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An Analysis of Land Resources Planning and Development in Tungabhadra River Basin of Kurnool district, Andhra Pradesh by using Geospatial Technologies

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Abstract: Human activates are one of the main driving forces of land use and land cover changes and generally in natural environment. These changes largely driven by population growth urban expansion, increasing demand for food , fodder, fuel and all changing socio-economic conditions. Land information is important for effective sustainable land resource management, effective utilization of natural resources and use as a tool for planning, monitoring, evaluation of development, industrial activity and reclamation. Remote sensing with its ability of synoptic viewing together with GIS field observation can be used as important tool for inventorying, periodic updating, monitoring and assessment, planning and development of these land resources s in different agro climatic regions. Integrated RS and GIS estimating the possible impacts of changes in land use changes. The Tungabhadra River basin is located in North western part of the Kurnool District. Agriculture is single most important type of land use in the basin. More than 70 % of the people in the basin engage in agriculture. A total of three thematic maps such as land use land cover, slope and Drainage map. The LULC Map was prepared from Land sat 8, the thematic maps of slope and drainage maps were generated from SRTM Dem data. Land use land cover pattern fall sunder the broad categories of Agriculture land, forest, Water bodies, barren land, and urban area. Drainage map contain stream order Range I^{st} order to VI^{th}order. The streams have been formed in Dendric Drainage pattern. Drainage Texture of the Basin (2.41) km^2 (2-4) that indicates course Texture.

I. INTRODUCTION:

Land Resources plays a strategic role in the socio-economic development of a nation. Among the land resources, Agricultural land resources has played a vital role since time immemorial engaging the largest percentage of the inhabitant of the world. Therefore, in any plan which aims at utilizing the resources in scientific, rational and economic manners, the land use surveys are of fundamental importance **(Noor Mohammad,1992**). Land use studies are great important when the resource base of any region is under examination. Optimum utilization, conservation and scientific management of land resources play a crucial role in developing the agricultural economy of any region. In the regional economy the need of land use studies and planning is much more importance. Land use is back bone of agricultural economies and it is providing substantial economic and social benefits (**Jun jie wc**). Planning, policy formulations and decision making, to be realistic, effective and sustained, require qualitative and quantitative information primarily on existing land uses. (**Y.V.N.** Krishnamurthy**;** Stephan j**.** Goetz et al ,2005**).**

Land use denotes the human employment of land. Land use involves both the manner which the biophysical attributes of land are manipulated the purpose for which the land use used (**Viswanath B.C, 2014**).Land use applications involve both base line mapping and subsequent monitoring since timely information is required to know what current quantity of land is in what type of use and to identify the land use changes from year to year .this knowledge help develop strategies to balance conservation, conflicting uses and developmental pressures. Sustainable development of natural resources relies on maintaining the fragile balance between productivity functions and conservation practices through precise identification and systematic monitoring of problem areas in various resources and developmental sectors. The land water resources are best managed and planned on sub basin level. The management of natural resources on scientific basis is very

essential for our country in general and for drought prone areas in particular. The concept of land resources has been well documented by scientists of international institute of land reclamation and improvement Netherlands. **Shafi (1969)** has described the methodology and techniques in land use studies, land classification and land capability. **Goutham and Narayan (1982)** have suggested land use and land cover classification system by using remote sensing techniques. Nageswara Rao and Vaidyanathan (1981), Samba SivaRao (1982, 1983,1985,1986,1996,1997,2002,2005, and 2012) have evaluated the land evolution studies river basins.

Remote sensing and GIS play a vital role in the field of Land and resource planning and development. NRSA is Standing First in Conducting Research on Indian Land Use and Land Cover by Applying Remote sensing and GIS Techniques. Remote sensing with its ability of synoptic viewing together GIS, GPS filed observation can be used as on important tool for inventorying, periodic updation , monitoring , assessment , planning and development of these land resources in different agro climatic regions.(**Remote sensing application for land resource management ,2019**). One of the greatest advantages of using Remote sensing data for natural resource management, its ability to generate information in spatial and temporal domain, prediction and validation (**Praveen Raj Saxena, 2008**). Remote sensing technologies has long been recommended for its potential to detect map and monitor degradation problems (V. Sunitha et, al 2011). However, these technologies may be applied to an area in order to generate sustainable developmental plans **(S.D. Vikhe, 2014).**

Study area: The study area located northern western part of the Kurnool District in Between $77^0 0' 00"$ E to $78^0 15' 00"$ longitude and $15^0 15' 00"$ N to $16^0 0' 00"$ N Latitudes it is covered by the survey of Toposheet57E/1to57E/16and57I/1to57I/5.River Tungabhadra is a river in india that starts ans flows through the state of Karnataka Duringmost of its course, before flowing along the border between Telangana,Andhra pradesh and ultimately joining the Krishna River near sangameswaram village in Kurnool district of Andhra Pradesh .The Tungabadra river enters in to Andhra pradesh at myaliganur village in kowthalam mandal , Kurnool district which is about 45 Kilometers,upstream to mantralayam , Kurnool District from ther it flows through Mantralayam and then enters in to bhavapuram upstream of kurnooltown Further it receives Tributary Hundri and then joins River Krishna near Alampur Village of Jogulamba,Gadwal District of Telanagana state.

