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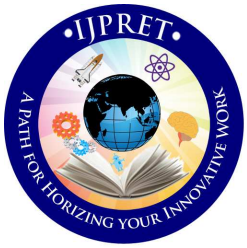

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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GEOMORPHOLOGICAL INVESTIGATION OF WRV-WATERSHED MANAGEMENT IN WARDHA DISTRICT OF MAHARASHTRA INDIA; USING REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM TECHNIQUES.

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Abstract

In this study has been made to prepare the detail morphometric characteristics of WRV1 watershed, which itself is part of the mega Wardha basin in Wardha district, Maharashtra. For detailed study, we used SRTM data for preparing digital elevation model (DEM), the database is created using various techniques for the watershed management and Morphometric analysis the drainage map is digitized from SOI top sheet and open source satellite image using Arc Map software. The land use /land cover map created using supervised and unsupervised classification method in ERDAS Imagine software and Arc GIS 10 versions. Other thematic layers like soil, geomorphology, slope, land use land cover, lineament and drainage density are also generated using Arc Map software using the available reference data.

Introduction:

Hydrologic changes resulting from urbanization of watersheds often lead to severe problems involving quantity and quality of stream flows. Whereas the physical impacts on the stream system can be lessened through application of currently available management techniques, Land and water are valuable and essential resources which form the basis of all the life and forms key resource in all economic activities ranging from agriculture to industry (Rokade, et al. 2004). The importance of conservation of water and land assumes special significance in countries like India where the main stay of people is agriculture. In view of uneven temporal and spatial distribution of rainfall, agriculture suffers in areas where irrigation facilities are inadequate or non-existent. A GIS is a composite of computer based decision support tools for the integration of spatial data from different sources and for the analysis, manipulation and display of these data (Anji Reddy, 2001). The Remote Sensing and GIS have been widely used for understanding the causes of study area. Utility of the Remote Sensing data has also been amply demonstrated through a number of studies (Tiwari and Kudarat 1988; Bhan *et al.* 1989; Tiwari *et al.* 1991; Raghubanshi *et al.* 1991). Therefore, present study is to understand the Morphometric analysis and watershed management in Wardha district using R.S and GIS approaches. A GIS is a composite of computer based decision support tools for the integration of spatial data from different sources and for the analysis, manipulation and display of these data (Anji Reddy, 2001). It is therefore, an excellent tool for the management of large bodies of spatially extensive data with all the advantages of a computer environment: precision, consistency and absence of computational error. The GIS applications as a long-term goal in the realization of a new strategy in watershed analysis primarily assumes the collecting, systematization, and analysis of topographic, pedological, and hydro-meteorological data (Thapa, et al. 1990). The recent technologies like Remote Sensing and GIS helps us by giving a quicker and cost effective analysis for various applications with accuracy for planning.

GIS and remote sensing techniques have opened up wide range of avenues for effective watershed management. The remote sensing data combined with field survey data can provide a unique and hybrid database for optimal planning and management of watershed (Solanke, et al. 2005). Space borne remote sensing technology is a unique tool to provide spatial, multi-spectral and repetitive information for effective planning (Lillesand and Keiffer, 2004).

Study Area And Methodology

The study area lies in the Survey of India Topographic Sheets No. 55L/13, 55L/14 is bounded by 67°35'50"E 80°52'59"N latitude and longitude is 68°20'51"E 76°20'59"N (Figure 1) and is located at Wardha District. The LISS-III Open Source satellite image was used for linear, aerial for drainage basin analysis and interpretation (Figure 2). The image interpretation characteristics such as tone, texture, shape, size, pattern and association along with sufficient ground truth and local knowledge were used to finalize the maps of the WRV-1 watershed area. the maps are prepared by georefrancing and digitization from SOI toposheet using Arc GIS 10. Attributes were assigned to create the digital database. The Survey of India toposheets of scale 1:50,000 are used for delineating the watershed boundary, drainage pattern for the preparation of base map and extracting different thematic layers for the various part of analysis namely drainage, road and water bodies etc. The order was assigned stream by following Strahler, (1964) stream ordering technique. Various morphometric parameters, such as linear aspects of the drainage network: stream order (N_u), stream length (L_u), and bifurcation ratio (R_b), and areal aspects of the drainage basin: drainage density (D_d), as presented in Table (2).

The groundwater zonal distribution of climates, soil types, and vegetation between the poles and the equator is a well known fact. Groundwater zonal distribution of natural phenomena was first establish by V.V. Dokuchaev, a prominent Russian pedologist which is presented.

