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Mariyala-Veeranapura micro-watershed development plans using Remote Sensing and GIS in Chamarajanagar district, Karnataka, India

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ABSTRACT

Watershed hydrology plays a significant role in generation and quantification of runoff and sediment loss from watersheds. With an aim to asses runoff and soil loss Geographic Information System (GIS) tool was used to assist in data base development which acted as input to a developed conceptual model. The input to the model was in the form of data tables and digitised maps comprising of soil parameters, topological information and land use features of Mariyala-Veeranapura watershed in Chamrajanagar district, Karnataka, India. The topological information indicated the elevations of corners of square grid array. The model used 4-point pour-point technique to route surface flow from one grid to the other in an overlaid grid array of the watershed. The digitised watershed topology and square grid array was created using ARC/INFO GIS tool (Version 3.5). Manning's formulae was used to route water over the entire watershed coupled with water budgeting technique corresponding to rainfall events. The out put of the model generated event based Direct Runoff Hydrographs (DRH) for the watershed. The non-parametric statistical analysis (Wilcoxon's matched pair signed rank test) performed on the predicted value and observed runoff rate at the oulet of the watershed revealed that there is no significant difference between the observed and predicted values at 0.05 probability level. The topological information extracted using GIS was also used to obtain the geomorphological parameters of the watershed. The hypsometric analysis which is under geologic geomorphological component was performed using GIS tool. The analysis showed the erosion status of watershed, which is moderately prone to erosion and is at equlibrium stage.

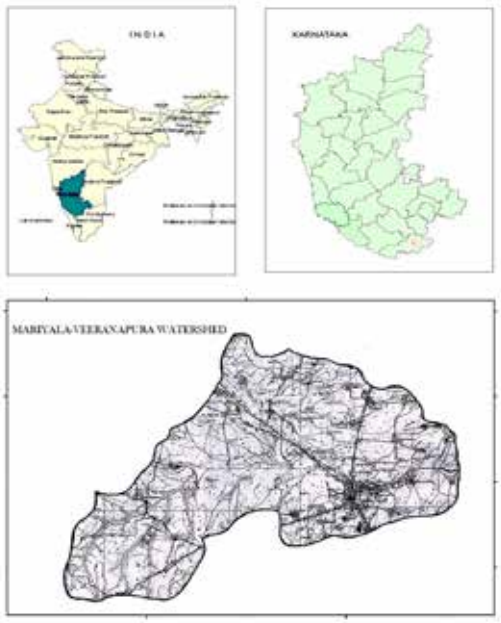
KEYWORDS:

Introduction

Micro-watershed level planning requires a host of inter-related information to be generated and studied in relation to each other. Remotely sensed data provides valuable and up-to-date spatial information on natural resources and physical terrain parameters. Geographical Information System (GIS) with its capability of integration and analysis of spatial, aspatial, multi-layered information obtained in a wide variety of formats both from remote sensing and other conventional sources has proved to be an effective tool in planning for micro-watershed development. In this study an approach using remote sensing and GIS has been applied to identify the natural resources problems and to generate locale specific Mariyala-Veeranapura micro-watershed development plans in Chamarajanagar district, Karnataka. Study of multi-date satellite data has reveled that the main landuse /landcover in the area is rainfed agriculture, wasteland with/without scrubs in the plains and undulating land and scrub forests with forest blanks on the hills. Due to paucity of ground water for irrigation, the rainfed agriculture area lacks sufficient soil and moisture to support good agriculture. The agriculture areas along the streams are constantly washed and undergo sheet erosion, thus converting valuable agricultural land into unproductive wastelands. For a major part of the year, the hills remain barren except for few small areas displaying a variety of thorny scrubs and few scattered trees growing along the less assessable slopes. Few varieties of grasses also spring up during the monsoon. The degraded ecosystem has affected the life of the residents within the micro-watersheds. There is always a scarcity of fuel, fodder and water for drinking and domestic use. The depleting vegetation cover has resulted in excessive soil erosion exposing barren rocky wastes. The steep rocky hill slopes facilitate high runoff leading to poor ground water recharge and increased siltation in the village tanks and ponds. According to the local people even today shepherds from adjoining taluka regularly visit to graze hordes of sheep and cattle. In addition to this there is the problem of the ever-increasing human and livestock population. Thus a heavy pressure exists on the scarce biotic resources of the study area. The main actions suggested for development of land and water resources in the area are being implemented.

Study area:

The Mariyala-veeranapura watershed is located about 5kms, from chamarajanagar town west. Mysore-chamrajanagar state high way and railway lines are passing in the North part of the watershed and chamarajanagar-Gundlupet district road is passing towards in the southern part of the watershed. The total extent of the micro watershed is 70 sq.kms. It lies between North Latitude 11051" to 11058" 30' and East Longitude 760 48" 30' covered under survey of India toposheet NO.58A/13.



