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Land Use Planning for Conservation Measures of Basin Using Remote Sensing and GIS Approach: A Case Study

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Abstract

Geographical information system proves efficient tool in delineation of watersheds and its planning. Land use planning through Land capability is the basis of watershed management programme. Land use planning for conservation measures of Basin using Remote Sensing and GIS Approach for Sukhana Basin of Aurangabad District, Maharashtra state has been carried out. Study area is located between 75.33°, 75.76° E longitudes, and 19.66°, 19.98° N latitudes. Class suitable for cultivation are II, III and IV have areal extent 134.41, 150.12 and 165.80 sq.Km. which is 67.32% of the total basin area and class VI and VII are not suitable for cultivation has areal extent 101.68 and 116.68 sq.Km respectively which is 32.68% of the total area. Based on land capability classification, land use planning with reference to conservation planning for Class II,III,IV are gully control measures, farm bunding such as compartment bunding, contour bunding and graded bunding. Whereas, for class VI measures are continuous contour trenches and staggered trenching and for class VII treatment propose a pasture development.

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Introduction

Watershed development and management planning is based on land capability classification. The knowledge of land capability classification is a prerequisite and important for planning, implementation and execution of soil and water conservation programmes[1]. Natural resources should be managed in a sustainable manner so that the changes proposed to meet the needs of development are brought without diminishing the potential for their future use[2-3].

Use the satellite data and Geographic Information System to produce the soil map and use the spatial analysis technique to assess the soil capability[4-9].

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Land use planning with reference to the agricultural crops has been attempted by various researchers. Integration of remote sensing data such as aerial photographs, IRS-ID, IRS ID LISS-III fused with PAN data, LANDSAT TM image, Cartosat and GIS environment such a software ARC/ INFO and ARCVIEW along with ILWIS, SWAT, ERDAS imagine, C# language and GPS can be effectively used for land use planning[10].

The land capability map makes available in a simple and practical language. It indicates the hazards of soil and water erosion and difficulties to be encountered in using the land. It also indicates the most intensive, profitable and safe use which can be made of any piece of land. In this research paper land capability classification has done by considering soil texture, soil depth, severity of erosion, slope of terrain in GIS environment through which engineering conservation measures may be planned by using RS and GIS technique.

Materials and Methods

Study Area

Geographical information system and remote sensing used Land use planning for conservation measures of Basin using Remote Sensing and GIS Approach of Sukhana Basin, which is divided into 35 sub watersheds of Aurangabad District, Maharashtra state. Study area is located between 75.33°, 75.76° E longitudes, and 19.66°, 19.98° N latitudes. Study area covers 93 villages. Study area is shown in Fig.1 and details of study area is given in table 1

Table 1: Summary of study area

Name of watershed	No of watershed	Area of watershed in SqKm	No .of villages covered
AU/GP-10	09	351.75	52
AU/GP-17'	06	172.25	32
AU/GP-17	02	66.00	09
Total—03	17	590.00	93

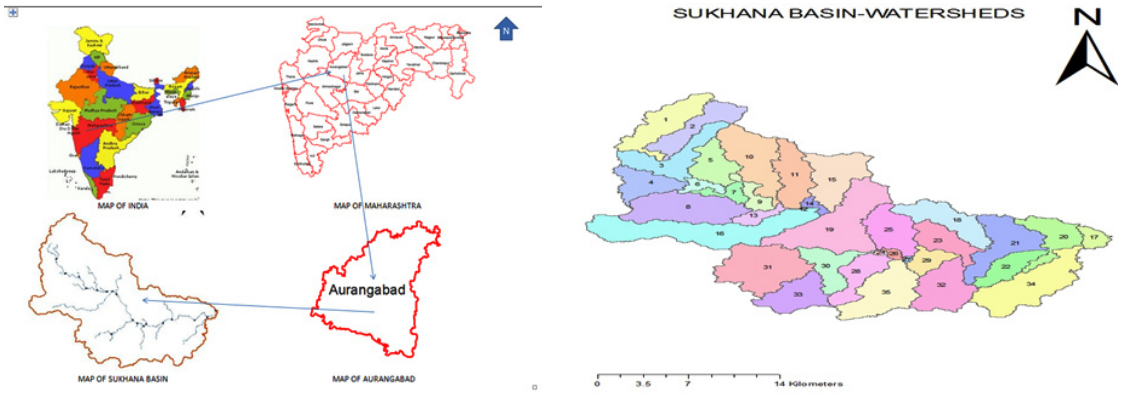

Fig.1: Study area map

Data used

Spatial data consists of toposheets of Survey of India, satellite image and DEM of study area, state and district map for exact location of study area, Details of data shown in table 2.

