Development of RS and GIS based Indicator for Paddy Cultivation Lands

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Abstract— Paddy is most significant food crop for the people of many countries in the world. Especially the majority of Asians primary occupation is agriculture. The cultivation of paddy products has been reduced day by day due to various reasons. One important fact among many reasons is natural disaster that suffers the cultivation of crops in many ways. Thus, utilizing available technologies leads to improvement in the fields of the agriculture cultivation. This paper presents an approach to prepare an index model for cultivation lands that is suitable to guide the time and place to cultivate paddy crops. Remote sensing and GIS was used to develop this model. In order to predict the land is suitable or not to cultivate paddy crops some of the parameters include topography, physical and chemical soil properties are considered. To prepare the model with these mechanisms, western coastal plain land located in between Western Ghats as well as the Arabian Sea in Karnataka was selected.

Keywords—GIS; Remote Sensing; index model; rice cultivation.

1. INTRODUCTION

As paddy is a significant food crop of the maximum Asian people in the world, important must be focused to the cultivation of paddy. Few decades back, the most cultivation lands of majority of states in India was in good condition to cultivate any type of crops. So, there is not much scarcity for crops in terms of food for the people on those days. But recently, the amount of cultivation land has been shrinking due to various reasons[1]. One important cause is the cultivation lands are becoming people residence, industries and being used for other purpose. Thus, Indians are in position to import food grains from other countries. If it continues the people of India will always depends on other countries to satisfy their food needs. Second important cause for food scarcity is natural disaster like flood, earthquake and hurricane that damages the crop in any time of their life stages. These kinds of problems are not only suffering the people, it suffers the farmers, government and other animals like domestic and insects. Statistics reports says that farmers in India often committed suicide due to loss of crops from field to its harvest due to

some natural disaster and problems in soil etc[2][5]. they face heavy economic loss and mental stress. Thus they are tempted to commit suicide. So it is highly recommended that agriculture must have to be improved with the help of the technological developments.

Recently, Remote Sensing (RS) and Geographical Information System (GIS) offer lot of benefits to various disciplines. Because of its nature of capturing spatial details, many data can be collected from the earth [7][9]. Those data are stored in the earth station and gets processed. Applications of GIS and RS are widespread which includes army, navy, climate predictions, mapping development etc [3][4]. The spatial and time data captured by this technology can be forwarded for further process like processing and producing results which in turn aids to take decision making. As the invention on different sensors are able to capture different frequencies of details on the land spaces. For that case, same location of earth land provides different data by different sensors [6][8]. Based on perfect analysis method, various reports can be generated which is helpful to gain a lot of knowledge and inferences.

Crop land analysis is pre required method to know about the proper utilization of the land for cultivation. The main aim of the map generation is to increase the agriculture productivity by adopting suitable cultivation methods. This work attempt to develop index model to determine suitable land for rice cultivation in the western coastal area located in Karnataka [10]. The main cultivation in this region is banana, ginger and green chili, the cultivation of paddy is less where they cultivate only once in year due to heavy rain and floods in the region .In order to overcome this problem the study has been under taken to improve the agriculture productivity. The required data to derive this map is collected from Indian Institute of Remote Sensing (IIRS).

Section II gives the details of proposed methodology with the data required to prepare this index model. Apart from that a brief description of ideal vector analysis is also present. Result for the suitability of the rice cultivation in terms of qualitative and quantitative is discussed in section III. Conclusion of this work is given in section IV.