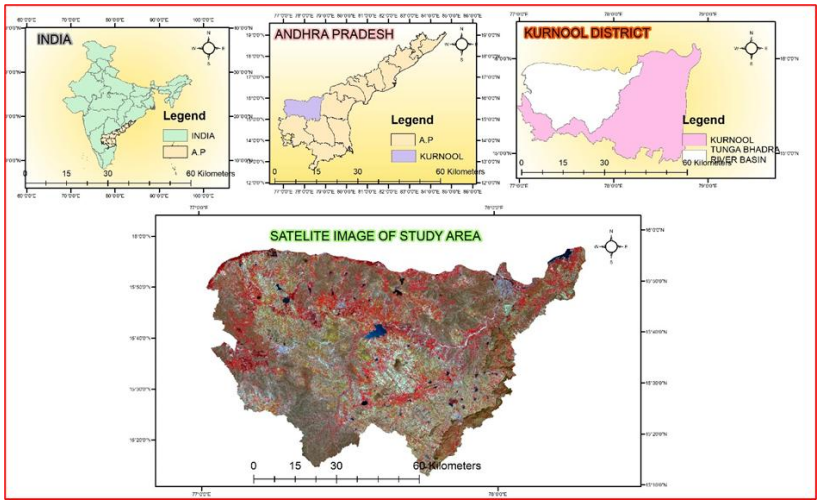

Figure 1 Location map of the study area

Physiography and climate: The study area elevation varies 246m to 674 m. The slope of the study area varies 0-87.7^0. The climate of the basin is normally good and healthy January, February, March months are normally pleasant with moderate winds, April and May hottest months of the year during these months the wind shifts shower by the end of May. The basin normal rainfall 400-600 mm and the months of may consider to be the hottest (40.5^0 c) while December is considered to be the coldest (25^0 c). The land scape of the terrain in the study area is dominated by low undulating terrain. The various geomorphic units delineated have a direct bearing on the utilization of the terrain. The Pedi plain in the study area ideal for Agricultural, urbanization and industrial development. Geomorphologically, the study area has been classified into three units based on relief, slope factors. The three groups are a) Structural land forms- Hills, valleys &plateaus b) denudation land forms c) fluvial land forms. The forestic composition of the basin stands in direct relation to the climate and edaphic conditions and the biotic influence in various locations. The basin comprising of Adoni, Peddakadumur ,Aspari, Patttikonda, Devanakonda, Krishnagiri,veldurty,kodumur and kowthalammandals present a desolate Appearance and the vegetation that exist is confined mostly to small pockets of reserve forests.

Geology: The geologically the basin underline by Crystalline rocks of the peninsular Gneissic complex (PGC) Comprising the granitic gneisses, Granite and migmatite found in west and southern part of the basin. The K-rich granite (equivalent to close pet granite) of lower preterozoic age, Distributed in northern part of the basin. The Cuddapah super group of rocks (Middle Proterozoic) uncomformable resting over the Crystalline, comprise of Conglomerate, quartzite, shale, limestone/ Dolomite were found as small patches in north eastern part of the basin. The basic dykes and quartz veins are noticed in the west and southern part of the basin.