Determination of the Land Capability Class

The common parameters such as soil texture, soil depth, slope and erosion, which are recorded on a survey map for land capability. The land is classified into capability classes according to each parameter with the help of table. 3. The capability class will be the higher number given to any of the properties according to severity of limitations.

The capability of above class is II and its subclass is d4 (soil depth limitation) and its mapping symbol

will be IIs. In this way mapping symbol is done for 113 locations in the basin. Procedure is shown in flow chart Fig.2

Table 2: Details of data

Sr. No.	Type of data	Source
1.	Study area map	Ground Water Survey Development Authority (GSDA)
2.	Toposheets	Survey of India department
3.	Satellite image	www.earthexplorer.in
4.	Soil type	NBSS, Nagpur Maharashtra
5.	Precipitation	www.globalweather.tamu.edu

Result and Discussion

Slope

Slope map is shown in Fig.3 shows that maximum area 276.82 sq.Km. under category 1-3% slope which is about 41% , following 159 sq.Km. under 3 to 5% which is about 24% of total area of the basin minimum area of 19.85 sq.Km. found in the category of 15-25%..

Erosion

As shown in Fig.4, areal extent for moderate erosion found to be 285 sq.Km. and severe erosion 116.84 sq.Km. which account 18% of the total area of the basin veryslight and slight erosion accounted is 151 sq.Km. and 115 sq.Km.

Soil

Deep and moderately well drained soil is about

Table 3: Land Capability Rating Table

Sr. No.	Particular	Class I	Class II	Class III	Class IV	Class V	Class VI	Class VII	Class VIII
1.	Colour on map	Green	Yellow	Red	Blue	Dark green	Orange	Brown	Purple
2.	Soil texture	Loam (L)	Loam (L)	Clay & loamy sand (LSC)	Clay & Sand (CS)	—	—	—	—
3.	Soil depth	Very deep (>90) d5	Deep (45-90) d4	Moderate (22.5-45) d3	Shallow (7.5-22.5) d2	Very deep (>90)d5	Very shallow (<7.5)d1	Very shallow (<7.5) d1	Rock
4.	Slope	Nearly level (<1) (A)	Gentle (1-3) (B)	Moderate (3-5) (C)	Strong (5-15) (D)	Nearly level (<1)	Steep (15-25) (E)	Very steep (>25)	—
5.	Erosion	None to slight (e_1)	Slight (e_1)	Moderate (e_2)	Severe (e_3)	None to slight	Very severe (e_4)	Very severe (e_5)	—

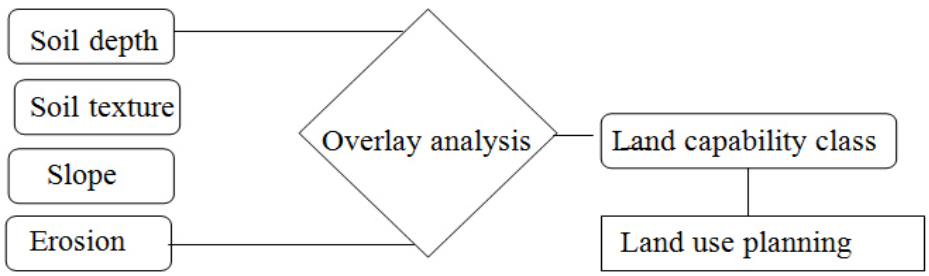

Fig. 2: Methodology for land use planning.

For example, the mapping symbol L-d4/A-e1 for which details are given in Table 4.

Table 4 : Example of determine land class

Parameters	Land capability class
L = Loam (medium)	I
d4= soil depth	II
A = Slope, level (0-1%)	I
e1 = Erosion absent or t very sligh	I

341.75 sq.Km. which is 51% of the total area following shallow loam soil about 270 sq.Km. and very shallow loamy soil about 56.78 sq.Km. which account 40% and 9% respectively very shallow soil observed on upper reach near ridge line. Soil map is shown in Fig. 5.

Soil Depth

It is observed that 209.84 sq.Km. area is under very shallow depth less than 7.5 cm. Moderate depth about 146.76 sq.Km. and deep soil area extent is 73.71 sq.Km as shown in Fig.6.

