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Analysis of Land Suitability for Agriculture in Hemavathy Watershed

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Abstract: ***Scientific Land evaluation reduces the human influence on natural resources; identify appropriate land use, able to increase the land productivity. The present study is to study the land suitability of crops in Hemavathy basin watershed in order to implement sustainable cropping systems enabling optimum crop development and maximum productivity. GIS technology has been used in matching the suitability of soil details for main crops according to requirements of the crops and land characteristics in the sub watersheds for land-suitability assessment. Various date satellite data of khariff, rabi are studied to know the land use status for the particular agriculture season. A large database has been created for land use / land cover suitability, for planning sustainable agricultural development. In this study only 6 major crops were selected i.e., paddy, ragi, jowar, maize, sugarcane, and coffee. Suitability and capability maps for each land use were developed to illustrate their suitability degrees, soils suitable for agriculture, in better land use options that could be implemented compared to land evaluation methods for the suitability of various crops.***

Keywords: Classification, Crop suitability, GIS, Land use, land suitability, Soil site suitability

1. Introduction

The productivity of land is depending on land qualities, the ability of land to tolerate production of crops in a sustainable way and characteristics for planning optimal land use and sustainable development. An integrated approach of land evaluation guides decisions on optimal utilization of resources, for land use planning and development, enables decision makers, land use planners to develop a crop management in increasing the productivity. Land evaluation involves with accompanying data, maps, reports in selection of suitable land, cropping pattern, irrigation methods which are practicable and economically viable, helps during various stages of planning, designing, implementing, monitoring of the project[1].Remote sensing with GIS help in assessing suitability ofeach selected crops under various soil conditions according to the principles of FAO[2].

The need for interpretation of soil strata information in land suitability for growing specific crops is important for better land use to yield maximum benefits without risk in an area.According to suitability classification, FAO (1976, 1983, 1985 and 2007), soils of the study area could be classified into five classes of lands recognized within two orders (S and N).**S-1** Highly suitable**,** unit represent optimum conditions for plant growth, without or with only slightlimitations.**S-2** Moderately suitable with conditions, affects productivity by 20% or less; **S-3** Marginally suitable which affects significant productivity but still considered economical, Order **'N' represent** Not for sustainable results under consideration[3]

Effective soil and water conservation measures of an area helps in planning basic needs of farmers, improving socio-economic conditions and evolving a policy for sustainable development [4].

Hemavathy basin, watershed is dominated by agriculture in nature, with kharif and rabi season crops, double crop area, with other categories such as forest, waste land, settlement and water storage bodies, hypothesizes in proper management of ground water, watershed management and agriculture planning mitigate the problem of scarcity of water and thereby improve sustainability of agriculture for optimum crop development and maximum productivity. Land could be categorized into spatially distributed agriculture potential zones based on the soil properties, terrain characteristics and analyzing present land use to develop a planning strategy to use the available water resources in sustainable manner [5].

2. Objectives

The objectives considered are:

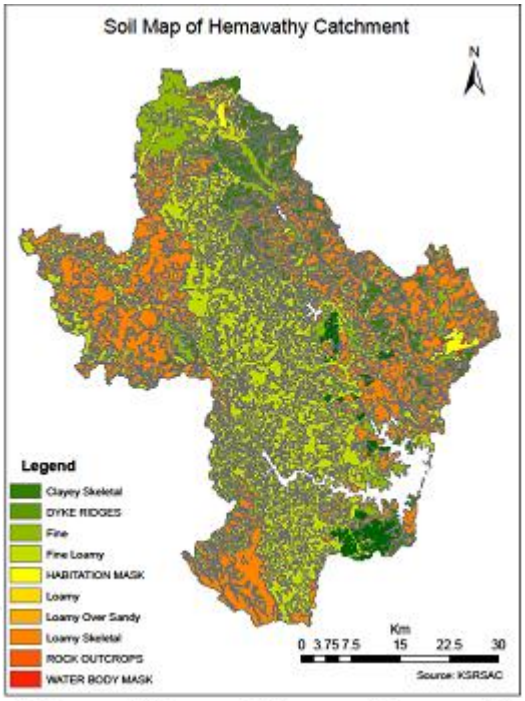
1) To assess suitability of land for major agricultural crops in the basin area.
2) To generate the suitability index for selected crops in the Hemavathy watershed.
3) To study the land use and cropping pattern to understand the agricultural setup in the region.