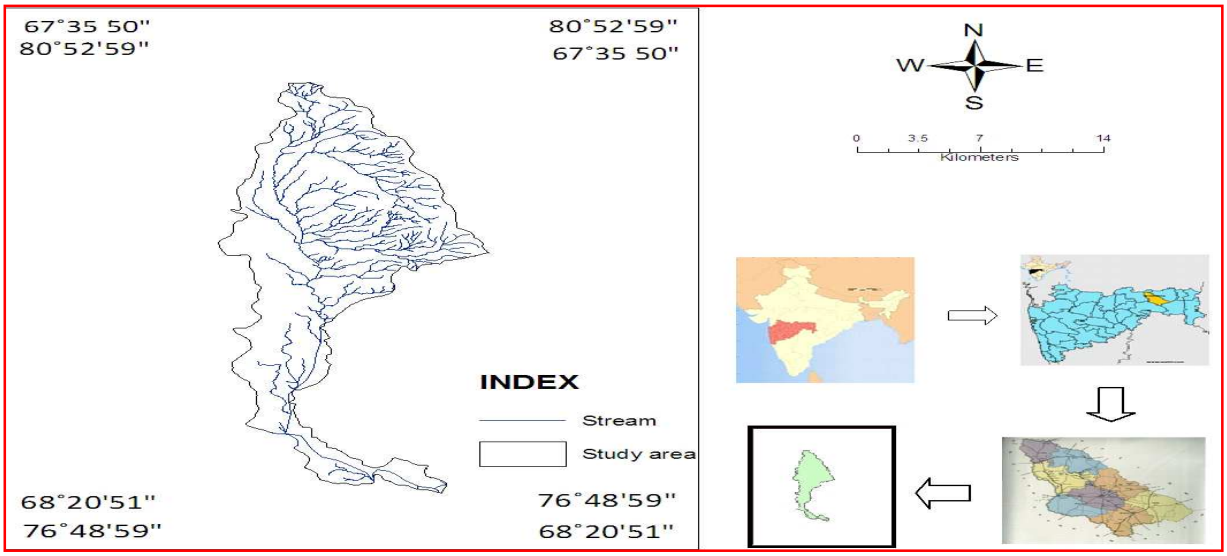

Fig.1: Location Map of Wrv-1 Watershed Area.

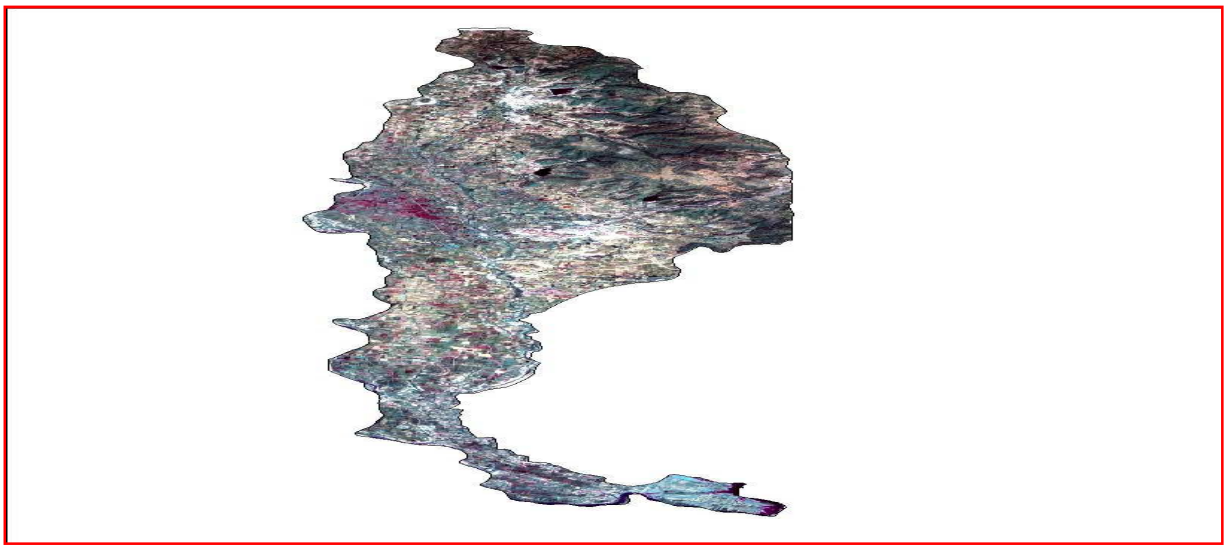

Fig.2. RS-1 LISS-III FCC image (bands 3, 4, 5) and corresponding Black and White Images of band 3, band 4 and band 5 data of path .108, row 56, Showing WRV-1 Watershed Area and Surrounding Areas