Land Capability Class

Details of land capability classification is shown in table 5 with symbol of class and its limitation. Various points for which land class symbol is found is shown in fig.7. From table 6, it shows that land class II, III, IV, VI and VII are present in the basin. Land class IV is dominant class with respect to areal extent in the basin, which is account for 165.80 sq.Km. (24.82%), other classes II,III, VI, and VII covers area 20.12%, 22.47%, 15.22% and 17.46% respectively as shown in Fig.8.

From above table it is found that out of 113 locations class II, III, IV, VI, and VIII are available at 15, 24, 33 ,18 and 23 locations respectively.

Table 5: Details of Land capability classification

Point_id	Symbol	class_ e	class_ d	class_ s	class_ slope	land_ class	Limitation
0	e4-d1/ls-F	IV	VI	III	VII	VII	slope
1	e4-d1/cs-F	IV	VI	IV	VII	VII	slope
2	e4-d2/scl-B	IV	IV	II	II	IV	depth,erosion
3	e4-d2/cs-E	IV	III	IV	VII	VII	slope
4	e4-d3/scl-D	IV	III	II	IV	IV	slope,erosion
5	e4-d4/ls-A	IV	II	III	I	IV	erosion
6	e4-d1/ls-F	IV	VI	III	VII	VII	slope
7	e4-d1/scl-B	IV	VI	II	II	VI	depth
8	e4-d1/ls-C	IV	VI	III	III	VI	depth
9	e4-d2/ls-B	IV	IV	III	II	IV	depth,erosion
10	e4-d2/scl-C	IV	IV	II	III	IV	depth,erosion
11	e3-d1/cs-F	III	VI	IV	VII	VII	slope
12	e3-d1/cs-F	III	VI	IV	VII	VII	slope
13	e3-d1/cs-F	III	VI	IV	VII	VII	slope
14	e3-d1/ls-E	III	VI	III	VII	VII	slope
15	e3-d1/cs-E	III	VI	IV	VII	VII	slope
16	e3-d1/ls-F	III	VI	III	VII	VII	slope
17	e3-d1/ls-D	III	VI	III	IV	VI	depth
18	e3-d1/scl-C	III	VI	II	III	VI	depth
19	e3-d1/ls-F	III	VI	III	VII	VII	slope
20	e3-d1/ls-F	III	VI	III	VII	VII	slope
21	e3-d1/ls-D	III	VI	III	IV	VI	depth
22	e3-d1/ls-F	III	VI	III	VII	VII	slope
23	e3-d1/ls-F	III	VI	III	VII	VII	slope
24	e3-d1/ls-E	III	VI	III	VII	VII	slope
25	e3-d2/ls-B	III	IV	III	II	IV	depth
26	e3-d2/ls-F	III	IV	III	VII	VII	slope

