International Journal of Information and Computation Technology.
ISSN 0974-2239 Volume 3, Number 10 (2013), pp. 1093-1100

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Watershed Planning and Development Plan by Using Rs and GIS of Khultabad Taluka of Aurangabad District

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Abstract

The aim of the project is to develop an action plan for watershed management. Watershed management is the process of creating and implementing plans, programs, and projects to sustain and increase watershed functions that affect the plants, animal and human communities inside watershed boundary.(Wikipedia) The recent technologies like remote sensing and GIS support us to giving a quicker and cost effective analysis of various applications with accuracy for planning. It also gives a better perspective for understanding the problems and therefore helps Planners evolve a better solution for sustainable development.
From the final output of these themes generate; Recharge wells, percolation tank and check dams are recommended for the study area, mainly to control sedimentation from the catchments. To increase the groundwater recharge and vegetative cover to control soil erosion, various action plans like construction of recharge structures, afforestation etc have been proposed. This project describes in brief the work carried out for the study area using remote sensing and GIS.

Keywords: Watershed, Watershed Development, Arc-GIS, LISS III Image, DEM, Drainage Map, Flow Accumulation Map, Khultabad.

1. Introduction

Water resources are increasingly in demand in order to help agricultural and industrial development, to create incomes and wealth in rural areas, to reduce poverty among

rural people, and to contribute to the sustainability of natural resources and the environment. Reliable and timely information on the available natural resources is very much essential to formulate a comprehensive land use plan for sustainable development. The land, water, minerals and biomass resources are currently under tremendous pressure in the context of highly competing and often conflicting demands of an ever expanding population. Consequently over exploitation and mismanagement of resources are exerting detrimental impact on environment.

In India more than 75% of population depends on agriculture for their livelihood. Agriculture plays a vital role in our country economy. In order to mitigate droughts which occur frequently in several parts of the country especially in dry land areas the Ministry of Agriculture and co-operation has launched. An integrated watershed concept using easy, simple and affordable local technologies. Watershed approach has been the single most important landmark in the direction of bringing in visible benefits in rural areas and attracting people's participation in watershed programmes.(Singh J, Praveen Raj Saxena et.al,2005) The basic objective is to increase production and availability of food, fodder and fuel; restore ecological balance. Watershed management is an iterative process of integrated decision making regarding uses and modification of lands and waters within a watershed. Development of the watershed needs better understanding about the various natural resources their relations with each other and their relations with livelihood of the stakeholders. The present study is an attempt using Remote Sensing and GIS techniques to propose various water harvesting and soil conservation measures in order to suggest integrated land and water resource development plan for Khuldabad sub-watershed covering 46.138Km^2 in Aurangabad district in Maharashtra.

2. Location and Extent

The study area is bounded by North latitudes $20^0$18'0" to $19^0$52'0" and East longitudes $75^0$60'0" to $75^0$24'0" falls in the Khuldabad Taluka of Aurangabad district in Maharashtra and covered by Survey of India toposheet no. (46 P/4, 46 P/8, and 47 M/1, 47 M /5) with scale of 1: 50,000. The area experiences Moderately Tropical type of climate. The Average annual rainfall of the area is about 796.13mm. The mean maximum and minimum temperatures recorded in the area 43ºC and 13ºC respectively. Location of study area is shown in (Fig. 1)**.**

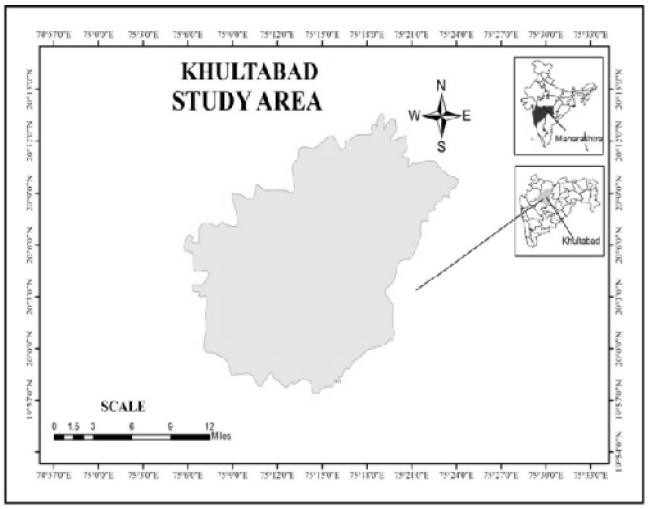


Figure 1: Study Area Map.