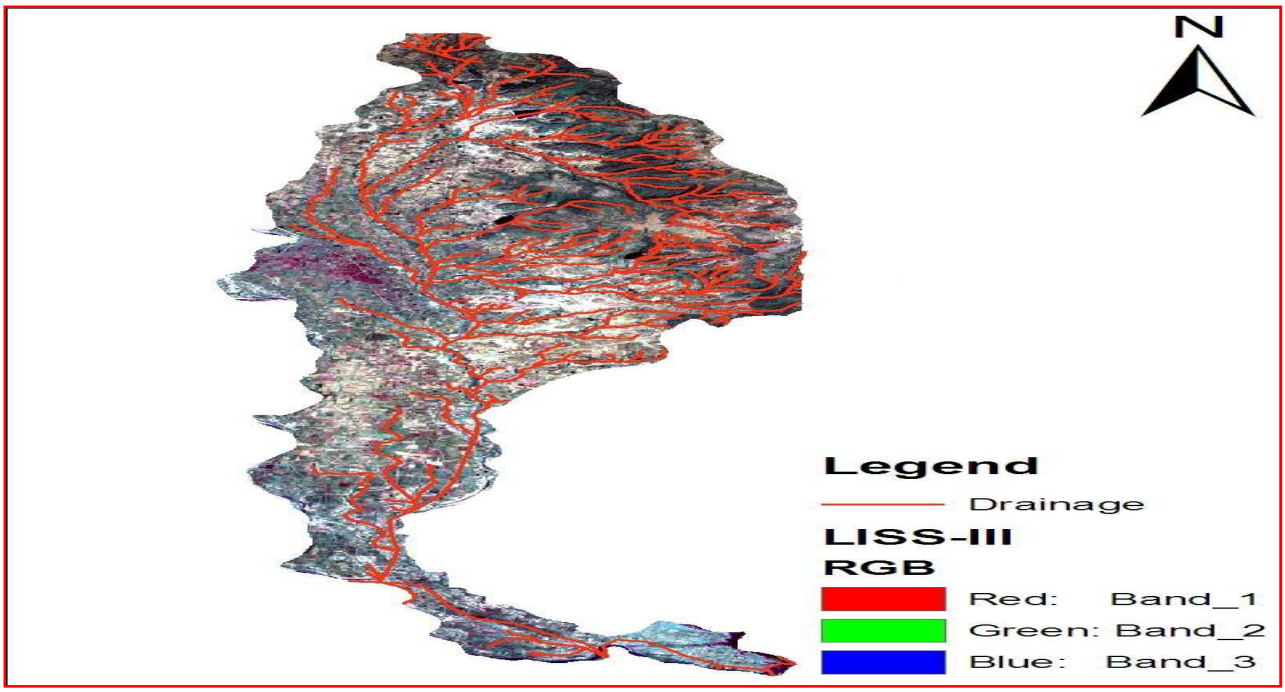

Fig . 3: Drainage Map of Wrv-1 Watershed Area

Land Use/ Land Cover

Land Use/Land Cover analysis is carried out with the help of LISS III open source satellite image. The supervised, unsupervised classification techniques and ground truth verification method used for the preparation of land use/ land cover map. Various features are identified and distinguished using interpretation key and visual interpretation technique. In this study multi-criteria overlay analysis has been used to prepare the watershed management and Morphometric analysis of WRV-1 sub-watershed in Wardha Tributary. Slope, drainage, geomorphology, land use/land cover, soil texture, the themes were prepared from various sources. The WRV-1 Sub-watershed area of Wardha tributary. The previously mentioned DEM and TIN are used to understand the detail nature WRV-1 Sub-watershed area. The average elevation of the WRV-1 Sub-watershed ranges between 265 to 466 m. The surface features of the study area carried out from toposheet map and open source satellite

data with ground truth generally reveals various geomorphic features as highly dissected plateau, moderately dissected plateau, lower dissected plateau, ridges, basin, valley fill, alluvial plains, and flood plains.

