Drought Issues Monitored Through Integrated Spatial Process Model For Assessing Land Productivity And Wasteland Development Strategies

Kumar.R.Rao, Sreekeshava K.S, Prashant Sunagar, Manish S Dharek

Abstract: The integrated raster GIS analysis can utilize number of water and soil conservation parameters into the analysis for generating holistic disaster management plans. This is useful for ascertaining drought proneness of an area carried out by integrating spatial variation parameters associated with runoff, soil conservation, soil texture, and slope to generate agricultural Land Productivity Index as a quantitative measure for obtaining strategies to reduce the impact of drought. The vector spatial parameters can be integrated as per the process model developed utilizing the spatial variation factor that suits the local conditions for arriving at reliable developmental strategies leading to mitigation of drought. The wasteland development in the area is considered to be an important step in this direction wherein by virtue of spatial integration it is possible to identify wastelands of different categories based upon its amenability for development and suggestion of subsequent drought prevention measures. The details on the above issues are discussed in the paper.

Keywords: Drought Mitigation, integrated drought management, land productivity index, wasteland categorization, process model, raster analysis and vector analysis

1.INTRODUCTION

The drought prone zone in the India is not in position to achieve the agricultural growth, obviously due to scarcity of water. At semi-arid tropic locations of eastern Maharashtra, even the irrigated areas are facing the problem of retarding growth of agriculture. Majority of the villages in the drought prone regions have problem of drinking water along with main environmental issue due to depleted quality of surface water resources in the river that has been polluted to a large extent. The revitalization of agriculture in drought prone regions can be achieved by implementing integrated watershed management program in the drought prone area with a stress on agrarian development through formulation of strategies for micro level planning [1-2]. The integrated watershed management study need to divide the region into comparable size watersheds for appraisal of soil and water resources at one hand and agriculture and other agro based activities on the other. The extent of drought proneness can be ascertained by wasteland identification in the area for its prioritization and development using integrated approach [3]. The integrated evaluation for obtaining agricultural productivity of a drought prone region has potential for suggesting suitable action plans leading to improvement of drought prone area. This is obtained by incorporating factors that affect land suitability for irrigated agriculture such as temperature, soil texture, depth to bedrock and macro-topography.

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Changeable characteristics which may be altered deliberately or inadvertently typically may include vegetation, salinity, depth to groundwater, micro relief, and some social and economic conditions changeable at a cost. Land suitability must therefore be assessed and classified with respect to specified kinds of land use i.e. cropping, irrigation, and management systems [4]. It is obvious that the requirements of crops and irrigation and management methods differ, so the suitability of any land unit may be classed differently for various uses. It may be inappropriate to indicate suitability for irrigated agriculture in general if the land developer needs to know about its potential for a specific irrigated crop or irrigation method. Land evaluation requires a comparison of the outputs obtained with the inputs needed to generate these outputs, on different kinds of land [5]. Land productivity index maps and associated input spatial data required to generate land productivity index map in GIS raster analysis continue to be useful after the planning stage during design and implementation and for monitoring the integrated watershed development program since the land evaluation study provides a basis for monitoring changes in physical, social, and economic conditions. In response to such changes, the recommendations may need modification and updating from time to time [6]. The land cover details could be indicative of the extent of each landscape area required for drought mitigation. The developmental plans could be suggested for the wastelands in the area after its identification since wasteland development is considered as a sign of drought alleviation. In this context the characterization of wastelands is required based upon certain parameters. The parameters chosen can help in prioritization of wastelands leading to suggestion of action plans depending upon the priority type into which the respective wastelands fall.

2.STUDY AREA

The study area lies in Eastern Maharashtra between 19 015' to 190 50’ N and 74 017’ to 75012’ E extents. The location map giving the study area draped with LISS-III remote sensing data is given in Figure-1.

