, The plans for the crop suitability are tabulated below and also shown in subsequent figures.

Table 1: Area and Distribution of Suitability Classes of Major Crops Grown in Baisnabakhol –Hinjalachua MWS

Crops	Highly Suitable (S1)	Moderately Suitable (S2)	Marginally Suitable (S3)	Not Suitable (N)
Area in Hectares (% of TGA)				
Field Crops				
Paddy	-	395.64 (49.44)	396.72 (49.57)	2.05 (0.26)
Maize	-	395.64 (49.44)	396.72 (49.57)	2.05 (0.26)
Blackgram	-	395.64 (49.44)	233.5 (29.18)	165.27 (20.65)
Greengram	-	382.06 (47.74)	396.72 (49.57)	15.63 (1.95)
Groundnut	-	322.76 (40.33)	185.85 (23.22)	285.81 (35.71)
Mustard	-	382.06 (47.74)	233.5 (29.18)	178.85 (22.35)

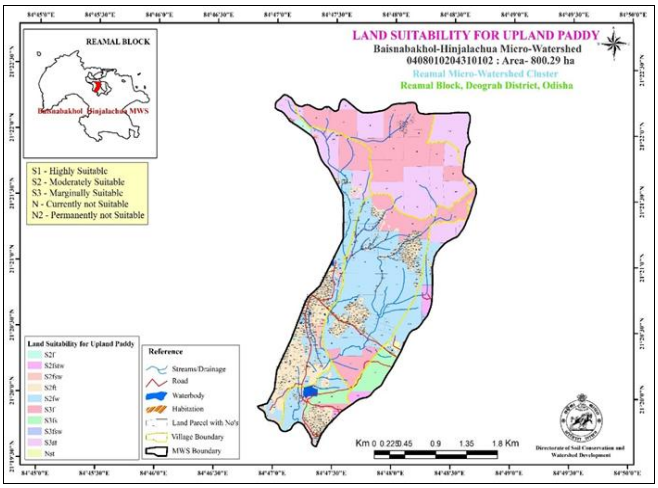

Fig 1: Land Suitability plan for Paddy

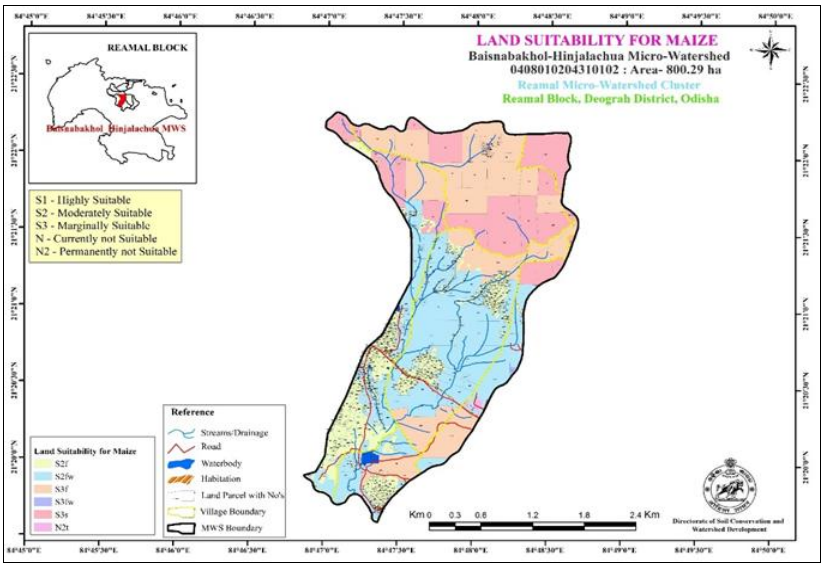

Fig 2: Land Suitability plan for Maize

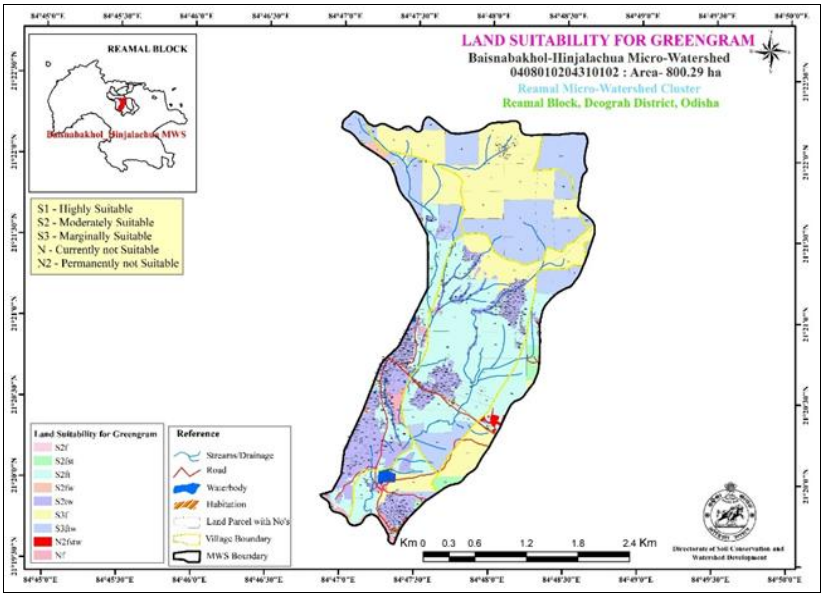

Fig 3: Land Suitability plan for green gram

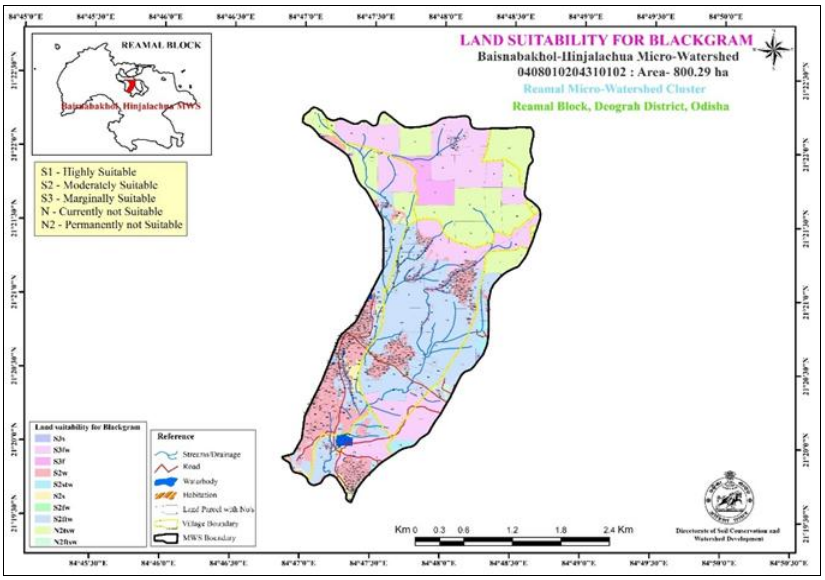