3. Scope of the Present Study

In large number of cases the failure of watershed development is largely due to adjustments with diverse facets of nature, caused by lack of awareness of the natural resources. In order to generate optimum utilization of existing natural resources like land, vegetation and water in watershed proper scientific surveys should be conducted. Geo-scientific studies of the terrain, socioeconomic appraisal of the stake holders and the use of Remote Sensing Data for faster assessment of natural resources such as soil, geology, drainage etc. as well as assessment of economic activities through land use and infrastructure of the watershed area is well known. This is also used for monitoring of watershed development at later years. GIS is a very powerful tool for development of the watershed area with all natural and socioeconomic facets for better planning, execution and monitoring of the project.

4. Objectives

The main objective of the present study is to generate information/databases on 1:25,000 scale pertaining to hydro geomorphology, Drainage, surface water bodies, watershed, transport network etc. using multi-temporal satellite data. Conversion of these databases into digital form for future analysis and utilization and to prepare location specific land, water resources development plans, by integrating these databases with socio-economic data and contemporary technology in the GIS environment such that control of soil & moisture conservation and land degradation, optimal management of croplands and conservation and management of water resources can be achieved.

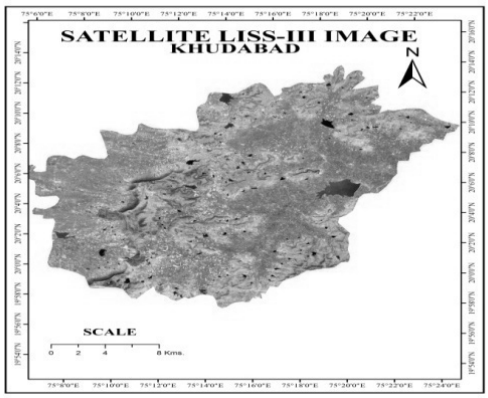
5. Methodology

To achieve the above objectives, the following methodology and procedure is adopted in the present study. Collection of satellite data and Survey of India Topographical maps, collection of rainfall and temperature data and other collateral data covering the study area, preparation of base map on 1:25000 scale using Survey of India Topographical Maps, preparation of Drainage, watershed and Surface water bodies using SOI topographical maps, preparation of contour map of 20mts contour interval using SOI topographical maps, preparation of DEM (Digital Elevation Model) from contour map, preparation of Slope, Aspect and Relief maps from DEM, Flow Direction Map, Flow Accumulation Map, preliminary pre-field interpretation of Hydro geomorphology using Satellite data on 1:25,000 Scale, ground truth data collection, verification of doubtful areas and correction, modification and transfer of post field details of Hydro geomorphology on to original maps, recommendation of land & water resources development plan.

6. Geomorphology

Geomorphology is the study of forms and process of landforms, which are the products of various exogenetic and endogenetic forces. Landforms play a significant role in land resource mapping, watershed studies, terrain evaluation and soil classification in addition to ground water studies. The ground water conditions vary from terrain to terrain.

For the present study IRS P6 LISS-III (2008) satellite imagery (Fig-2) and SOI Toposheet 1: 25000 scale have been used to map various geomorphic features in order to delineate ground water potential zones in the area. Based on the interpretation of the satellite imagery and SOI toposheet the following hydro-geomorphic units have been delineated on 1:25000 scale.



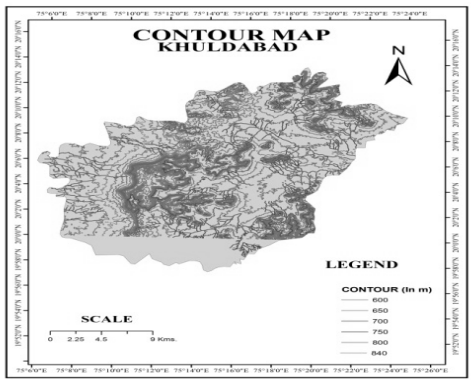


Figure 2: Satellite LISS-III Image (Year-2008). **Figure 3:** Contour Map.

