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Study on land use planning via linear programming and GIS.

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Abstract:

In this paper, an attempt is made to develop a model based on Geographical Information System (GIS) integrated with linear programming to make use of land development plan.

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INTRODUCTION: Due to urban development, Industrial development and some other land area demands, agricultural land rapidly going on decreasing day by day. This will be harmful to any developing nation. If necessary and affective actions should not be taken in near future the situation becomes vary nastily. In this paper an attempt is made to integrate the technique of linear programming with GIS for land use planning problem. Different types of land is selected with the help of GIS, then land is converted to another form for its proper utility, that is , source land is converted into target land. Expenditure incurred in develop land, labor, technical, requirement etc. are calculated along with the net return and profit. Then model is formulated as linear programming problem (LPP).

MODEL FORMULATION WITH GIS

Modeling real life problem helps in understanding there undetermined factors, which are not exhibited as such less understood. However any single approach is the best one can think of diverse technique available for users in general to solve various complex problems. Geographical information system is one such tool responsible for revolutionizing the era of spatial data management. A GIS can be considered as tool for then integration and analysis of geographically referenced data. Basically it is commercial system, which is required in applications in the field of hydrology, soil science, forestry and land use planning.

Linear programming technique for calculating the optimal returns from the proposed infrastructure for land use development or any development plan in general. Linear programming (LP) has been used science 1950 in wide variety of planning situations. Its application field ranges from business planning managements to the problem of spatial organizations. Problem like transportation planning distribution of administrative area and location of central facility are solved by LP. The result and problem structure is discussed in the next section, before that an outlook of the necessity for integrating the GIS along with analytical model has been elaborated in the following section. Reviewing all these aspects integration of GIS and mathematical models are very much necessary and is what we wish to do in our case study.

THE STUDY AREA

The Nanded district situated in southern Maharashtra (Marathwada Region) and lies between 180.15 and 19^0.15 degree north latitude and 770.7' and 78^0.15' degree east's longitude. The entire northern and eastern portion is covered by hills, forests and interspersed plain cultivable land and long canal water system in one of the part .the western part comprise plains rising gradually to east and drained by rivers and interspersed by sprinklings of low hills. The soil of the northern and eastern region of the district is shallow rocky and black in texture. Following table shows statistical information about land of the area under study.

TABLE: 1 AERA IN HECTARES OF DIFFERENT TYPES OF LAND UNITS.

Sr. No.	Land Type	Land Area Available (In Hectares)
1	Single Crop Land	2565.47
2	Double Crop land	7078.201
3	Grass Land	545.966
4	Forest Land	4917.965
5	Shifting Cultivation	1367.707
6	West Land	284.442
7	Water Bodies	1040.185

(Source: Census hand book of the Nanded district)

The result and problem structure is discussed in the next section.

INPUT MATRIX FOR SOLVING THE LP PROBLEM.

Shifting cultivation land has been merged into the forest land area for the problem under study and water bodies are not taken into account for land use transformation or development scheme.

Characteristics for each type of land studied with the help of GIS based on ground water, soil type, and slop of the land.

The remaining land has fertile and alluvial soil. The area is traversed by rivers out of which Godavari is the biggest river. It flows from West North to South West direction. The area also has few lakes of considerable size and out of this district and total sub area of 17799.928 hectares is selected. This region is dominated by single crop activity and is possessing more than seventy percent of forest reveres.

The following table gives area matrix of land use from one form to another.

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TABLE :2 AERA MATRIX OF LAND USE FROM ONE FORM TO ANOTHER FORM.

Sr. No.	From /To	West Land	Grass Land	Forest Land	single Crop land	Double Crop land
1	West Land	----	72.637	211.805	----	----
2	Grass Land	----	309.790	20.764	97.821	117.795
3	Forest Land	----	----	5976.720	145.764	163.342
4	single Crop land	----	----	----	2025.507	512.963
5	Double Crop land	----	----	----	----	7080.201

(Source: District Census hand book for year 2008-2009 Crop)

The entire sub-area is divided into polygon of different land use activity namely single crop, double croup, fallow land, deciduous forest, shifting cultivation, scrub land and water bodies consisting mainly of canals, lakes, and ponds. The total area consists of 12679.749 hectares of land use area. The total water body area is about 1040.185 hectares.

To formulate a linear programming problem for the problem under study, following table can also be used.

TABLE:3 JOB AND PROFIT RETURN FROM DIFFERENT LAND USE PER HCCTARES.

Sr. No.	VARIABLE	EMMPLOYESS/ PROFIT PER HECTARES	NOTES
1	West Land	0/0	No Employment
2	Grass Land	2.0/500	Grazing labor
3	Forest Land	4.0/10000	Rangers, Wood
4	single Crop land	10.0/25000	Rural Labor Force
5	Double Crop land	15.0/50000	Labor and Technical Service

(Source: District statistical abstract, Nanded district 2008=2009)

The information from tables is used to write the linear programming problem.

OBJECTIVE FUNCTIOPN:

$$Z= \text{Max}\{ 0WW+2Wg+4Wf+10Ws+15Wd+2gg+4gf+10gs+15gd+4ff+10fs+15fd+10ss+15sd+15dd\}$$

Subjected to constraints:

For west Land

$$WW+Wg+Wf+Ws+Wd<284.44$$

For grass Land

$$gg+ gf+gs+gd+<545.966$$

For forest Land

$$ff+fs+fd<2565.47$$

For single crop

$$ss+sd+<6285.672$$

For double Crop

$$dd< 7078.201$$

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CONCULSIONS:

Linear programming is valuable tool for modeling the land use with the GIS framework. It provides objective criteria for the different land where different goals are being considered. Linear programming is also flexible method for generating different planning scenarios and with the help of LPP multiple relationships between the decision variables and the contributions can be interpreted. The contribution of GIS to LP is considered as a method for data collection and mapping of results with GIS as put as future work to be done and this subject to utilize available land for various purpose with increased employment opportunities at local places with optimal subject.

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