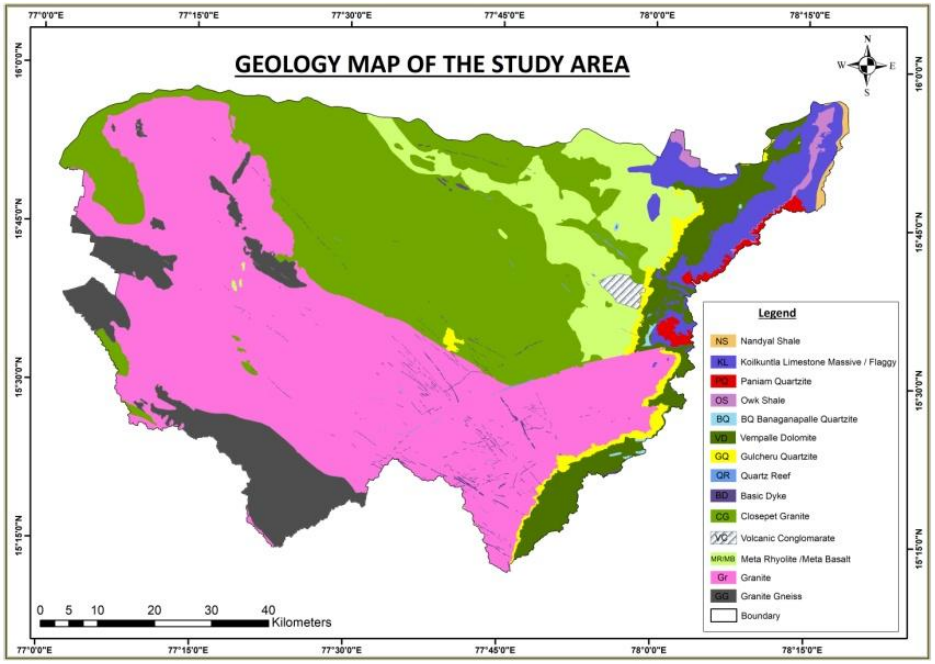

Figure 2 Geology map of the study area

Data use and methodology: The study was attempted by Three different layers say Drainage, slope and land use and land cover. These data were collected from different sources and processed in Arc GIS 10.3 software. The study was applied both visual and digital land sat image interpretation in order to generate thematic layers. In the study area we used SOI Toposheets57 E/1 to 57 E/16 and 57 I/1 to 57I/5 on 1:50,000 scale for the purpose of base map preparation.

The thematic maps of Drainage and slope maps were processed of shuttle radar topography mission) SRTM DEM data with 30 m resolution. The thematic map of the land use and land cover (LULC) map was generated from Land sat 8 OLI. The actual work involved a comprehensive gathering of information and linked to the several related actives. The flow chart showing the methodology of land resources analysis is given Fig.3

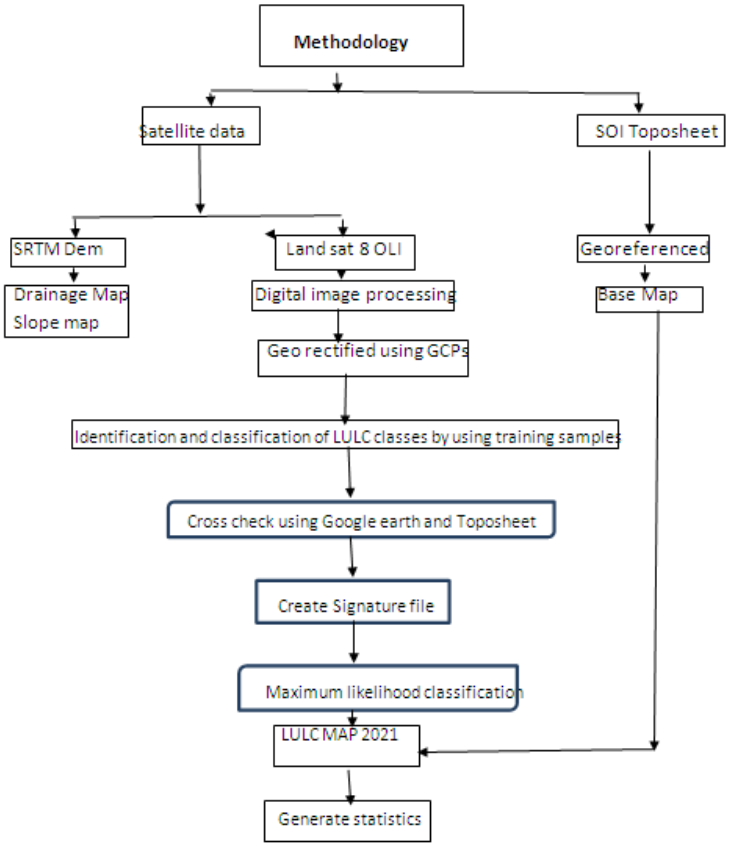

Figure 3: The flow chart showing the board methodology adopted in the study area

Table 1 Image interpretation Keys used for Land use and Land cover classification

Land use class	Interpretation Technique	Description
1)Agricultural land	Pixel reflection varies from light red to bright red	This category involves land under crops, fallows, plantation
2) Barren land	It appears greenish blue and brown in color with varying size and irregular and discontinued shape	It is a bare exposed that devoid of vegetation
3) Forest land	It appears in very dark Green in color	This category involves fairly dense forest land
4) Built- up area	It is having regular pattern and appears in cyan color	This category includes urban and rural settlements, recreation and utilities
5) water bodies	Water bodies include that pixel reflecting dark blue to light blue in standard FCC	This category comprises areas with surface water in the form of ponds,lakes,canals etc.

II. RESULT AND DISCUSSION:

Land Resources:

The land Resources are studied by preparing Land Use and Land cover map (LULC). The land use and land cover pattern fall under the broad categories Agricultural land, Forestland, Barren and, urban area, water bodies.