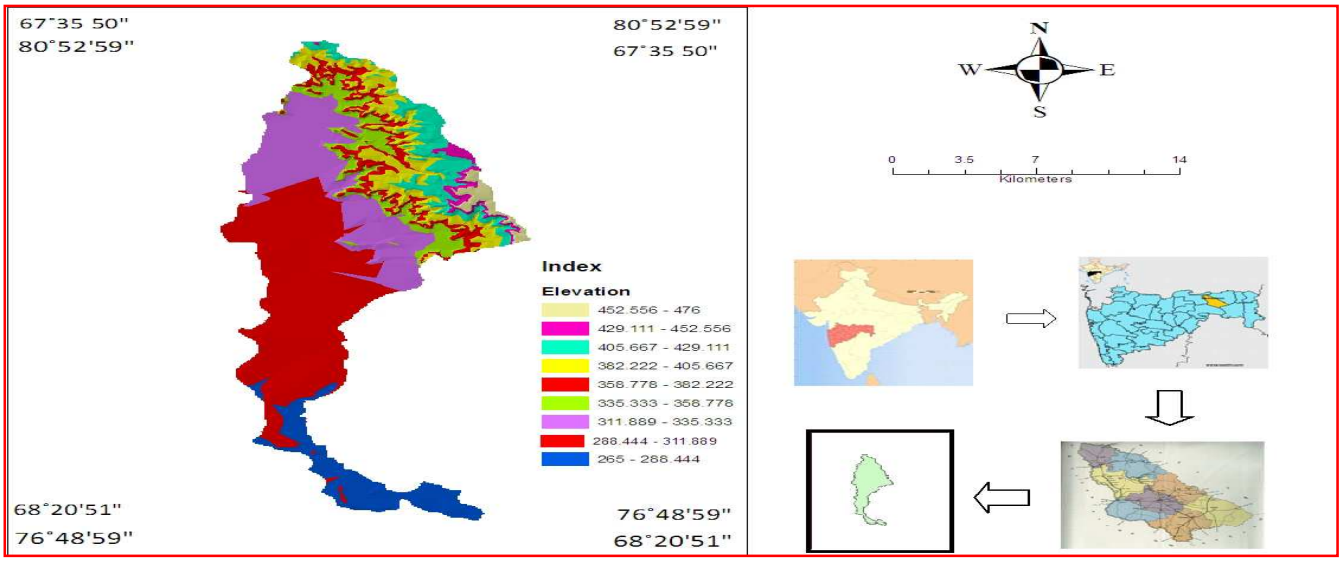

Fig. 4: Digital Elevation Model (Dem/Tin) Of Watersheds Area

Morphometric Analysis

Drainage Morphometry is found to be very important in evaluating drainage pattern and watershed management programms of the watershed area. The study area is dominated by erosional land forms like lava plateau, lava plains, linear ridges, conical hills, mesa, butte and escarpments, and depositional landforms such as alluvial cones, alluvial fans, and Bajada deposits. WRV-1Watershed area, which is one of the tributary of the Wardha River, Remote Sensing (RS), Geographical Information System (GIS) has proved to be an effective tool in delineation of drainage pattern and it provides effective solutions to overcome most of the problems of land and water resources planning and management arising due to usage of conventional methods of data collection. The occurrence and movement of groundwater in an area is governed by several factors, such as topography, lithology, geomorphology, structure, land use and interrelationship between these factors Jaiswal, et.al.,(2003). Morphometry is the measurement and

mathematical analysis of configuration of the earth surface and the shape and dimensions of its landforms (Thornbury, 1969). The drainage basin analysis of WRV-1 watershed in Wardha tributary has been carried out quantitatively including linear, aerial and relief aspects. In the linear aspects, the stream order, stream length, bifurcation ratio, and drainage density are analyzed (Table 1).

Table 1: Stream order and number of streams

Order of Stream	No. of stream segments	Bifurcation Ratio	Length of Stream (Km)
I	177	2.64	167
II	67	2.91	69.9
III	23	2.09	34
IV	11	11	22.9
V	1	-	41.9
Total Stream	279	-	335.99

Drainage Density = Total Length of steams of all orders

Area

$$= \frac{335.99}{258}$$

$$= 1.302$$

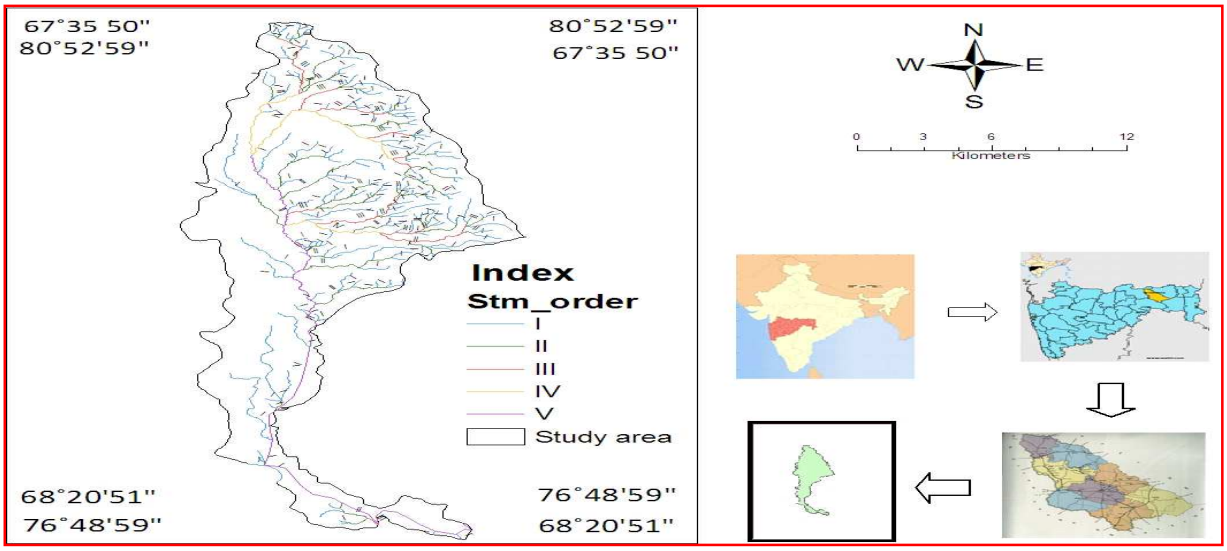

Fig.4: Drainage Map of Wrv-1 Watershed Area.