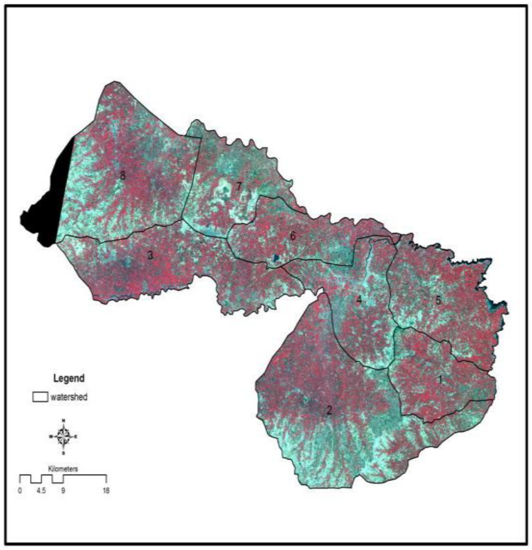


***Fig.1**. Standard False Colour Composite and Digital Elevation Model of Study Area*

A. Land Productivity Index/(Storie Index)

Land Productivity index for the soils of the area is an index that expresses numerically the relative degree of suitability, or value, of a soil for general intensive agriculture. The rating is based on soil characteristics such as soil erosion, soil type, slope of the region, runoff potential etc., apart from many other parameters such as depth,, intensity of subsoil, drainage, salts and alkali, availability of water for irrigation, climate, and distance from markets that might determine the desirability of growing certain plants in a given locality. The Storie index (s-index) is a method of soil rating that governs the land's potential utilization and productivity capacity. It is independent of other physical or economic factors that might determine the desirability of growing certain plants in a given location. Four general factors are considered in the Storie Index rating in the study area.These factors are (A) the soil erosion potential, (B) the slope of the surface soil; (C) soil type and texture and (X) runoff factors. Each of these four general factors is evaluated on the basis of a “100 percent” rating. A rating of 100 percent expresses the most favorable, or ideal condition; and lower percentage ratings are given for conditions less favorable for crop production. The Storie Index rating for a soil is obtained by multiplying the four factors, A, B, C, and X; thus, any factor may control the final rating.

The index is calculated from the multiplication of these parameters using the formula

$$S\text{-index} = (A/100 + B/100 + C/100 + X/100) \times 100$$

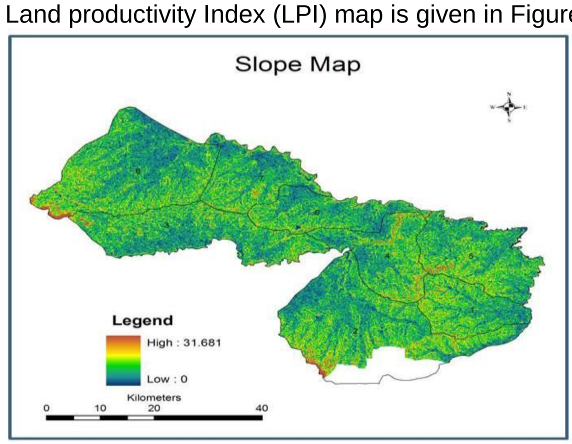
Lesser value of storie index signifies lower soil erosion, lower runoff potential, lower slope, and lower soil texture that can be a measure for improved land productivity.

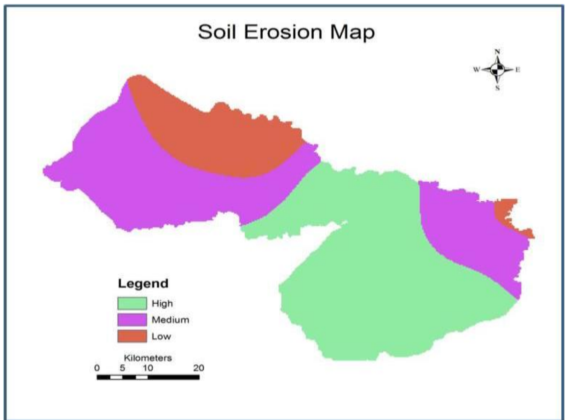
B. Integrated Development of Waste Lands

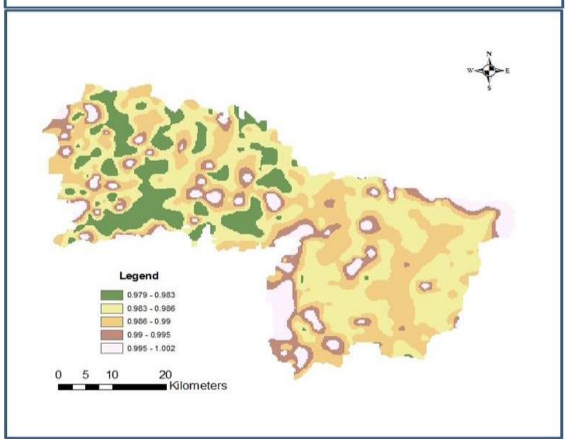
The integrated development of wastelands will have to be carried out based upon the extent of availability of different wasteland characteristics that govern its development. Each of the different parameters that define the wasteland characteristics is having the different abilities in its development and collectively their contribution adds up to varying magnitudes of abilities, which defines the suitability of the wasteland for development. Equation has been generated by incorporating and integrating the various wasteland characteristics governing its characteristics and subsequently its prioritization. Waste land development Potential = (Ground water Electrical conductivity polygon layer + Road Proximity buffer polygon layer +Slope vector layer + Soil type polygon vector layer + Land productivity Vector layer + Ground water potential vector layer + Spatial vector variation of ground water table and yield). All the vector layers pertaining to the different parameters indicated in equation -2 can be integrated as per the Boolean logical operators available in the vector spatial analysis tools.