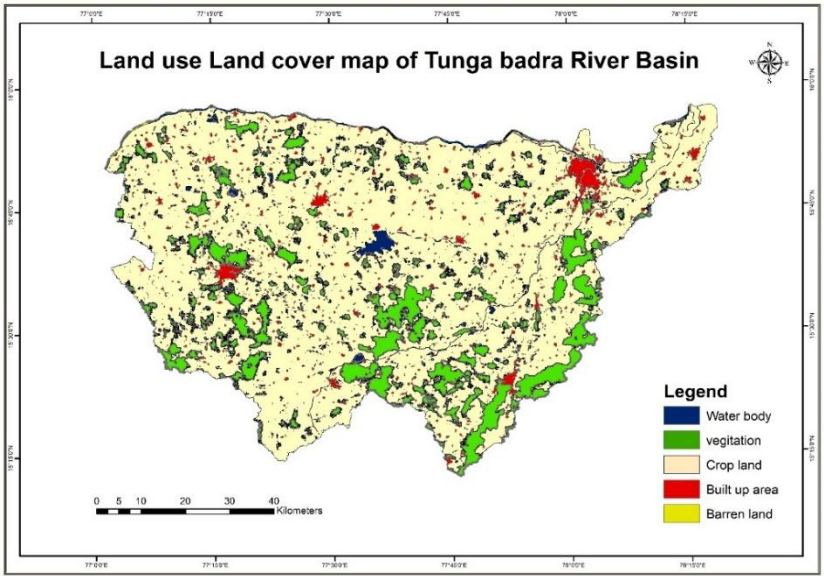

Figure3, Land use and land cover map of the study area

LULC Class	Area in sq.km	Area in Percentage
Water bodies	68.76	0.99
Agriculture land	5860.34	84.52
Barren land	604.66	8.72
Built up area	120.19	1.73
Forest	280	4.04

Table 2 Land use and land cover statistics of the study area

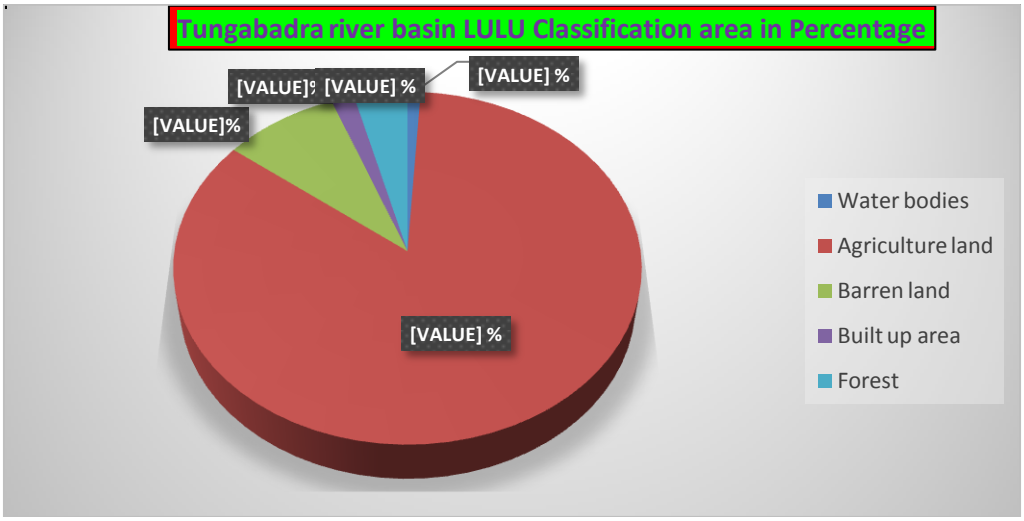

Fig 4 Tungabhadra River basin Land use and Land cover in percentage

Agricultural land: Agricultural land is primarily land devoted to agriculture, the system and controlled use of other forms of life particularly the rearing of livestock and production of crops to produce for human. It includes crop land, fallow land, commercial and horticultural crops, confined feeding operations. The Tungabhadra river basin is characterized by high cultivation along the main River ,channals , Tributaries and canals.Agricultural / crop lands are observed mostly in the south western, south eastern, central parts of the district. The main occupation and source of livelihood for thisbasin is agriculture.More than 70 % of the people in basin engage in agriculture.The main crops grown by the farmers were cotton ,bengal gram,korra,jowar,ground nut , pulses and vegitables (chilleys,onion).It covers about 5860.34Sq. km and is 84.52% the total area.as shownin the table 2.