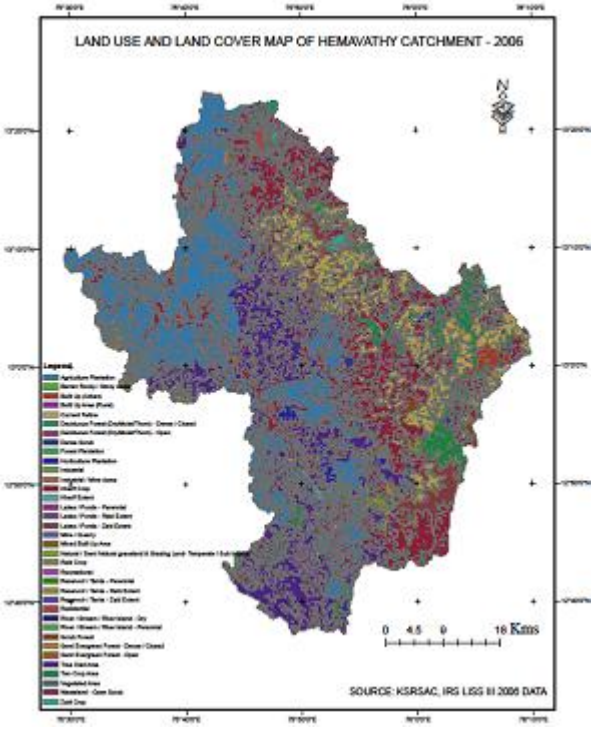
3. General Description of the Area

Present area selected for study was Hemavathy catchment situated in Chikmagalur, Hassan and Kodagu district lies geographically between 75º30’0” and 76º15’0” E longitude and 12º30’0” and 13º30’0” N latitude. It covers an area of 2910Sqkm. It is 245 km long and it has a drainage area of about 5, 698.65 km2. In the study region, the loamy structure of red soils makes them suitable for the cultivation of a large variety of crops. Soils are generally shallow and permit free lateral and downward penetration of water.

4. Methodology

Satellite images data along with the resource collected from statistical department and various sources are used for classification of land use/ land cover for the year 2006 and 2011to identify various landforms based on geographical conditions based on color, tone, texture, pattern and land use. Drainage, watershed information is extracted from SOI toposheet with additional inputs from satellite data for up gradation. Based on land characteristics slope suitability map was generated which is used along with crop suitability criteria to generate crop suitability maps. ARCGIS 10.2 and image processing software ERDAS9.2 and simple statistical methods are used to calculate the cropped area of selected crops and to map the same so as to make a spatial analysis of cropping pattern. With the help of these parameters and guidelines of NBSS (National Burrow of Soil Survey and Land use Mapping) for crop suitability, the land suitability for particular crops was identified. **Figure 1** shows soil map. Land use / Land cover maps are prepared using two season data (Kharif & Rabi) for a crop calendar year. The main categories shown are single crop (Kharif/Rabi), Double Crops, Forests (Density and Vegetation), wastelands, degraded lands, water bodies etc. **Figure 2** shows land use/land cover map for 2006 and **Figure 3** shows land use/land cover map for 2011.



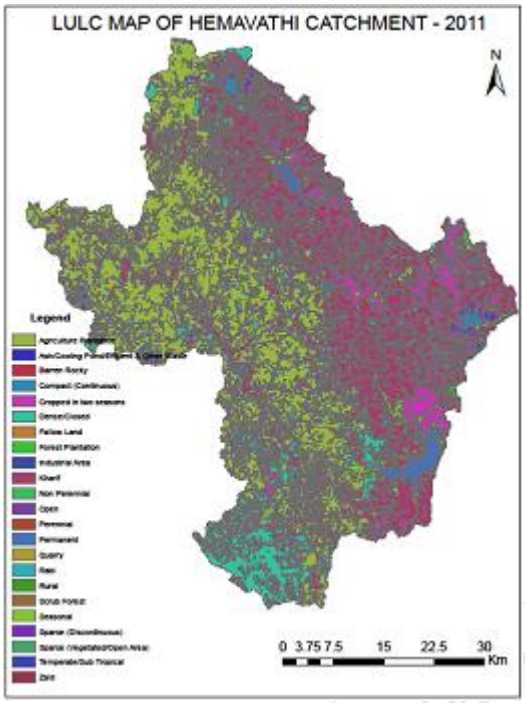


4.1. Land characteristics

Soil drainage is the important factor in the land suitability analysis, deep soils which allow excess water to readily pass through them and retain enough water to help maintain crops until the next precipitation were classified as the best soils for agriculture. Soil depth and its capacity for nutrients and water determine the yield from a crop. Moderately coarse medium and fine textured soils have good retention water capacity and aeration are considered most suitable for agricultural use

4.2. Land suitability for crops

The performance of any crops depends on soil parameters like depth, drainage, texture and climate for land evaluation. Soils vary in their suitability for different crops, yield influencing factors for important crops have to be evaluated and the results obtained may be applied for higher production of these crops through proper utilization and scientific management practices.