3. RESULTS AND DISCUSSION

The storie index raster layer as a function of land productivity was generated by incorporating and integrating soil erosion layer, slope layer, soil map and runoff potential layer in the raster calculation and was reclassified into ten range of land productivity classes indicating different suitability for land productivity based upon the land productivity value obtained in the raster calculator of the software. The reclassification was ranged from 0 to 255. The reclassified raster layers in respect of different parameters were integrated into the raster based process model of the land productivity index to arrive at the final land productivity raster layer useful for assessment of area wise land productivity as an indicator for arriving at action plans to control the drought. The runoff raster layer generated using Soil Conservation Services Runoff model, the slope raster map, the soil erosion potential map generated using Stheliks model and raster Land productivity Index (LPI) map is given in Figure-2.







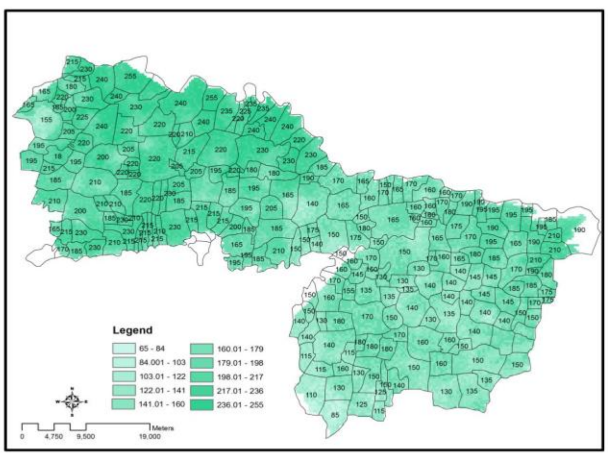
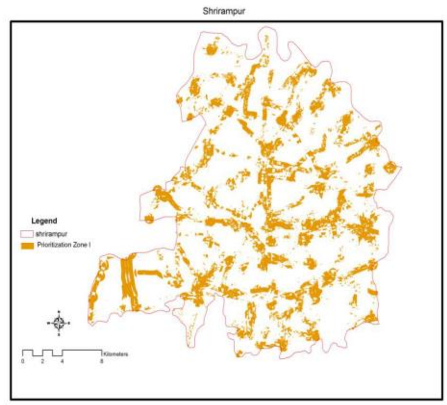
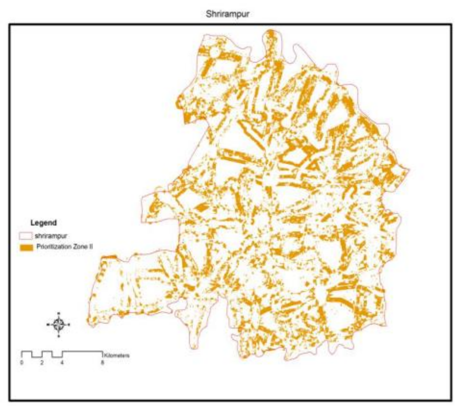


***Fig.2**. Runoff Raster layer, Slope Raster map, Soil Erosion Potential Map and Raster Land productivity Index (LPI) map*

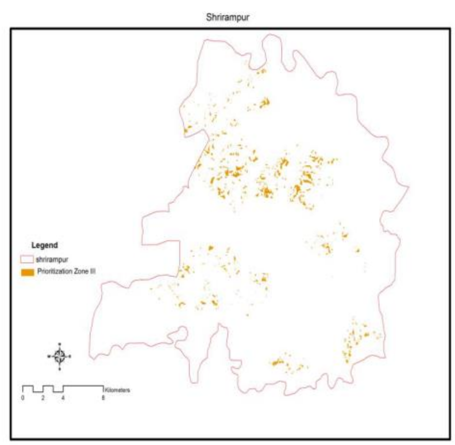
On the basis of composite wasteland development potential assessed through the different parameter integration, the output layers were generated on the basis of the different degree of suitability of wastelands for carrying out its development. In this context, it is observed that the wastelands falling in Zone-I are highly suitable for development while the wastelands falling in Zone-II is moderately suitable and the wasteland falling in Zone-III is least suitable for development. Suitable action plans can be formulated in accordance with the category of wastelands falling in the respective zones of the district.



WASTELAND FALLING IN ZONE-I



WASTELAND FALLING IN ZONE-II



WASTELAND FALLING IN ZONE-III

***Fig.3**. Wasteland Categories falling in Three Zones of Area (Srirampur Taluka)*

4. CONCLUSION

The integrated drought studies need to integrate the different spatial layers using appropriate process models to obtain decision support output layers. In this context it may also be required to carry out spatial interpolation tools to generate outputs that can be useful for data integration. The generation of resources potential spatial outputs and other landscape spatial representation could be of value addition. The wasteland identification and formulation of strategies for its categorization and suggestion of implementation plans for its development is considered to be an important facet in drought mitigation schemes. A properly formulated drought mitigation plan should be giving outputs after considering number of attributes that characterize the physical issues, resources potential and terrain aspects of the area. The integrated analysis can also involve multiple weighted criteria as per their importance to formulate prioritization plans required for according priority to the drought affected area to facilitate phase wise development.

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