WATERSHED CLASSIFICATION, MORPHOMETRIC ANALYSIS AND HYDROLOGICAL MODELING USING GEOSPTIAL TECHNOLOGY-A CASE STUDY

Environmental Science

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ABSTRACT

Water is the vital natural resource essential for the survival of mankind. Rainfall is the main source of water which is unevenly distributed spatially and temporally. Unprecedented increase in population, urbanization, agricultural expansion and industrialization leads to higher levels of human activities. As water demand increases, issues on water availability and demand become critical. This makes the management of water resources, such as assessing, managing and planning of water resources for sustainable use, a complex task. Therefore, it is essential to make measurement of factors such as size, slope, soil type and land use, vegetation and flow capacity of the channel. The drainage area, length of the water courses and mainstream are the most significant variables for prediction of run-off. Geospatial Technology has been efficiently used in generating input parameters of hydrological models. In the present investigation, an attempt has been made to develop a GIS based Watershed Model for the assessment of spatial distribution of runoff for the Velchal Project in Mominpet mandal in Ranga Reddy, Telangana, India. The GIS layers namely, contours, stream network were prepared including watershed boundary. A Hydrological Model of the study area was also generated in ArcGIS using Contours and Stream layers. Subsequently Slope and Aspect maps were generated for the study area.

KEYWORDS

Watershed, Hydrological Model, Digitization, Geospatial Technology.

1. INTRODUCTION

Land degradation is caused by deforestation and inappropriate use and management of the natural resources, (soil and water). It leads to both non sustainable to agricultural production and increased risks of catastrophic flooding, sedimentation, landslides, Rangareddy district is believed to be one of the Telangana's most seriously affected by land degradation. It has been reported that land degradation in Rangareddy district accounts for 8% of the Indian total. In spite of substantial progress in watershed management in Rangareddy district region, land degradation and unsustainable natural resource base is still continuing. Sustainable natural resource is essential for conserving water, land and biodiversity, enhancing local livelihoods, improving the economy of highland inhabitants and people living in downstream areas and can only be achieved by an integrated approach through local people's participation.

2. OBJECTIVES

1. Collect and enhance spatial data for use in a watershed modeling environment, with clear rationales for selection of specific data sets;
2. Construct a working GIS software environment that provides an integrating interface for selected models/procedures used for evaluating hydrologic, economic, and ecological effects of land use changes.
3. Identify the limitations of the GIS environment, especially with respect to the issue of spatial/temporal resolution in integration of multidisciplinary models.

3. STUDY AREA

Velchal Project in Mominpet mandal in Ranga Reddy was selected as IWMP Project based on the criteria circulated by NRAA. A contiguous area of 4224 ha is selected in this Project and 6 micro watersheds were proposed from 6 villages. This Project covers 6 GPs namely Velchal, Mominpet, Moranga palli, Govinadapur, Ramnath Gudipalli and Durgamcheruvu. This Ranga Reddy district is under DPAP category.Fig-1 Showing the Location of Study Area.
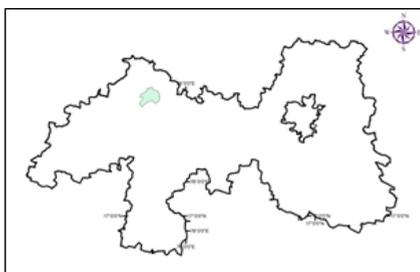

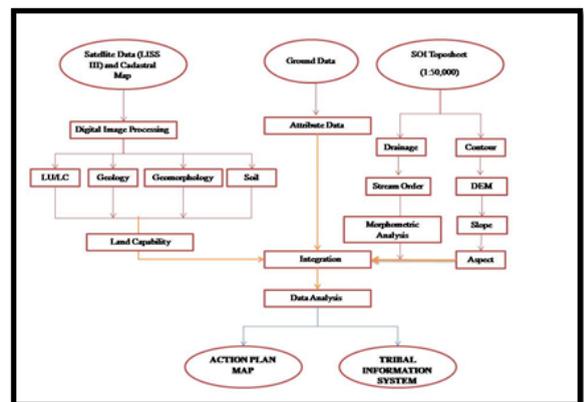**Fig-1 Showing the Methodology**

4. METHODOLOGY FLOWCHART


Fig-2 Showing the Methodology

5. RESULTS AND DISCUSSION

a) Watershed Delineation

Delineated watersheds are required for modeling and fpr BASINS watershed characterization reports. So we can characterize and investigate what is going on in one portion of the study area versus another. Delineation is part of the process known as watershed segmentation, i.e., dividing the watershed into discrete land and channel segments to analyze watershed behavior. There are two methods in watershed delineation, one is automated delineation while the other is manual delineation. Waterbodies such as drainage, streams and rivers were derived from Moosi block Survey of India toposheets (1:50,000 scale) to generate drainage map which is prerequisite to delineate watershed of any size. Watersheds in Moosi river basins are suffixed by numerical like, 1, 2, 3, 4, 5 and 6. The smallest tributaries are referred to as first order while the largest rivers are 5 and 6 order waterway.

b) Morphometric Analysis of Drainage Basin

The following paragraphs describe the physical meaning of various morphometric parameters. Further values of these parameters are obtained as per methods proposed by various researchers for the study area and indicated in respective descriptions. Fig-3 Showing the drainage Map of the study.