Major crops cultivated in the area were paddy, ragi, jowar, maize, sugarcane and coffee. The order of the suitability is expressed by S (suitable) which characterizes a land with sustainable use giving good benefits according to expectations, N (not suitable) indicating land characteristic are not adequate for sustainable results.

S1: Highly suitable**,** unit represent optimum conditions for plant growth, without or with only slight limitations.

S2: Moderately suitable land with nearly optimal conditions, affects productivity by 20% or less

S3: marginally suitable land which affects significant productivity but still considered economical,

The land-suitability assessment in classes S1, S2, S3 and N arrived by matching soil map units with land-use requirements and their qualities.Order **'N' represent** Not for sustainable results under consideration

5. Results and Discussion

The Total catchment area of Hemavathy basin is classified into two zones for the study. Zone 1 includes taluks Alur, Arkalgud, Belur, Chickmagalur. Zone 2 includes Mudigere, Sakleshpur, Somwarpet. Six major crops cultivated in the study area considered for study are paddy, ragi, jowar, maize, sugarcane, and coffee. While paddy and ragi are main food crops, sugarcane and coffee are major commercial crops. Details of crops grown in the catchment during 2011 as obtained from statistical department are shown in tables**.**

5.1. Land suitability for paddy

Rice is grown in various climate-soil-hydrological conditions. The average temperature required for the crop ranges from 21^0 c to 35 ^{0}C, water requirement under rain fed conditions is 1000mm or more depending on the soils. **Table1** shows land suitable for paddy. As seen, zone one recorded the largest area in S3 class, because of the annual rainfall of more than 2200 mm and temperature lower than 24^0 C,

Table 1: Land suitable for paddy crop-2011

Orders	Zone one (area in hectares)	Zone two (area in hectares)
S1	0	0
S2	30411 (20.07%)	0
S3	89198 (58.87%)	8309 (7.37%)
N	31891 (21.05%)	104491(92.63%)
Total	151500	112800

5.2. Land suitability for ragi

Temperature between 28^0cto 34^0 C and distribution of rainfall throughout the growing season is more important during the period. 750 mm to 900 mm annual rainfall is highly suitable for its growth. Well drained and moderately well drained soil is most suitable. **Table 2** shows land suitability for ragi. As seen in zone one, land of marginal suitability status exceeds high suitable status. In zone two, a greater amount of land is not suitable for ragi cultivation, because high rainfall and undulated topography is more predominate.

Table 2: Land suitable for of ragi crop-2011

Orders	Zone one (area in hectares)	Zone two (area in hectares)
S1	5942(3.92%)	0
S2	44310(29.25%)	0
S3	69477(45.86%)	39258(34.80%)
N	**3**1771(20.97%)	73542(65.19%)

5.3.Land suitability for jowar

Crop season with 600 mm of rain and temperature between 27^{o}C to 35^{o}C is ideal for the optimum crop performance. **Table 3** shows land suitability for jowar. In the study region, zone one has highly suitable land for jowar crop cultivation with 35, 689 hectares of land have S1 characteristics. Arkalgud taluk have the largest area i.e., 11, 924hectares. In zone one 42, 798 hectares and in zone two 5, 880 hectares of land have S2 characteristics. The taluk of Hassan has 33, 858 hectares of land moderately suitable for jowar crop cultivation.

Table No: 3: zone wise land suitable for jowar crops-2011

Orders	Zone one (area in hectares)	Zone two (area in hectares)
S1	35689(23.56%)	0(0.00)
S2	42798(28.25%)	5880(9.83%)
S3	37195(24.55%)	27856(46.58%)
N	35818(23.64%)	26064(43.59%)

5.4. Land suitability for maize

In the South, maize is sown anytime from April to October. The most suitable temperature is 21^{o}C to 32^{o}C.**Table 4** shows land suitability for maize. In zone one 14, 908 hectares of land are classified in the S1 class. Arkalgud

recorded the largest highly suitable area i.e. 12, 152 hectares. In zone one and zone two 88, 522 hectares and 21, 091 hectares of land are moderately suitable land respectively. In zone one, Hassan taluk recorded the largest area i.e. 35200 hectares of suitable land.