Remote Sensing & GIS: The success of planning for developmental activities depends on the quality and quantity of information available on both natural and socio-economic resources. It is, therefore, essential to devise the ways and means of organizing computerized information system. Remote Sensing (RS) data and Geographical Information System (GIS) play a rapidly increasing role in the field of land and water resources development. One of the greatest advantages of using Remote Sensing data for natural resource management is its ability to generate information in spatial and temporal domain, which is very crucial for successful model analysis, prediction and validation. Examples from recent literature spotlight several uses of GIS as applied to groundwater exploration. Gustafson (1993) used a GIS for the analysis of lineament data derived from SPOT imagery for ground water potential mapping. Minor et al. (1994) developed an integrated interpretation strategy to characterize ground water resources for identification of well locations in Ghana using GIS as a unifying elem of Northwest Florida Water Management District, Richards et al. (1996) took the advant ent. For the assessment of ground water resources age of GIS for the spatial analysis and data visualization. Krishnamurthy et. al. (1996) developed a GIS based model for delineating ground water potential zones Marudaiyar basin, Tamil Nadu, India by integrating different thematic layers derived from Remote Sensing data. The field verification of this model established the efficacy of the GIS in demarcating the potential ground water reserve. Similarly Sander (1997) and Teeuw (1999) have applied GIS for ground water resource assessment.

In the present study most of the analysis was done using

Hydrological analysis tools in ArcGIS 9.3software. The hydrological analysis process in GIS is one of the effective methods in terms of cost and time in proposing various water harvesting structures. This process deals with assessing various hydrological characteristics of a surface. The basic parameter that controls the surface water flow (run-off) is the shape of the surface (terrain). Slope and aspect play a vital role in determining the shape of a surface. The basic inputs required to generate a hydrological model for a region are slope, aspect, sinks, flow direction, DEM Map (Fig-4), flow accumulation (Fig-5), pour points and a possible stream network. The whole hydrological process can be broadly divided into 2 phases i.e. (1) Surface analysis and (2) Hydrological analysis.

Water resource development plan has been prepared on the basis of integration of information on hydrogeomorphological characteristics, surface water availability, landuse/Landcover (Fig-6), drainage, present status of ground water utilization and considering the present and long term needs of water in the study area. Conservation, management and development of water resources form integral component of the development plan. Suitable structures are suggested for surface harvesting / recharge. Proposing different soil and water harvesting structures plays a very crucial role, which requires a well-qualified and well-experienced work force with thorough knowledge in various water conservation programmes. For this purpose the following thematic layers like slope, flow direction and flow accumulation output raster maps along with

drainage, land use/land cover, hydro geomorphology are used. Weightages are given to significant units (on priority basis) in various thematic layers such as Hydrogeomorphology, slope, drainage, soils and land use/land cover in raster form in order to prioritize locations for suggesting appropriate recharge structures.

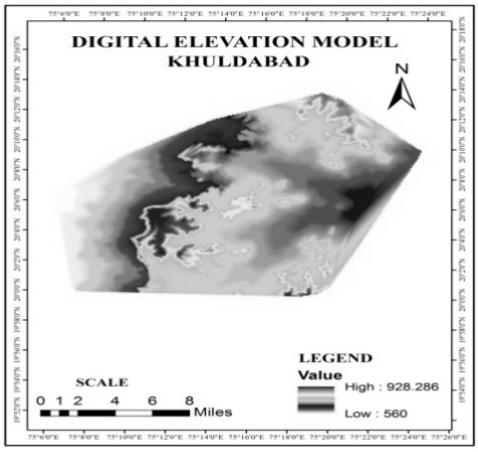


Figure 4: DEM Map.