Fig 4: Land Suitability plan for Black gram

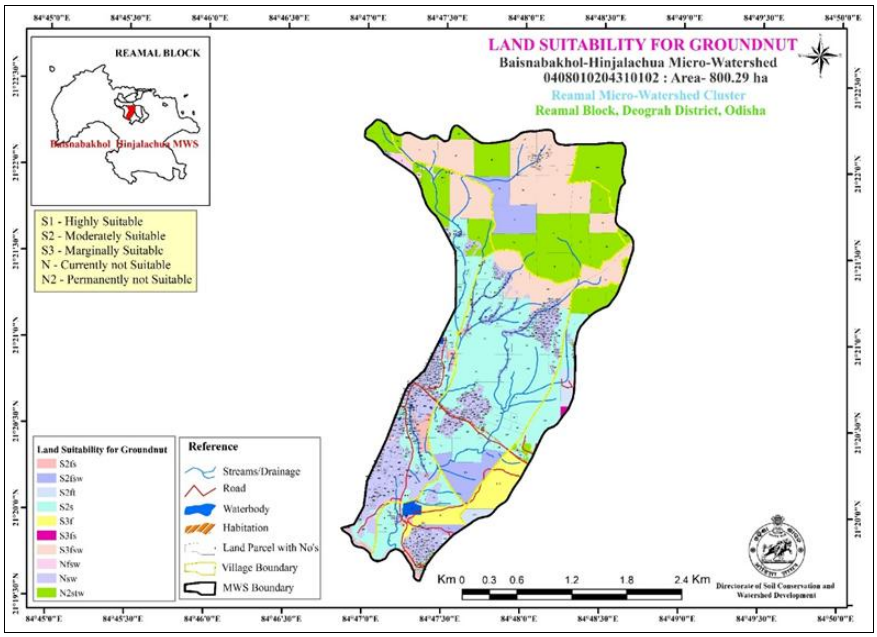

Fig 5: Land Suitability plan for Groundnut

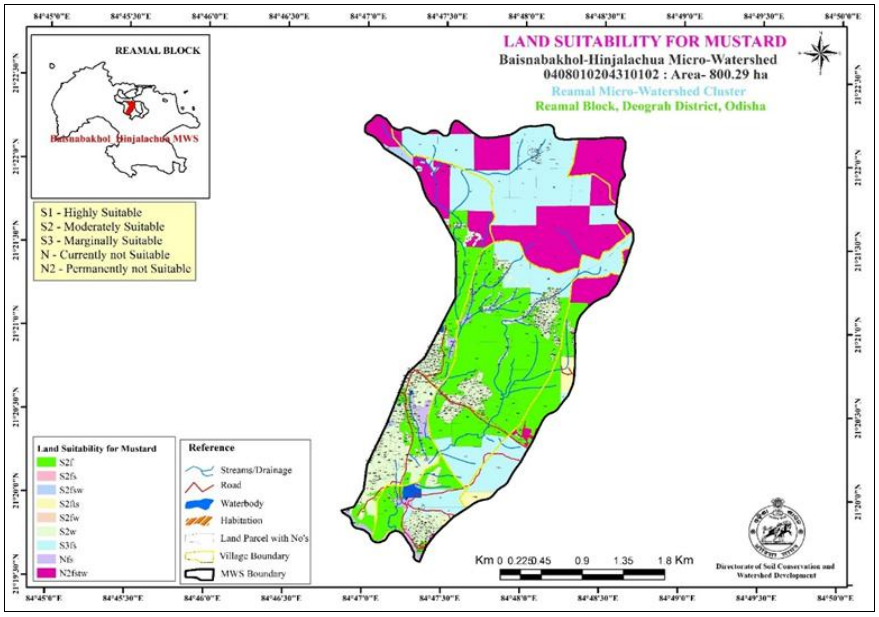

Fig 6: Land Suitability plan for Mustard

Identification of Benchmark Soil phases in in Baisnabakhol-Hinjalachua MWS

The criteria of identification of benchmark soil phases in MWS includes following:

- Benchmark soil phase should represent arable lands.
- It should promote the maximum crop diversification potentiality.
- The land should have a good biophysical suitability and potentiality for crop planning.
- It should cover a substantial quantity of plot numbers with a sizable number of farming community for participation in community consultation for larger benefits in the MWS areas.

Soil Phase	Description	Area (ha.)	% of TGA
BrkE5cB1fb	Granite-gneissic Landscape, Plain, 1-3% Slope, Barkote-E Series, Deep Soils (100-150 cm), Sandy loam Surface Texture, Slight Erosion, Slightly Gravelly, field bunding	175.37	37.88
BrkF6cBf1fb	Granite-gneissic Landscape, Valley, 1-3% Slope, Barkote-F Series, Very Deep Soils (>150 cm), Sandy loam Surface Texture, Slightly Gravelly, Occasional flooding, field bunding	46.35	10.01
BrkE5cA1fb	Granite-gneissic Landscape, Plain, 0-1% Slope, Barkote-E Series, Deep Soils (100-150 cm), Sandy loam Surface Texture, Slight Erosion, Slightly Gravelly, field bunding	18.64	4.03
Total		240.36	51.92

Summary and Conclusion

In the present investigation, a total of 800 hectares of land were subjected to a detailed soil survey to determine crop adaptability and land suitability for major crops production in the respective micro watershed as well as the benchmark soil phases are identified for diverse crop diversification. Overall, the research concluded that soil inventory plays an important role in the judicious use of natural resources and to mitigate climate change.

Acknowledgment

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