2. PROPOSED METHODOLOGY

Multi criteria decision making approach is a process where land data based on geographical features is transformed into a decision by using GIS and RS as well as Ideal Vector Approach. Here, GIS is used to feed data, store in it, process and output of spatial data. RS is used to provide a lot of spatial information includes soil, drainage, slope details etc. Combining both RS and GIS offers a powerful tool to develop decision–making systems about spatial of earth as well as other planets. Ideal Vector approach is used to evaluate land suitability to paddy crop cultivation based on several criteria. Fig. 1 shows the important criteria used for developing tropical map.
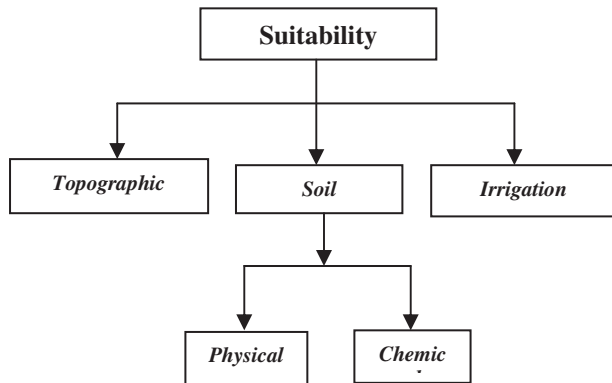
Fig.1 Parameters requires to find suitable land for rice cultivation

2.1 Topographic database

Dem is generated using topographical maps using Universal Transverse Mercator .Using 3D surface analysis the DEM is generated which have been met to digitalization by topographical maps. Edge to Edge DEM data set is generated with the help of SRTM for entire study area .The Slope tool is used to calculate the maximum rate of change between each captured cell. Each cell has a slope value ,the higher slope value indicate the down region where as the lower slope indicate flat region .The aspect is measured from due north to north of 360degree , the value of each cell indicates specific region.

2.2 Soil Database

Soil plays a significant role in growing any plant on the earth. It is much important to find out the suitable soil to cultivate particular crops. The physical and chemical features of the soil must have to be studied before to lead the further process. The effective depth of the soil indicates the thickness of the soil. Most annual crops have the depth of 50cm, for trees the rooting system is up to 150cm below the earth the 100cm depth roots can yield very good crop which has been taken as upper limit. Similarly the type of soil indicated as texture has to be identified which helps to penetrate the root in the soil.

PH value of the soil plays a very important role where it is taken as negative logarithm of the Hydrogen ion concentration of the soil solution, A PH value of 6-7 is goop for paddy cultivation. Organic carbon is another important criterion to the advancement of paddy crops.

2.3 Irrigation data

Cannel and Groundwater are the main water sources of rice cultivation. Favorably paddy is grown in the tropic and sub tropic region averaging rainfall of 1250mm to 2000mm of annual rainfall.

2.4 Ideal Vector Analysis

The main aim of using ideal vector is to obtain the performance index of suitability classes for the individual parameter used. It is based on positive and negative ideal solutions derived among the individual groups of attributes. Both provide shortest and longest distances of the attributes from them. So, based on collecting distance of a particular attributes to the groups Soil Physical (SP), Soil Chemical (SC), Topographic (T) and Irrigation (I), similarity would be calculated. Below vector-matching procedures are used to measure the degree of similarity for attribute from positive and negative ideal solution.

Degree of Resemblance to the positive ideal success is measured using the following mathematical equation.

$$R_{ij}^{+} = \frac{X_{ij} X_{j}^{+}}{\max\left(X_{ij} X_{ij}, X_{j}^{+} X_{j}^{+}\right)} \text{------------------- (1)}$$

Similarly, Degree of Resemblance to the negative ideal success is calculated with the help of the given formula.

$$R_{ij}^{-} = \frac{X_{ij} X_{j}^{-}}{\max\left(X_{ij} X_{ij}, X_{j}^{-} X_{j}^{-}\right)} \text{------------------- (2)}$$

Where, $X_{ij} = (x_{i1}, x_{i2},..., x_{im})$ is the overall success matrix of number of classes of the groups such as SP, ST, T and I.