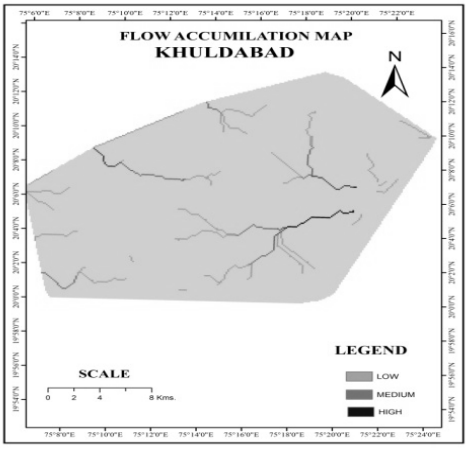


Figure 5: Flow Accumulation Map.

First, all the thematic layers have been converted to raster form in Arc Map using convert features to raster option to assign Weightages, since the analysis should be performed in raster mode. In the Hydro geomorphology layer high priority (1) is given to structural valleys, moderate (2) priority to moderately dissected plateau and low/least (3) priority is given to undissected plateau. In the land use/land cover layer high priority (1) is given to double cropped areas, moderate priority (2) to kharif un-irrigated areas and least priority (3) to fallow lands. In the soil layer top priority (1) is given to black loamy Soils and least priority (2) to black soils. Similarly, the slope classes have been reclassified into 2 categories like class 1 (0-1%) and class 2 (1-3%). Slope class 2 is given high priority (1), class 1 is given least (2) priority. In stream order raster 3rd order streams are given high (1) priority, 2nd order streams are given moderate (2) priority and 1st order streams are given least (3) priority. These themes have been calculated using raster calculator in spatial analyst of ArcGIS 9.3, based on the Weightages decided. The formula for this raster calculation is as follows:

((Hydrogeomorphology)*0.2+ (Land Use/Land cover)*0.2 + (Soils)*0.1 + (Slope)*0.2 + (Drainage)*0.3)

A drainage raster indicating high and low priority locations has been generated by evaluating this equation. Based on this location priority raster, various water-harvesting structures have been proposed (Fig-7). All these functions are used either by themselves or in conjunction with other mathematical or statistical or simulation models for varied applications in GIS. There is a wide range of spatial analysis functions in a GIS. To take advantage of its capabilities, user must define his problem

clearly; decide the data required and the spatial operations to be performed for reaching the goal. This will help in proper cartographic modeling of the decision problem and achieve the solution.

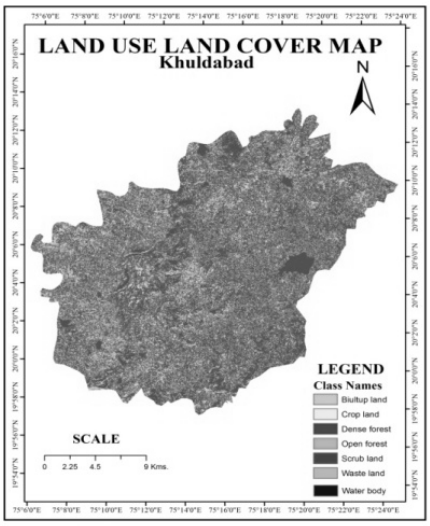


Figure 6: LULC Map

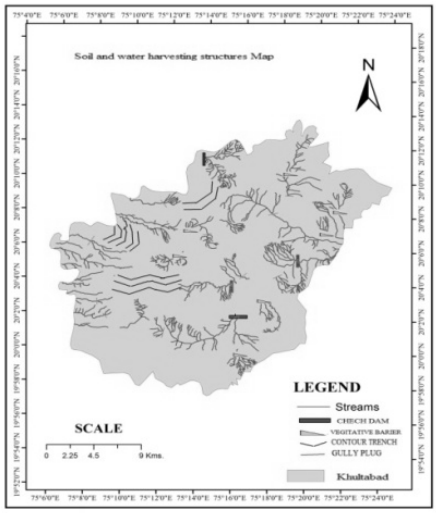


Figure 7. Soil and water harvesting structures map

7. Conclusion

Khultabad watershed with gentle slopes tending towards south direction and elevations of 600 to 840 m above mean sea level is drained by numerous streamlets. Thus from the study it is recommended that water harvesting should be given importance to avoid the wastage of rainwater from the watershed. This will also increase the groundwater recharge besides providing supplementary irrigation during Rabi season. Farmers should be encouraged with regard to making of farm ponds and soil conservation measures.

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