Vegetation/Forest: Forests are capable producing timber and other wood products and support many kinds of outdoor creation. forest land is an important category environmentally because it affects air quality, water quality, wildlife habitat, climate and many other aspects of the ecology of an area. (Y.Vinod kumar,2021).The

forestic composition of the basin stands in direct relation to the climate and edaphic conditions and the biotic influence in various locations. The basin comprising of Adoni, Peddakadumur ,Aspari, Patttikonda, Devanakonda, Krishnagiri,veldurty,kodumur and kowthalammandals present a desolate Appearance and the vegetation that exist is confined mostly to small pockets of reserve forests. It covers 280.00Sq.km and 4.40% of the total area.

Built up area: Built up area is described as an area of human habitation developed by virtue of non-agriculture use it consists of residential, commercial, industrial,institutional,transportation, roads, mixed urban. (G.Veeraswamy Yadav (2017)).In the study area major towns Kurnool Mantralayam,adoni,aspari, pattikonda,Kodumur Dhone, veldutri. Village, hamlet/ dispersed households are the identified sub categories of built area in the basin .it covers about 120.19 sq.km. And is 1.73% of the total area.

Barren land: Barren lands is described as the rock exposure of varying lithology often barren and devoid of soil cover with limited capacity to support life and having less than 5 percent vegetation cover (Nagaraju Arveti, 2016).it includes barren land, mixed barren land sandy and Gravel pits.It covers about 604Sq.kmand 8.72 % of the total geographical area.

Water Resources: The water bodies includes both natural and manmade water features such as ponds, lakes open wells, canals, reservoirs, Rivers etc. The principal rivers flowing in the district are Tungabhadra, and its tributary Hundri. The major source of irrigation in the district canal source with Kurnool –Kadapha canal and TBP low level canal and other sources surface water are and Gajuladinne, sanjeevaiah sagar project presented in the study area near Gajulienne village and Hundri niva sujala sravanthi irrigation project. These are used for demotic, irrigation, and industrial etc. small ponds, Artificial recharge zones, check dams and summer storage tank etc, confined all the Mandal of basin. It covers about 68.76Sq.km. And is 0.99% of the total geographical area. As shown in the table 2 and fig 5.

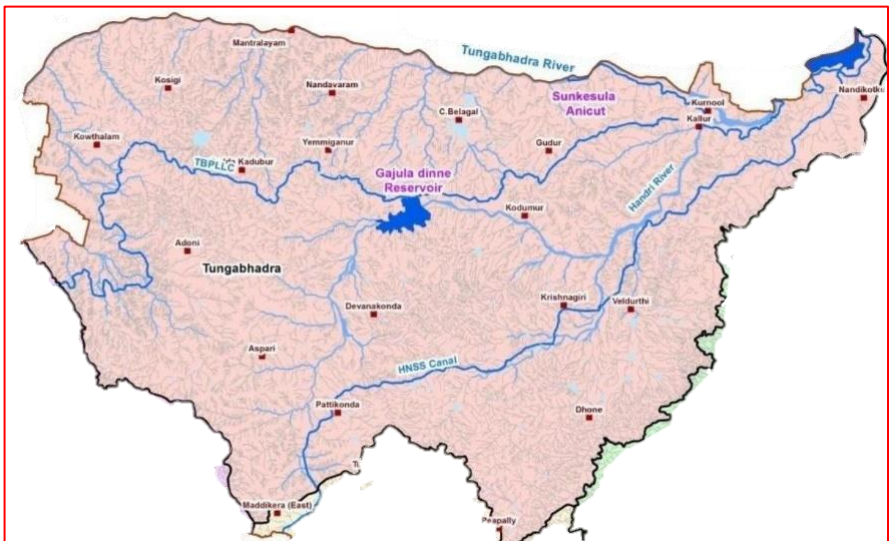

Figure 5: Tungabhadra River basin map

Morphometry of the Tungabhadra River Basin

Morphometric analysis plays a significant role in understanding the geohydrological characteristics of the drainage basin. Remote sensing and GIS are the proven efficient tools in the delineation updating and morphometric analysis of drainage basin. The study of stream orders has been classified based on its relative position in the stream. De martone (1934) in his Traite de geographic physique adopted the expression 'morphometry' and defined it as the numerical systematization of the forms of land relief as it can be interpreted from a topographic map.

Clark (1967) defined morphometry as the measurement and mathematical analysis of configuration of earth's surface and of the shape and dimensions of its land forms. The main aspects examined the area, altitude, linear, areal and relief, volume, slope, profile and texture of the land forms as well as the varied characteristics oof rivers and drainage basins it has been used primarily to facilitate description of specific features erosion surfaces, slopes, valleys and relief as whole. Morphometric is the measurement of mathematical analysis, this analysis successfully measures the linear, aerial, relief aspects of the basin .it is explored and understanding the behavior of hydrological parameters. morphometric analysis of river basin to explore interrelationship between hydrological parameters and geomorphological parameters.

