

Original Research Article

<https://doi.org/10.20546/ijcmas.2021.1001.150>

GIS Based Land Capability Classification of a Watershed for Land and Water Resource Management

Purnima Mishra^{1*} and R.R. Babu²

¹Department of Horticulture Engineering, College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad – 500030, India

²National Bank for Agriculture and Rural Development, Bandra Kurla Complex, Bandra (East), Mumbai – 400051, India

*Corresponding author

ABSTRACT

With a view to suggest suitable land and water resource management measures in a degraded micro-watershed, land capability class map of a micro-watershed, falling in upper catchment of Dwarakeswar river, Chotanagpur plateau was prepared in Geographic Information System (GIS) environment by generating and integrating various thematic maps. The generated and integrated thematic maps of watershed using GIS included land use/cover, soil slope, drainage network, soil depth, soil texture and erosion status, etc. Based on the integrated land capability class map of the watershed, four land forms viz., upland -class VI, midland -class IV/III, low land - class III and valley *Bohal*-class II were found. 78% of total area of watershed was under class III, which is mostly mono-cropped agriculture land, while 15% of the area of watershed, which is wasteland was found be under class IV. The area under land class II comprised of 4% of total area of watershed in which double cropping is practiced. The land class of uplands was found to be VI, which comprised of 3 % of total area of watershed. Finally, based on the land class map, a package of soil and water conservation measures were suggested that can be taken up for land and water resource management with local people active participation.

Keywords

Land Capability Class, GIS and Watershed

Article Info

Accepted:

12 December 2020

Available Online:

10 January 2021

Introduction

Rainfed areas constitute about 52% of net cultivated area and contribute to more than 40% of food production of the country. They are home to small and marginal farmers, poor and vulnerable sections of the society. The rainfed areas are characterized by severe land degradation and low productivity. Further, of late, the adverse effects of climate change are

posing serious threat to sustainability of rainfed farming. Watershed development programmes in rainfed areas aim at conservation and regeneration of natural resources and help in protection of soil, moisture and vegetation, thereby facilitate livelihood of the people depending on these vital resources. In any watershed development programme, the first step is the establishment of land capability class, based on which the

problems and potentials can be known and the treatments and alternative land use practices are planned.

In order to plan suitable soil and water conservation measures, after delineation of watershed on topo sheet using the present land use map along with drainage network, plot wise/survey number wise land class of the watershed is to be established. After establishing the land class, suitable soil and water conservation measures with their design details along with proposed land use map can be prepared. With the advent of remote sensing and Geographic Information System (GIS), generation of required thematic layers, their integration and spatial analysis have become easy and convenient. Several researchers (Suryawanshi *et al.*, 2005, Mishra *et al.*, 2006, Mishra and Babu, 2009, Mary Silpa and Nowshaja, 2016) demonstrated the use of remote sensing and GIS in establishing land use/cover and preparation of land capability class maps, etc., for different watersheds/study areas. In the present study, an attempt is made to prepare an integrated Land Capability Class (LCC) map, identify and suggest suitable soil and water conservation measures based on land class for effective land water resource management in a watershed.

Bhalukanala, an agricultural micro-watershed falling in the upper catchment of Dwarakeswar River, eastern part of India was selected for the study. The watershed is located at 23⁰11' & 23⁰14' N latitude and 86⁰54' & 86⁰56' E longitude. The total geographical area of the watershed is 1006.40 ha. The climate is sub-tropical humid with average annual rainfall of 1340 mm, of which more than 80% is received during South-West (June-October) monsoon period. The mean maximum and minimum temperatures are about 38⁰C and 10⁰C, respectively in the selected watershed.

Materials and Methods

The toposheet of Survey of India (73I/16/NE) covering the entire watershed was rectified and projected. Contours and stream network were digitized and the Digital Elevation Model (DEM) was generated and thus delineation of watershed was completed. The delineated watershed was separated from the main image and its vector feature was created. The land use/cover map of watershed was generated by Maximum Supervised Classification of the remote sensing (IRS P6 LISS III digital image (path 106 and row 55)) imagery coupled with field survey. The land use/cover map of Bhalukanala watershed was overlaid on the slope map and the physiography map was thus derived. This physiography map was taken as the base map and the field data pertaining to soil depth, texture and erosion status were collected for each mapping unit. Subsequently, thematic maps viz., Soil texture, Soil depth, Soil Slope, Erosion status and Drainage map were generated. All these thematic maps are superimposed on base map in the GIS platform. Looking at the rating table (Tideman, 1996), the land class of each mapping unit has been finalized and thus an integrated LCC map of the watershed was prepared using the GIS platform. Thereafter, land and water resource management plan was prepared in the form of package of soil and water conservation measures suiting to estimated land class.