Structure/Lineament Mapping

Generally Lineaments are weaker zones which have been formed due to movement of the earth crust and are defined as the significant lines of landscape, which reveals the hidden architecture of the rock basement. A lineament is a mapable linear or curvilinear feature of a surface whose parts align in a straight or slightly curving relationship that may be the expression of a fault of other line of weakness. Lineaments may be in the form of fault or geological contacts or shear or major points. Lineaments are proven secondary aquifer in hard rock region. Ground water occurrence is confined to fractured aquifer and is stored in the deeper zones. In the WRV1 watershed area there is 67 structure is present out of which 65 is lineament and 2 is structural trends.

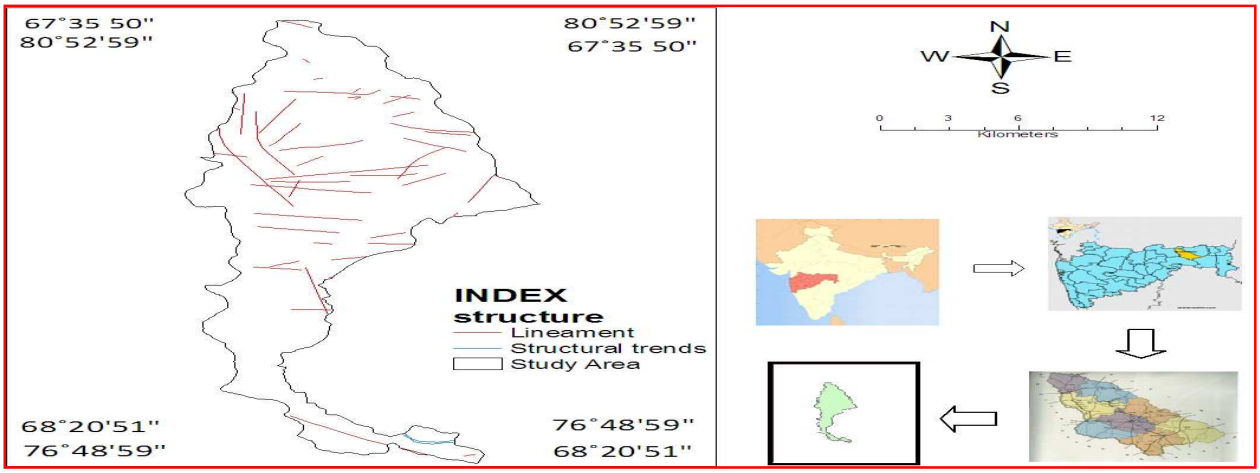

Fig. 5: Structure Map of Wrv-1 Watershed Area

Slope Analysis

The slope of a surface refers to the maximum rate of change in height across a region of the surface. Slope is an important terrain parameter and it affects the land stability. The slope map has been prepared from SRTM data. The slope of the study area ranges from 0 - 10% to 15-35 %. The most of study area is having slope between 0 – 10 % which covered by lower part of the study area. The upper area is having slope between to 15-35%. The runoff rate and soil erosion controlled by the slope of the area. The slopes in the study area have been categorized into seven classes. The following slope classes were mapped for the study area: nearly level, very gently sloping, gently sloping, moderately sloping, strongly sloping, moderately steep to steep sloping, and very steep sloping.

Table 1 Slope characteristics of the study area

Sr. No	Slope Category	Slope (%)
1	Nearly level	0-1%
2	Very gently sloping	1-3%
3	Gently sloping	3-5%
4	Moderately sloping	5-10%
5	Strongly sloping	10-15%
6	Moderately steep to steep sloping	15-35%
7	Very steep sloping	> -35%