Morphometric analysis incorporates the quantitative specification of slope, area, altitude, profile of land surface and drainage basin pattern, it has been providing quantitative specification to the geometry of the

drainage basin and its network, which helps in the characterizing the drainage network and examine the effects of variables such as rock structure, rainfall, recent diastrophism, geology, geomorphologic parameters. Morphometry of river basin is significant in the water and land conservation as well as controlling floods.

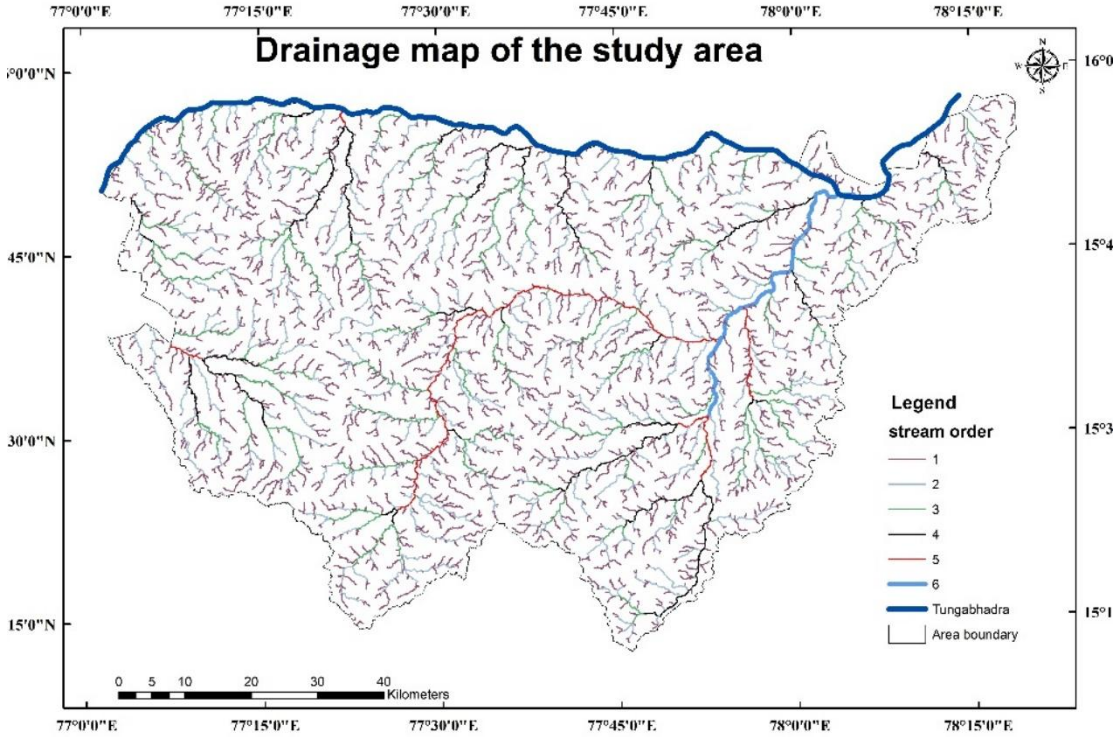

Figure 6 Stream order map of the study area

TABLE:3 Methods of Calculating Morphometric Parameters of Drainage Basin

	Morphometric parameters	Methods	References
LINER	Stream order (U)	Hirarchical order	Strahler,1964
	Stream length (L_u)	Length of the stream	Horton,1945
	Mean stream length (L_{sm})	$L_{sm}=L_u/N_u$, where L_u =stream length of order 'U' N_u=Total number of stream segments of order 'U'	Horton,1945
	Stream length ratio (R_L)	RL=Lu/Lu-1; where Lu=Total stream length of order 'U', Lu- 1=Stream length of next lower order.	Horton, 1945
	Bifurcation ratio (R_b)	R_b = Nu/ Nu+1; where, Nu=Total number of stream segment of order 'u'; Nu+1=Number of segments of next higher order	Schumn,1956
AREAL	Drainage density (D_d)	$D_d = L_b/A$ where, L=Total length of streams; A=Area of watershed	Horton, 1945
	Texture ratio (T)	T = N1/P where, N1=Total number of first order streams; P=Perimeter of watershed	Horton, 1945

TABLE:4 Result of morphometric analysis in liner aspects

Stream order	Number of streams	Bifurcation ratio R_b	Stream length (L_u) Km	Stream length ratio (R_L)	Mean stream length (L_{sm})
1	1326	-----	2169.28	---	1.63
2	643	2.06	1190.09	1.13	1.85

3	378	1.70	599.75	0.85	1.58
4	120	3.15	201.21	1.05	1.67
5	78	1.53	99.32	0.76	1.27
6	35	2.22	46.89	1.04	1.33

Table :5 Result of Morphometric analysis of Areal aspects	
Morphometric parameters	Result
Basin area($km^{2)}$	6933.95
Perimeter(km)	550.12
Drainage density	0.622
Texture ratio	2.41

Linear aspects:(Planimetric measurement)

Linear aspects of the drainage network are limited to laws of drainage composition and management and arrangements of the sets of channel network. the liner aspects of morphometric analysis of drainage basin includes stream order, stream length, Bifurcation ratio, stream length ratio, Average bifurcation ratio.