27	e3-d2/ls-C	III	IV	III	III	IV	depth
28	e3-d2/ls-F	III	IV	III	VII	VII	slope
29	e3-d2/ls-E	III	IV	III	VII	VII	slope
30	e3-d2/cs-E	III	IV	IV	VII	VII	slope
31	e3-d2/ls-E	III	IV	III	VII	VII	slope
32	e3-d2/ls-B	III	IV	III	II	IV	depth
33	e3-d2/scl-B	III	IV	II	II	IV	depth
34	e3-d2/ls-B	III	IV	III	II	IV	depth
35	e3-d2/scl-D	III	IV	II	IV	IV	depth,slope
36	e3-d2/ls-D	III	IV	III	IV	IV	depth,slope
37	e3-d2/scl-B	III	IV	II	II	IV	depth
38	e3-d2/scl-C	III	IV	II	III	IV	depth
39	e3-d2/ls-D	III	IV	III	IV	IV	depth,slope
40	e3-d2/scl-C	III	IV	II	III	IV	depth
41	e3-d2/ls-D	III	IV	III	IV	IV	depth,slope
42	e3-d2/ls-B	III	IV	III	II	IV	depth
43	e3-d3/scl-B	III	III	II	II	III	depth,erosion
44	e3-d4/scl-B	III	II	II	II	III	erosion
45	e3-d3/scl-C	III	III	II	III	III	depth,erosion. slope
46	e3-d3/scl-C	III	III	II	III	III	depth,erosion. slope
47	e3-d3/ls-E	III	III	III	VI	VI	slope
48	e3-d3/ls-E	III	III	III	VI	VI	slope
49	e3-d3/scl-A	III	III	II	I	III	depth,erosion
50	e3-d4/scl-A	III	II	II	I	III	erosion
51	e3-d3/scl-B	III	III	II	II	III	depth,erosion
52	e3-d3/scl-B	III	III	II	II	III	depth,erosion
53	e3-d2/ls-B	III	IV	III	II	IV	depth
54	e3-d3/ls-D	III	III	III	IV	IV	slope
55	e3-d4/scl-B	III	II	II	II	III	erosion
56	e3-d5/scl-A	III	I	II	I	III	erosion
57	e3-d4/scl-D	III	III	II	IV	IV	depth
58	e2-d5/scl-B	II	I	II	II	II	erosion,soil, slope
59	e2-d1/ls-D	II	VI	III	IV	VI	depth
60	e2-d1/ls-D	II	VI	III	IV	VI	depth
61	e2-d2/scl-D	II	IV	II	IV	IV	depth,slope
62	e2-d3/ls-E	II	III	III	VI	VI	slope
63	e2-d3/scl-A	II	III	II	I	III	depth
64	e2-d2/ls-E	II	IV	III	VII	VII	slope
65	e2-d3/ls-B	II	III	III	II	III	depth,soil
66	e2-d3/scl-C	II	III	II	III	III	depth,slope
67	e2-d3/ls-B	II	III	III	II	III	depth,soil
68	e2-d1/ls-D	II	VI	III	IV	VI	depth
69	e2-d1/scl-D	II	VI	II	IV	VI	depth
70	e2-d1/scl-D	II	VI	II	IV	VI	depth
71	e2-d1/scl-E	II	VI	II	VI	VI	depth,slope
72	e2-d1/scl-E	II	VI	II	VI	VI	depth,slope
73	e2-d1/ls-F	II	VI	II	VII	VII	slope

74	e2-d1/ls-F	II	VI	II	VII	VII	slope
75	e2-d2/ls-D	II	IV	II	IV	IV	depth,slope
76	e2-d3/scl-D	II	III	II	IV	IV	slope
77	e2-d4/scl-C	II	II	II	II	II	erosion,depth, soil, slope
78	e2-d4/scl-C	II	II	II	II	II	erosion,depth, slope
79	e2-d4/scl-C	II	II	II	III	III	slope
80	e2-d4/scl-B	II	II	II	II	II	erosion,depth, soil,slope
81	e2-d2/scl-D	II	IV	II	IV	IV	depth,slope
82	e2-d3/scl-B	II	III	II	II	III	depth
83	e2-d2/ls-E	II	IV	III	VI	VI	depth,slope
84	e2-d2/ls-D	II	IV	III	IV	IV	depth,slope
85	e2-d3/scl-B	II	III	II	II	III	depth
86	e1-d2/scl-C	I	IV	II	III	IV	depth
87	e1-d3/scl-B	I	III	II	II	III	depth
88	e1-d3/scl-C	I	III	II	III	III	depth,slope
89	e1-d3/scl-C	I	III	II	III	III	depth,slope
90	e1-d3/scl-C	I	III	II	III	III	depth,slope
91	e1-d3/scl-C	I	III	II	III	III	depth,slope
92	e1-d4/scl-B	I	II	II	II	II	depth,soil,slope
93	e1-d4/scl-B	I	II	II	II	II	depth,soil,slope
94	e1-d4/scl-A	I	II	II	I	II	depth,soil
95	e1-d1/ls-E	I	VI	III	VI	VI	slope
96	e1-d3/scl-D	I	III	II	IV	IV	slope
97	e1-d3/scl-B	I	III	II	II	III	depth
98	e1-d4/scl-D	I	II	II	IV	IV	slope
99	e1-d4/scl-B	I	II	II	II	II	depth,soil,slope
100	e1-d5/scl-A	I	I	II	I	II	soil
101	e1-d5/scl-A	I	I	II	I	II	soil
102	e1-d5/scl-A	I	I	II	I	II	soil
103	e1-d5/scl-A	I	I	II	I	II	soil
104	e1-d1/scl-D	I	VI	II	IV	VI	depth
105	e1-d2scl-D	I	IV	II	IV	IV	depth,slope
106	e1-d4/scl-A	I	II	II	I	II	depth,soil
107	e1-d4/scl-A	I	II	II	I	II	depth,soil
108	e1-d3/ls-B	I	III	III	II	III	depth,soil
109	e1-d3/scl-D	I	II	II	II	II	depth,soil,slope
110	e1-d5/scl-D	I	I	II	IV	IV	slope
111	e1-d5/scl-D	I	I	II	IV	IV	slope
112	e1-d5/scl-D	I	I	II	IV	IV	slope