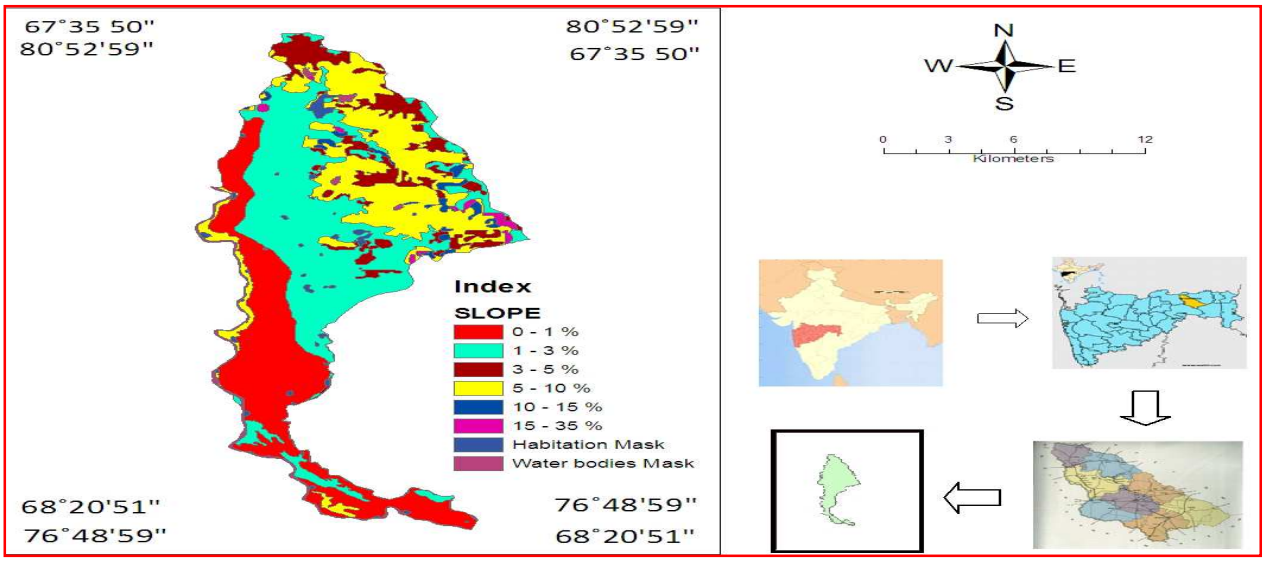

Fig.6 : Slope Map of Wrv-1 Watershed Area

Geomorphology

An integrated study of the geology and evolution of landforms is useful to understand the occurrence of porous and permeable zones (Karanth, K. R., 1999). The surface features of the study area were carried out from open source satellite image; toposheet map with field observation generally reveals various geomorphic features as highly dissected plateau, moderately dissected plateau, lower dissected plateau, ridges, basin,

valley fill, alluvial plains, flood plains. Geomorphologic studies of the study area were carried out through detailed remote sensing analysis and detailed geomorphologic of the study area with the aim to establish the elevation or geomorphic parameters to those of watershed management Morphometric analysis of the WRV-1 watershed was used RS and GIS technique. The geomorphology of the watershed is having landforms features area Alluvial plain, denudetional hill, flood plain, habitational mask, plateau ,water body mask which are show in the following figure.

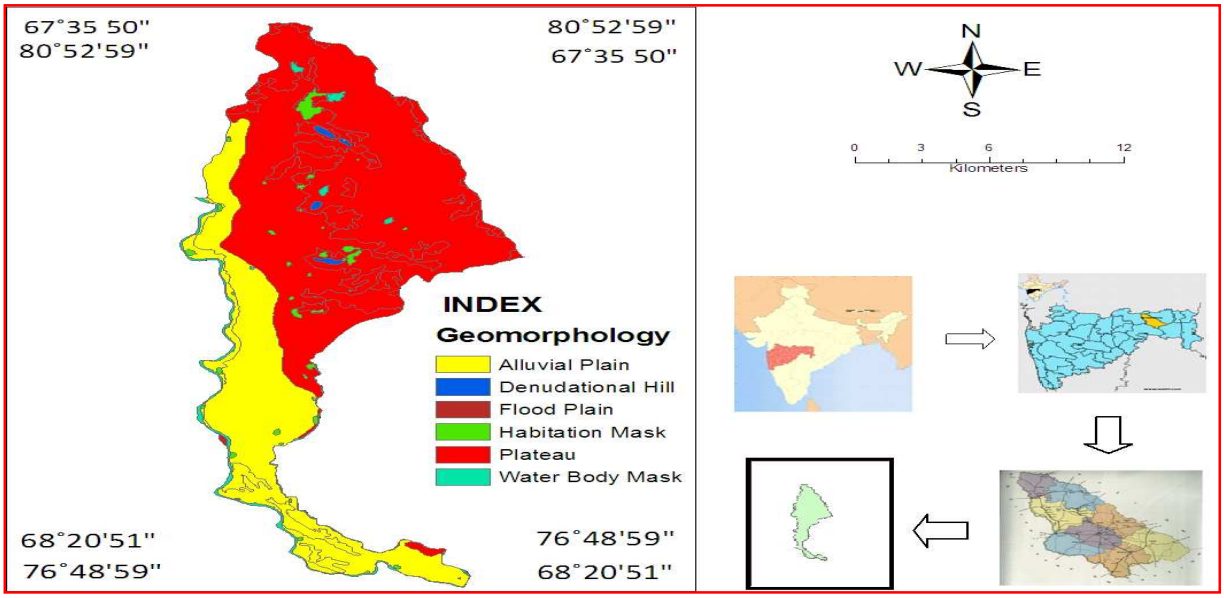

Fig. 7: Geomorphological Map of Wrv-1 Watershed Area

Land Use / Land Cover

Land Cover, defined as the assemblage of biotic and a biotic components on the earth's surface is one of the most crucial properties of the earth system. Remote sensing data and GIS techniques provide reliable basic information for land use mapping and play very important role in determining land use pattern by visual interpretation. Land use and land cover is an important component in understanding the interactions of the human activity with the environment and thus it is necessary to be able to simulate changes. Land use refers to man's activities