The success index of the group is given by:

$$P_j = \frac{R_j^{+}}{R_j^{+} + R_j^{-}} \text{---------------------------------- (3)}$$

Where j=1,2,…,n. The old values of the group (Ranking) used in this computation are change by this success indices. The weight used as normalization factor is calculated for obtaining the final suitability using AHP mechanism in given formula:

SP-WEIGHT = SP (SUCCESS)*(SC(Ranking)+ T(Ranking)+ I(Ranking))/3

3. RESULTS AND DISCUSSIONS

Erdas-11 and ArcGIS software were used to study and to prepare the topographical maps, it also includes the study of soil layers which involve physical, chemical layers and land access rating layers. All the variables are used to develop the index model which produce the topographic suitability and physical land suitability were stored in the temporary memory files which are used as the temporary memory input for suitable rice land cultivation.

Optical bands with suitable false color combination (SFCC) of LANDSAT 7 TM satellite image is used to find out forest cover density plots in the study area.Vegetation canopy cover datasets are generated from satellite images using Ideal Vector Analysis technique. Table I gives the different values of the parameters generated by the proposed technique.

Table I. Quantitative values obtained from the land images

pH	Ranking	IVA			
		+ve Resemblance	-ve Resemblance	Success	Weight
SP	1	1	0.0675	0.9117	0.0218
SC	0.3693	0.39851	0.162	0.6991	0.181
T	0.1774	0.176	0.3982	0.2922	0.0084
I	0.0676	0.0688	0.5734	0.1448	0.0043

Based on the proposed method, the map has been generated and shown in fig. 2 with different options for finding the suitable locations for the cultivation of paddy. The map is incorporated with six colors. The colors represent the ranges from unsuitable to suitable. Dark green represent high suitability in which paddy van be cultivated without any complication. Light green indicates moderate suitability. Marginal suitability is shown in the map by representing the yellow color. Rest of the colors present in the map list shows marginal unsuitability, unsuitable and constant area.
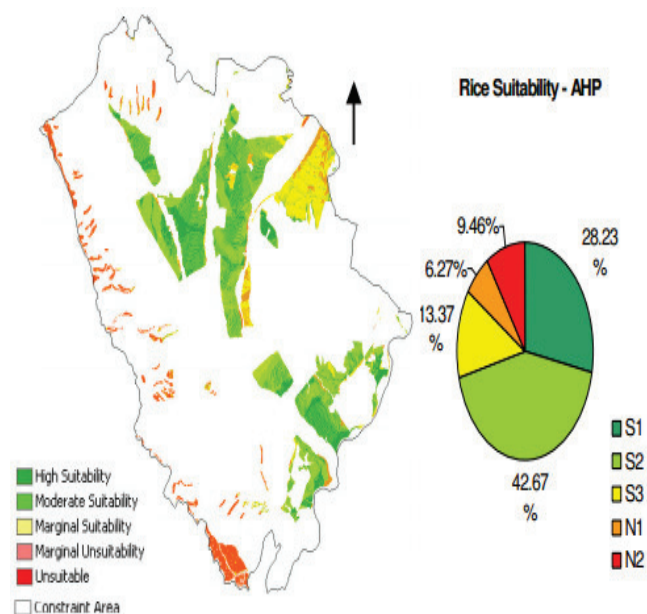

Fig.2 Topography of the suitable lands

Table II gives quantitative analysis of the suitable lands for cultivating paddy crops. In that, s1 covers almost 63% of land and it says that the entire area is suitable for rice crops. Compare than suitable area with non-suitable area, the non-suitable area scores very less amount of area.

TABLE II. Suitable areas

Index	Area (KM)	Area (%)
S1	64.19	28.23
S2	22.86	42.67
S3	13.45	13.37
N1	7.83	6.27
N2	10.76	9.46

4. CONCLUSION

A method is proposed to find the suitable land cover area for cultivating paddy crops in Sakelashpur area of Hassan District. For that, some important parameters includes topography, irrigation and soil are considered and are collected from the respective databases. Finally a map was generated using Ideal Vector Analysis for producing the details such as high, moderate and marginal suitability and unsuitability. From this analysis with the help of GIS and RS almost 64% of the area in the place is suitable to cultivate paddy crops.

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