Drainage Network map in the Watershed area

Legend
— Drainage
▢ Velchal Watershed
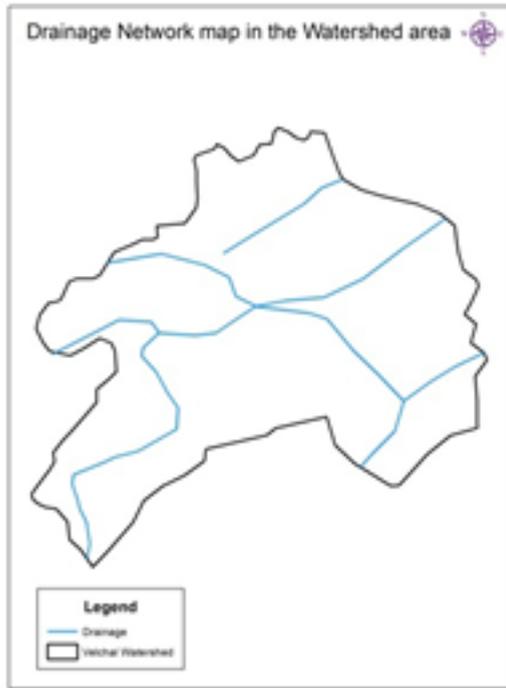
I. Linear Aspect
The linear aspect of morphometric analysis of basin include stream order, stream length, mean stream length, stream length ratio and bifurcation ratio.

II. Aerial Aspect
Area of a basin (A) is the important parameters in quantitative morphology. The area of the basin is defined as the total area projected upon a horizontal plane contributing to cumulate of all order of basins. The aerial aspect of the drainage basin refers to drainage density (D) and stream frequency (Fs). It has been calculated and results in a given table-1.

Table-1 Morphometric analysis of Drainage Basin

Sl. No	Stream Order (u)	Number of Streams (nu)	Length in Kilometers (Lu)	Mean Stream Length (LSM)	Stream Length Ratio (Rl)	Bifurcation Ratio(Rb)
1	1	1176	7522.9696	6.397083	-	4.2
2	2	280	212.9102	0.7603996	0.0283013	4.2424242
3	3	66	116.0796	1.7587818	0.5452045	4.4
4	4	15	52.98235	3.5321567	0.4564312	7.5
5	5	2	13.20155	6.600775	0.2491688	1
6	6	2	40.64607	20.323035	3.0788862	-
7	Total: 6	1541	7958.78937			

c) Hydrological Analysis
1. Sub watershed Mapping and Classification
The sub water sheds within the larger Rangareddy district, or all contributing watersheds flowing into Manjeera river basin, were each individually mapped, classified, and delineated. The following section describes the Velchal sub - watershed delineation, characterization, and hydrologic features. The watershed will be organized based upon main watershed management units. There were seven ephemeral streams that were classified and direct drainages in to Manjeera river.

The study area appear to be well-developed on the DEM-derived stream network , but that was not the case when visiting the physical locations shown in Figure 4.2. The unknown drainages and their associated watersheds had no relevant access points or important river uses by the surrounding populations and were typically dry, ephemeral streams. The percentage of physiographic regions was calculated for

each sub watershed in the Velchal watershed.. These percentages will be used to develop the sub watershed risk map. The hydrological process includes identifying maximum flow directions, possible accumulation points and basin demarcation based on flow direction of study area.

d) Generation of Hydrological modeling
Open *ArcMap*. All spatial analyst tools that are used for delineating stream network and watershed boundaries are available in *ArcToolbox*. If *ArcToolbox* is not activated within the map document, **click** on the *ArcToolbox* button to access the tools. Hydrology tools can be found by selecting *Spatial Analyst Tools -> Hydrology* within *ArcToolbox* as shown below:
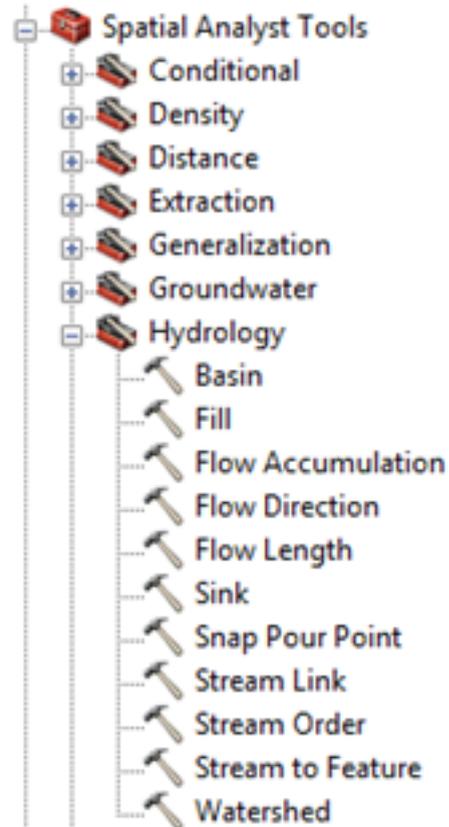

Fig-4. Hydrology tools within Arc Toolbox
It can be defined as the total area flowing to a given outlet. It delineates the all drainage basins by identifying ridge lines between adjacent basins.

Fig-5. River basin

6. CONCLUSION
In the present study, the methodology for the development of watershed and development of hydrological model using an integrated approach of Geospatial Technology has been described. This approach may be applied for various other Indian watersheds for developing effective management scenarios. The process of digitization of

Drainage was performed on georeferenced mosaiced topomaps, updated using latest satellite imagery along with Slope and Aspect maps were developed in ArcGIS. Furthermore, Flow direction, accumulation and development of stream network were analyzed.'

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