and the varied uses which are carried on over land and land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land (NRSA, 1989). The land use/ land cover is derived from the LISS-III Open Source satellite image using image classification techniques such as supervised and unsupervised. The most of the land is under agricultural crop land in the present study area and other area is covered by forest, built up, waste land, and Water body. Land use describes how a parcel of land is used such as for agriculture, settlements or industry, whereas land cover refers to the material such as vegetation, rocks or water bodies that are present on the earth surface. The water bodies include river, canal, tank, pond and reservoir etc.

Table 2 Land Use / Land Cover of WRV-1 Watershed

Land Use	AREA (Sq. Km)
Agriculture	436
Built- Up	43
Forest	184
Waste Land	43
Water Bodies	6
Total Area	712

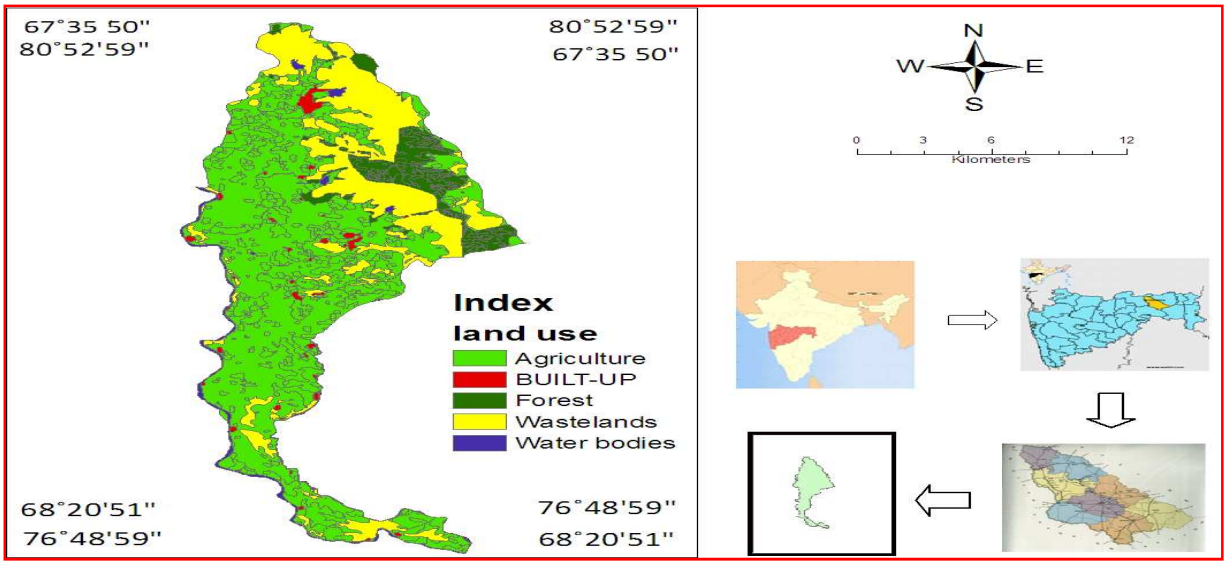

Fig.8 : Land Use And Land Cover Map Of Wrv-1 Watershed Area

Ground Water Prospect Zone Mapping

The groundwater prospect map is prepared taking into consideration the lineament map, along with drainage patterns in the area. By combining these maps a with limited information on ground water level, well yield of various geomorphic units, Different geological formations developing a variety of land forms such as structural hill, pediments, buried pediments, valley fills etc. have got different capacity of water holding thereby showing varied aquifer qualities. Their interaction with available water from rainfall, precipitation, slope, relief, vegetation cover condition and the overall porosity and permeability is taken into consideration for developing ground water prospect map. Considering the influence of different geomorphic and lithological units on ground water regime groundwater prospect zones – poor to nil, poor, poor to moderate, moderate to good and good; which are present. So there are eight type of the ground water prospectus zoning type which are shown in the table. The total area is eighty five square kilometer covered by the ground water prospectus zones in the Wardha district of Maharashtra. The area statistics of different ground water prospect zones are given in the following figure.