Stream order: stream analysis is the most fundamental numerical analysis of drainage basin. The analysis of stream ordering of a drainage basin gives a rough idea about the size, shape, Morphology and structural characteristics of that particular area. Stream order analysis permits comparison of the drainage network developed on the area with patterns originating under natural conditions (Schumm,1956, p.602). The Strahler's method has been followed in this study according to his definition smallest head water tributaries are called first order streams, where two first order streams meet, a second order stream is created, where two second order streams meet, a third order stream is created and so on,as shown in (Fig 6). The stream order of the basin form first order to six th order. Total number of streams are2580 out of which1326 are first order, 643 are second order, 378 are Third order,120 are fourth order, 78 are fifth order and 35 are sixth order stream. The streams have been formed dendritic drainage pattern. The calculated number of streams in number of orders retrieved that number of stream segments are decrease as the stream order is increase. Most drainage networks show a linear relationship with small deviation from a straight line. Plotting the algorithm of number of streams against stream's order shows a straight line which states the number of streams usually decrease as the stream order increase, as shown in Fig 7.

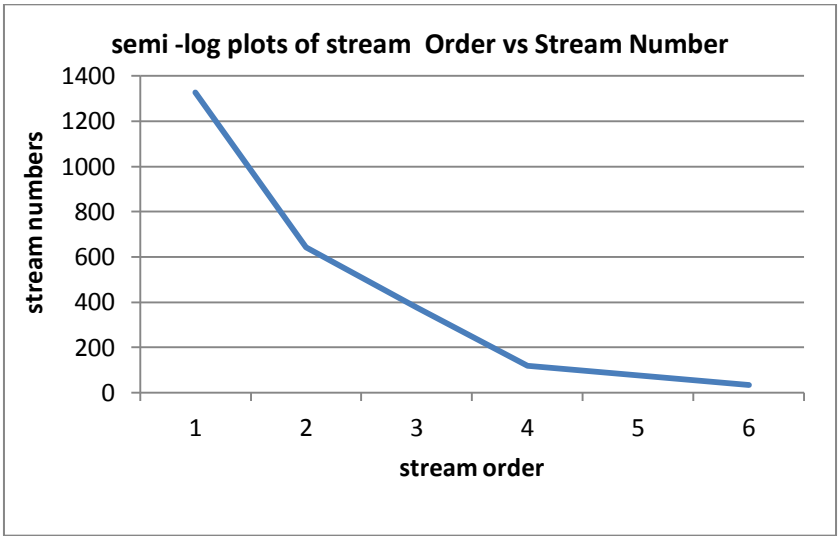

Figure 7 semi –log plots of stream order vs stream number

STREAM LENGTH:

The stream length is calculated on the basis of the law proposed by Horton (1945). The length of first order is 2169.28, second order stream is1190.09 third order stream is 599.75 fourth order stream is 201.21, fifth order stream is 99.32and sixth order stream is 46.89. The length of stream segments is maximum for first order streams and decrease as the stream order increase, as shown in fig 8.

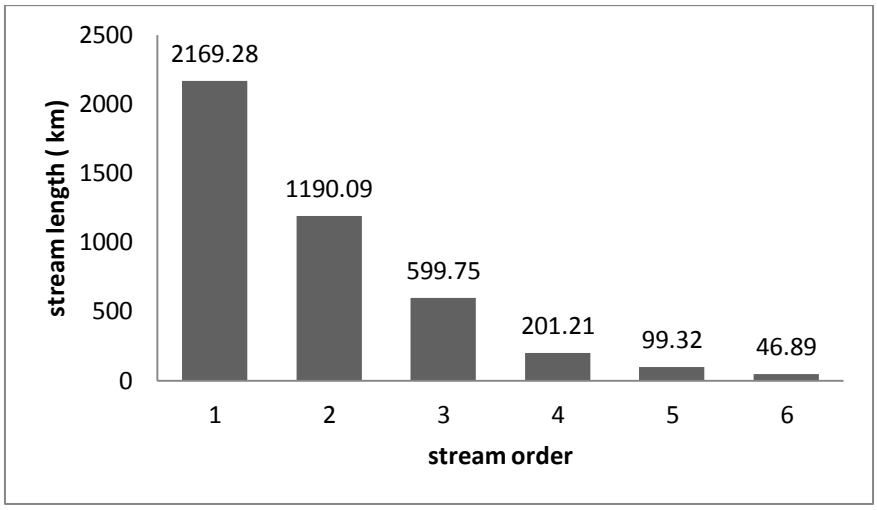

Fig 8 Graphical representation of stream order vs stream length

Stream length Ratio:

The stream length ratio can be defined as the ratio of the mean stream length of a given order to the mean stream length of next lower order and having important relationship with surface flow and discharge. The ratio between the orders in the study area differs from one order to another, as shown in table 4. which indicates late youth to mature stage of geographic development.