Results and Discussion

The generated and integrated thematic maps of watershed using GIS including land use/cover, soil slope, drainage network, soil depth, soil texture and erosion status, etc., were used in preparing LCC map of Bhalukanala watershed. The final LCC map of Bhalukanala watershed is given in Fig. 1. The area under different land classes is

presented in Fig. 2. The land forms/classification in Bhalukanala watershed revealed typical characteristic resembling to Chotanagpur plateau. The land forms/class in this watershed were classified into four groups upland-class VI, midland -class IV/III, low land - class III and valley-class II, based on the topography and soil characteristics. The land class wise summary of recommended soil and water conservation measures and alternate land use practices for effective land and water resource management are given in Table 1. The presented results in Fig.1, Fig. 2 and Table 1 are discussed below:

The analysis of area under different land classes in Bhalukanala micro-watershed (Fig. 1) indicated that about 78 % of total area of watershed falls under land class III, which is mostly mono-cropped Agriculture land.

Repairs to existing field bunds and construction of on farm reservoir or water harvesting tanks will help in *in situ* retention of rainfall and maintaining soil moisture for longer period. These measures will also facilitate farmers in growing short duration second crop like chickpea and help in improving the income of farmers. As the soils of laterite zone are poor in organic matter content application of organic and green manures to soil will help in enhancing its content in the soil thereby improving the moisture holding capacity of the soil. The area under land class II (which is 4% of total area of watershed) also needs application of organic manures and repairs to existing field bunds and construction of water harvesting tanks (large in size) at appropriate places particularly in the valley region. Crop rotation (Paddy-pulses/vegetables) was suggested as land use.

Table.1 Suggested soil and water conservation measures and alternative land use practices for Bhalukanala watershed, Bankura

S.No.	Land class	Suggested soil and water conservation Measures	Suggested alternative land use practices
1	II _s	i) Repairs to existing Field Bunds. ii) Application o organic and green manures	Double cropping (Paddy-Pulses/vegetables rotation)
2	III _s	i) Repairs to existing Field Bunds and small (5%) rain water harvesting tanks in filed plots ii) Application of organic and green manures and mulching	Double cropping (Paddy-Pulses/oil seeds/vegetables rotation)
3	IV _s	i) Contour /Graded Bunding and small gully plugs with suitable grass cover/vegetative barriers ii) Application of organic and green manures and mulching.	Agro-Horticulture
4	VI _s	Staggered Contour Trenches/Negarian (30' x40') plots with seepage pits and gully plugs	Afforestation/Pasture development. Ban on free grazing and tree felling

Fig.1 Land capability class map of Bhalukanala watershed

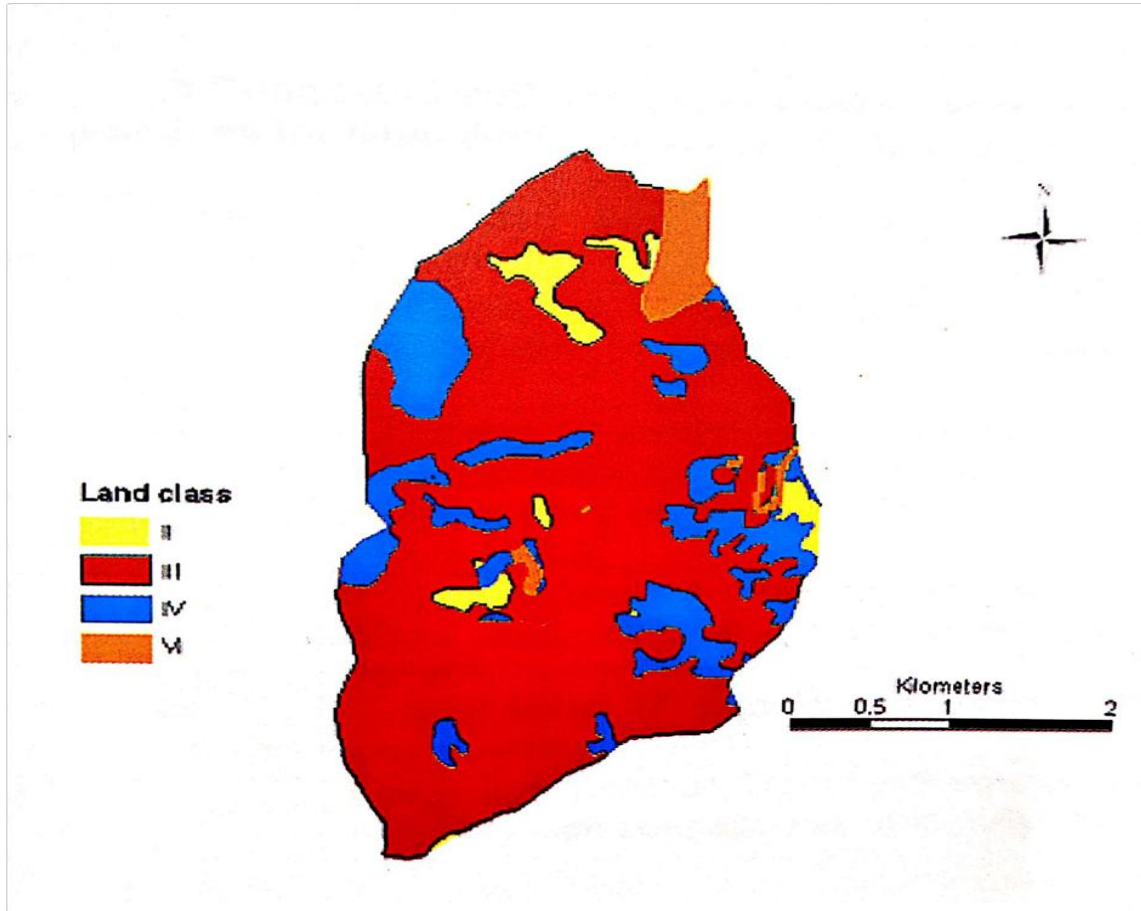
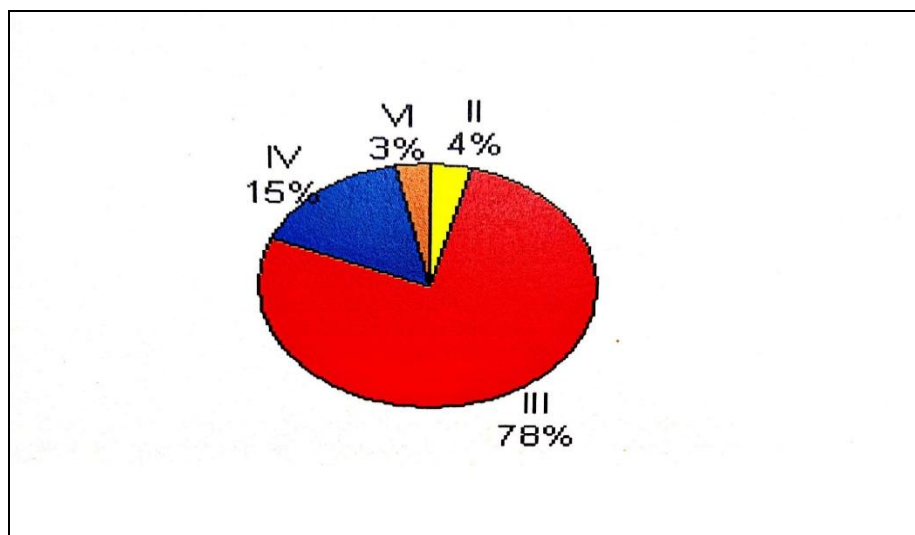