MAP OF THE STUDY AREA

Data Used:

Indian Remote Sensing Satellite (IRS) LISS-III data at 1:50,000 and 1:25,000 scale of December 1996, January and April 1997 and October, 1988 and collateral data such as Topographical maps at 1: 50,000,Geological / Hydrogeological, Water level and quality maps climate, rainfall data & Census data, etc. have been used

Methodology

The methodology comprises an integrated approach using multi-date satellite data for preparation and study of multi-thematic maps at 1:50,000 scale namely Hydrogeomorphology, landuse/landcover (1:25,000 scale), soil, slope, ground water level and quality, etc. Based on subject domain decision rules for land and water management, the integration of the natural resources and demographic theme has been carried out in GIS to identify the problem areas and to providing

prescriptions for solving them. The action plan maps thus generated were consequently validated in the field in consultation with local experts. Action plan maps for select watersheds have been generated at 1:25,000 scale using PAN+LISS III merged data where implementation of plans is to be carried out by Mahajanam.

Observations Theme map details

The details of different theme maps prepared are as below The hydrogeomorphological map comprised seven landform types namely flood plain (7.69 % area), denudational hills (15.10 % area) and residual hills (0.45 % area) over basalt, pediments (2.07 %), buried pediments (64.97 %) and valleys (5.55 %) dissected plateau (4.16 %) and lineaments. The ground water prospects within different landforms vary from good in the plains and valleys to poor and poor to nil in the denudational hill sand residual hills. Landuse /land cover classification using kharif, rabi and summer season satellite data reveled the spatial extent of built up land (3.42 %), forest land (16.88 %), agriculture land (66.85 %), waste land (12.15 %) and others like waterbodies/ stream (0.70 %) etc. The forestland comprised scrub forest (4.08%) and forest blanks (12.80 %). Further classification of forest blanks as forest blanks with good grass (4.37 %), moderate grass (4.84 %) and poor grass (3.60 %) was possible.

Surface water body, drainage and watershed map showing micro-watersheds and average slope map with seven slope categories have been prepared using SOI topographical maps with 20m contour interval.

The soil map obtained from National Bureau of Soil Survey and Landuse Planning (ICAR), Karnataka showed soils of hilly terrain, soils of pediments and soils of piedmont plains belonging to six series.

Analysis of 17 year (1980 to 1996) monthly rainfall data for five stations was carried out. The area receives 765 mm average annual rainfall with 25 rainy days.

Factors responsible for degeneration of the ecosystem

Following are based on study of data and detailed field visits:

i) Hills and pediments with rocky outcrops with poor soil formation and can support only sparse vegetation.
ii) Steep slopes causing high erosion.
iii) The existing sparse vegetation of thorny scrubs provides very little protection against erosion.
iv) Growing cattle population (local and migratory) and rampant grazing has led to depletion in vegetative cover.
v) Illegal felling of trees to meet fuel wood demands
vi) Lack of awareness among the local people.
vii) Little concern on the part of the monitoring agencies.

Suggestions and recommendations

Water Resources Development

The main recommendations for water resources comprise a) prospective sites for rain water harvesting / ground water recharge through construction of small, low cost structures using local material and techniques across lower order streams. Structures suggested comprise small masonry check dams (21), nala bund (61) and nala plugs (at regular interval). b) Desilting / deepening / modification of existing tank/ pond structures to increase the water holding capacity and facilitate recharge to ground water.

Land Resources Development

The land resources plans depict conservation measures with suitable change in land use/ land cover. Priorities (high, moderate and low) for development has been provided based on existing physical parameters within the micro-watersheds. The suggestions are as given below

- Staggered Pits & afforestation with non grazing variety of trees (2733.53 ha.) with high (569.72 ha.), moderate (1116.49 ha) and low (1047.32 ha.) Priority.
- Contour trenching & afforestation with non grazing variety of trees (799.22 ha. In Govt. land) with high (432.73 ha.), moderate (196.64 ha.) and low (169.85 ha.) priority.
- Contour trenching & silvipasture with non grazing variety of trees (1660.95 ha. Panchayat land) to meet fuel fodder needs.
- Pits & afforestation with non-grazing variety of shade trees (about 122.81 ha.) along path to hill shrines.
- Protective bunding & Silvipasture (2047.94 ha.) in sheet erosion areas.
- Gap filling with protection of forest (1117.13 ha.)
- Agro-Horticulture & Field Bund (26.01 ha.)
- Double Cropping With Ground Water Exploitation (4416.01 ha.)
- Minimum Action (Soil Moisture Conservation) (13752.62 ha.)
- Agro-Forestry (117.46 ha.).
- No Action (294.39 ha.), and others like river bed, water body etc.

Other significant measures like in general protection of forestland for natural regeneration of vegetation and development of pastureland based on traditional methods in the existing land have also been suggested.

Conclusions

Micro-watershed development planning can be done by following an integrated approach using remote sensing data and criteria based analysis in GIS.

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