Table 4: Zone wise land suitable for maize crop-2011

Orders	Zone one (area in hectares)	Zone two (area in hectares)
S1	14908(9.84%)	0
S2	88522(58.43%)	21091(18.70%)
S3	16466(10.87%)	34494(30.58%)
N	31604(20.86%)	57215(50.72%)

5.5. Land suitability for sugarcane

Well drained soil is more highly suited for sugarcane than the moderately or imperfectly drained, with ground water table less than 1.5 to 2.0m depth below. **Table 5** shows land suitability for sugarcane. In the study region 24511 hectares of land are marginally suitable for sugarcane crop cultivation in zone one. Zone two has the largest area of unsuitable land for growing sugarcane, because of unsuitable temperature, rainfall amount, soil depth and slope**.**

Table 5: Zone wise land suitable for sugarcane crop-2011

Orders	Zone one (area in hectares)	Zone two (area in hectares)
S1	0	0
S2	6811(4.50%)	0
S3	24351(16.07%)	117(0.10%)
N	120338(79.43%)	112683(99.90%)

5.6. Land suitability for coffee cultivation

The suitable temperature for coffee crop plantation is 22 ^{o} to 32 ^{o}C, with annual average rainfall of more than 1250 mm and well drained soil drainage. Soil depth of more than 100 cm and a slope of up to 15 percent is highly suitable. Table 6 shows land suitability for coffee cultivation. In the study region zone one and two having largest highly suitable area i.e., 121465 ha and 108272 ha, taluks of Mudigere, Sakleshpura and Somvarpet having highly suitable area due to the favorable soil parameters suitable for coffee plantation.

Table 6: Land suitability for coffee cultivation

Orders	Zone one (area in hectares)	Zone two (area in hectares)
S1	121465(80.17%)	108272(95.99%)
S2	30035(19.83%)	4528(4.01%)
S3	0(0.00)	0(0.00)
N	0(0.00)	0(0.00)

5.7. Crop concentration in zone one

Totally, in this zone, Alur has medium levels of paddy and ragi, high level of maize crop concentration. Arkalgud has recorded medium levels of paddy ragi and maize crop concentration. Chikamagalur recorded high levels of jowar, sugarcane, coffee and medium level of paddy crop concentration. Belur recorded high crop concentration of maize, medium level of sugarcane. Table 7 shows crop concentration.

Table 7: Hemavathy watershed crop concentration in zone one (2011-12)

Crops	Low (<0.5)	Medium (0.5 to 1)	High (>1)
Paddy		Belur	Alur, Arkalgud, Chikkamagalur
Ragi	Belur	Alur, Arkalgud	Chikkamagalur
Jowar		Alur, Arkalgud	Chikkamagalur, Belur
Maize	Chikkamagalur, Arkalgud	Alur, Belur	
Sugarcane	Alur	Arkalgud, Belur	Chikkamagalur
Coffee	Arkalgud	Alur, Belur	Chikkamagalur

5.8 Crop concentration in zone two

In zone two. Somvarpet taluk recorded medium levels of paddy, high levels of ragi, coffee and maize crop concentration. Mudigere recorded high levels of paddy, medium levels of coffee crop concentration and Sakleshpura recorded high levels of paddy, sugarcane crop, medium level of coffee crop concentration. Table 8 shows crop concentration in zone 2.

Table 8: Hemavathy watershed crop concentration in zone Two (2011-12)

Crops	Low (<0.5)	Medium (0.5-0.99)	High (>1)
Paddy		Somvarpet	Mudigere, Sakleshpura, Somvarpet
Ragi	Mudigere, Sakleshpura		
Jowar	Mudigere, Somvarpet, Sakleshpura		
Maize	Mudigere, Sakleshpura	Somvarpet	
Sugarcane	Mudigere, Somvarpet		Sakleshpura
Coffee	Mudigere, Sakleshpura	Somvarpet	

6. Conclusion

In this study, only 6 major crops were selected i.e., paddy, ragi, jowar, maize, sugarcane, and coffee. In the Hemavathy watershed, only 11.50 percent of land is moderately suitable for paddy crop cultivation. 19.01 percent of the land is moderately suitable for ragi crop cultivation, 13.50 percent and 5.60 percent of the land is highly suitable and 18.42percent and 41.48 percent moderately suitable for jowar and maize crop cultivation, respectively. Mudigere, Saklesphura and Somvarpet taluks is not highly suitable for paddy, ragi, jowar, maize, sugarcane but are highly suitable in coffee crop cultivation, due to heavy rainfall, low temperature, high depth of soils (<150 cm) and steep slopes.Maize is one of the crops which suits in different soil climatic characteristics and required less rainfall. In rest of

the taluks except Mudigere, sakleshpura and somvarpet the other taluks are having moderately suitable land.

7. Acknowledgement

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