Fig.2 Area under different land classes



Most of the area under wasteland category was found to be under land class IV comprising of 15 % of total area of Bhalukanala micro-watershed (Fig.1). The suitable measure for this class of land is contour/graded bunding. Alternatively, the Negarian plots with seepage tanks could also be practiced for improving the soil moisture and controlling further soil erosion. Horticulture development is an ideal alternative land use practice for the area under land class IV. The land class of uplands was found to be VI, which comprised of 3 % of total area of watershed. The uplands possessed very shallow soil depth with light textured soil on the surface. These are fallow lands without the cover of vegetation and require immediate attention for treatment. The suitable treatment could be Staggered Contour Trenches/Negarian plots with seepage pits. The suggested alternative land use for the area under land class VI is Afforestation/Pasture development.

The final LCC map needs to be overlaid on digitized cadastral/village maps to come out with plot/survey number wise land class. The suggested soil and water conservation measures (Table 1) and alternate land use practices need to be discussed with land owners and watershed community and finalized for implementation for effective land and water resource management leading to livelihood security of the inhabitants.

In conclusion, the developed LCC map and suggested package of soil and water conservation measures of Bhalukanala

watershed, on implementation would help in arresting soil erosion, insitu conservation of rainfall, maintaining soil moisture for longer period and regeneration of natural resource base. This in turn stabilizes farming and meet the food, fodder and timber/fuel wood requirement of people in a sustainable manner in Bhalukanala watershed.

References

- Mary Silpa, T.J. and Nowshaja, P.T. 2016. Land Capability Classification of Ollukara block panchayat using GIS. *Procedia Technology* 24(2016): 303-308.
- Mishra, P., Mazumdar, A., Roy, D. and Ravi Babu, R. 2006. Land capability class map of an agricultural micro-watershed using GIS. *Environment and Ecology*, 24(3): 485-489
- Mishra, P. and Ravi Babu, R. 2009. Simulation of storm sediment yield from an agricultural watershed using remote sensing, GIS and MUSLE. *Journal of Soil and Water Conservation*, 8(3): 12-21.
- Suryawanshi, S.L., Pathak, S.V., Pali, A.K and Das, S.N. 2005. Application of remote sensing and Geographic Information System in Land Capability Classification. Hydrology and watershed management, Himanshu publications, Udaipur. In: Kumar, V, Singh, PK and Purohit, R.C. (ed). pp: 210-223.

How to cite this article:

Purnima Mishra and Babu, R.R. 2021. GIS Based Land Capability Classification of a Watershed for Land and Water Resource Management. *Int.J.Curr.Microbiol.App.Sci.* 10(01): 1268-1272. doi: <https://doi.org/10.20546/ijcmas.2021.1001.150>