Table 3. Ground water prospectus zones of WRV-1 watershed

Ground water Prospectus zones	Area (sq. km)
Very-good	1
Very good to good	2
Good	7
Habitation	42
Moderate	13
Moderate-to-poor	6
Poor	4
Poor-to-nil	4
Total	85

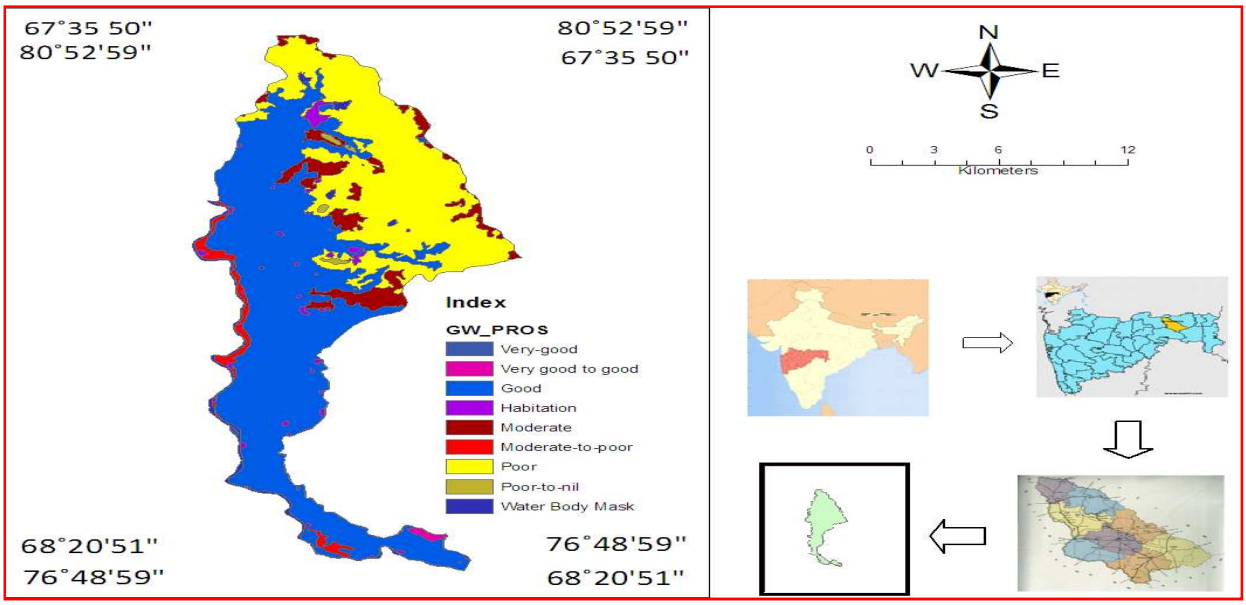

Fig.9: Ground Water Prospectus Zone Map Of Wrv-1 Watershed.

Summary and Conclusions

By integration of all the maps (drainage, structure, geomorphology, land use and land cover, Dem /TIN, geomorphology, ground water prospecting zone map) and further analysis of the data the morphometric analysis takes place. In this analysis we are concluded that the stream order is ended at the fifth order. The other

calculation which are also takes place like bifercation ratio, drainage density etc. the ground water potential zones were delineated and classified. The groundwater prospect map is a systematic effort and has been prepared considering major controlling factors, which influence the water yield and quality of ground water. The map which are essential as basis for planning and execution of groundwater exploration. The high potential zone because of suitable surface and subsurface conditions like occurrence of lineaments, permeable aquifers and nearness to streams create conducive environment for higher water yield as well as favorable discharge. Low potential zones include rocky area, which act as runoff zones. The aquifers are deep and yield is very poor. Further, new sensors and imaging technology are increasing the capability of remote sensing to acquire information at a variety of spatial and temporal scales. The scope of hydrological applications has broadened dramatically, although the problems of flood protection and water resources management continue to be of importance and relevance for the security of communities and for human, social and economic development (Rokade, et al. 2004).GIS and remote sensing applications have proved to be indispensable tools in decision making in the case of problem involving watershed conservation because of the enormity of spatial data involved. In this present study, illustration of how we can benefit from remote sensing and GIS technologies in watershed management and planning. Watershed management is the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal, and human communities within a watershed boundary.

The remote sensing data combined with field survey data can provide a unique and hybrid database for optimal planning and management of watershed. Space borne remote sensing technology is a unique tool to provide spatial, multi-spectral and repetitive information for effective planning. The land forms along with slope gradient and relief intensity are other parameters to determine the type of water harvesting and water conservation structures. This study has provided

information regarding the soil map, land use land cover, slope map, Geomophological parameters, drainage density map, drainage pattern, Morphometric analysis and Digital Elevation Model investigations and watershed Management response in WRV-1 Watershed in Wardha region in Wardha District Maharashtra, India. The relationship between geological setup and drainage pattern is analyzed using a topographic maps and triangulated irregular network (TIN). Regional and local trends of geological setup are reflected in the variable orientation of channels of different rank in the catchment.

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