Table 6: Land capability classification in the basin

Sr. No.	Area	Symbol
1	134.4151	II
2	150.1243	III
3	165.8045	IV
4	101.6851	VI
5	116.6801	VII

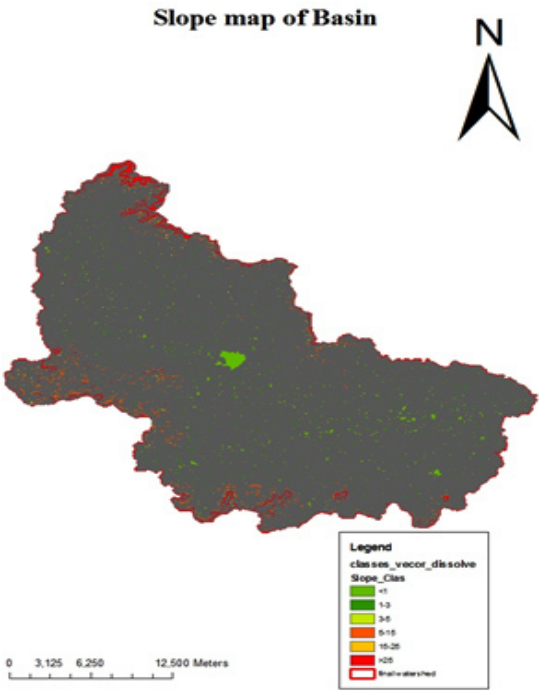

Fig. 3 : Slope map

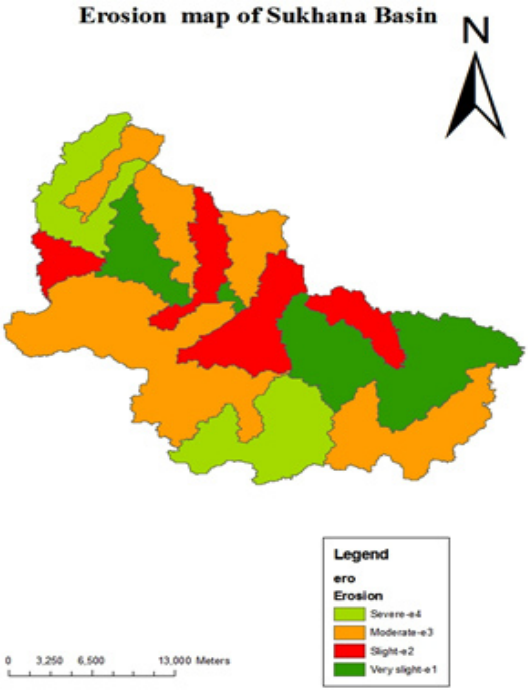

Fig. 4 : Erosion map

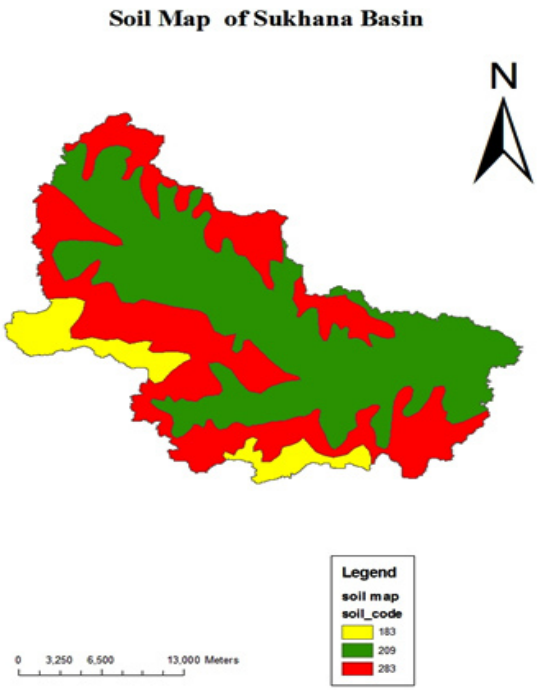

Fig. 5 : Soil map

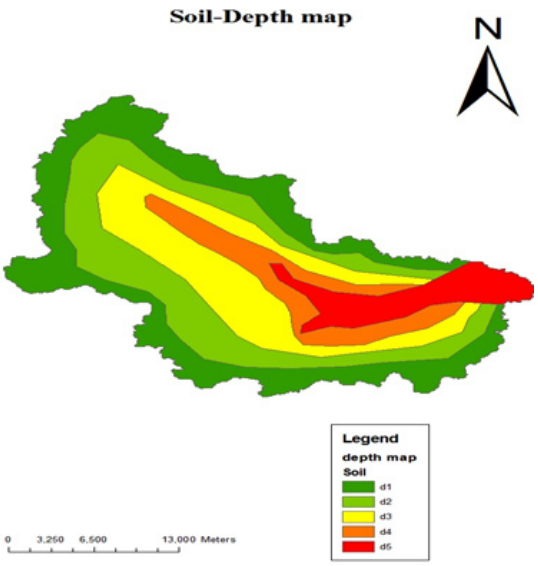

Fig. 6 : Soil depth map

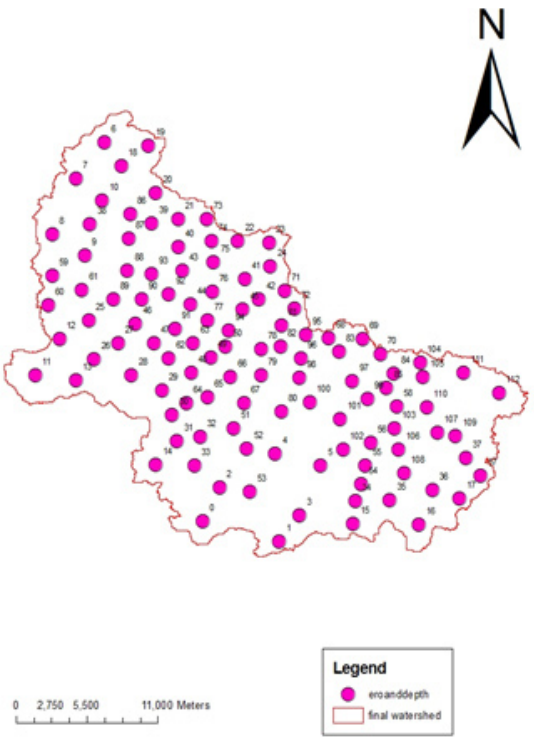

Fig. 7 : Mapping symbol map

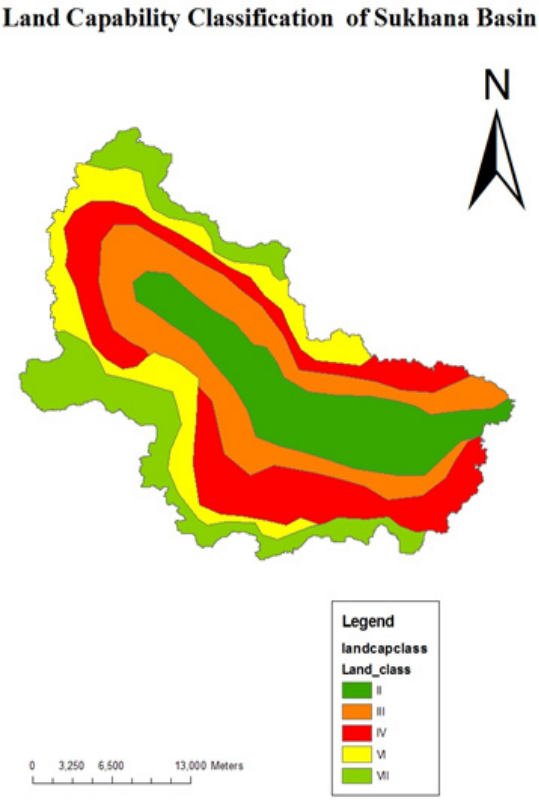

Fig. 8 : Land capability map

Conclusion

The analysis shows that shows that land class II, III, IV, VI and VII are present in the basin. Class suitable for cultivation are II, III and IV have areal extent 134.41, 150.12 and 165.80 sq.Km. which is 67.32% of the total basin area and class VI and VII are not suitable for cultivation has areal extent 101.68 and 116.68 sq.Km respectively which is 32.68% of the total area. Based on land capability classification land use planning with reference to conservation planning for Class II,III,IV are gully control measures, farm bunding such as compartment bunding, contour bunding and graded bunding. Whereas, for class VI measures are continuous contour trenches and staggered trenching and for class VII treatment propose a pasture development.

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