Bifurcation Ratio:

Bifurcation ratio (Rb) which is related to the branching pattern of the drainage network, is defined as the ratio of the number of streams of a given order (nu) to the number of streams of the next higher order (nu+1) (Horton,1945, p.280) and it is expressed in terms of following equation

$$\mathbf{R_b = N_u/N_u+1}$$

The study area bifurcation ratio results shows that low in fifth order &high in fourth order ranges between 1.53 to 3.15 as shown in table 4. The mean bifurcation ratio R_b of the basin 2.13, i.e., the average bifurcation ratio of all orders. The R_b value suggests the need for structural control due to higher permeability and more geological complexity, which can be done by more vegetation and check dam formation in the basin.

Areal aspects:

Drainage Density: Drainage density is the total length of all the streams in the water shed to the area of water shed (Strahler, 1964).

$$\mathbf{D_d = L_b/A}$$

A high drainage density reflects a highly dissected drainage basin with a relatively rapidly hydrological response to rain fall events, while a low drainage density means poorly drainage basin with slow hydrologic response. The drainage density of the Tungabhadra River basin 0.622 per km^2, as shown in table 5. Which indicates that basin has a highly resistant permeable subsurface material with intermediate Drainage and low to moderate relief.

Drainage Texture:

Drainage texture depends upon several natural factors such as climate, vegetation type and density, rock and soil type, infiltration capacity, Relief and stage of development. Low drainage density leads to coarse drainage texture while high drainage density leads to fine drainage texture. It indicates relative spacing of streams(smith,1950) categorized the drainage texture in five classes as very course (<2), course (2-4),moderate (4-6) fine(6-8) and very fine (>8) here texture ratio in Tungabhadra river basin has a 2.41, as shown in table 5.which indicates course texture.

Watershed modeling:

The concept of water shed development in India has been proposed by Y.P.Bali in (1974).The ministry of Agriculture, Govt of India, initiated the programs of soil and water conservation development Adopting watershed as a planning unit .The Drought prone area programme adopted water shed approach in (1987) to focus on non-arable lands and minor Drainage systems for a insitu soil and moisture conservation ,Agro forestry , pasture development Horticulture and alternative land use practices.

Water shed development programs is, therefore considered as an elective tool for addressing many of these problems and recognized as potential engine for Agricultural growth and development in fragile and rain fed areas. Sustainable development of natural resources relies on maintaining fragile balance between productivity functions and conservation practices through precise identification and systematic monitoring of problem areas in various resources and developmental sectors. The land and water resources are best managed at sub- basin level. The basin is a geo-hydrological unit is which rainfall flows in to a stream, lake etc., The management of natural resources on scientific basis is very essential for our country in general and for drought prone areas in particular.After studying the total conditions of the area, it is concluded that the Basin is poor in water resources, top priority should be given for its development. The water distribution in the study area is not uniform it depends on the Drainage pattern.

III. CONCLUSION:

From the above discussion it is concluded that Remote sensing data is most common source for detection, Quantification and mapping of land use and land cover pattern due to its respective data acquision. Vectorization, editing, overlay analysis and area estimation of land use classes is easier in Geographic information system. The present study reveals that in the study area land use and land cover pattern falls under the broad categories of Agriculture land , vegetation,, Built –up land , water bodies and barren land . In the study area the Agricultural land/ crop land covers an area of 84%. Basically the basin comes under agro- based economic activities by people. More than 70 % of the people in the basin engaged in farming. Agriculture, mostly rain fed. The important point to be considered in the study area, there is 1 % of water bodies. There is no irrigation source like canals, river or open wells. The Ground Water Distribution in the Study Area Is Not Uniform and It Is depends on the drainage pattern. Since water is a critical resource for development of other resources the assessment of water available and demand for water for various purposes i.e., agriculture, domestic and industrial use, of utmost importance without which it is difficult to prepare any developmental plan. The quantitative analysis of morphometric parameters evaluated using by Geographical information system. Tungabhadra river basin has been 6 th order exhibiting dendritic drainage pattern. The bifurcation ratio range from 1.53 to 3.53. the higher values of R_b indicate strong structural control on drainage pattern , while the lower values indicates that are not affected by structural disturbances. The basin Drainage density is 0.622 km^2. It shows that sparse vegetative area and moderate relief. The Drainage texture of the basin is 2.41 Indicates course texture. Since the Region is very poor in water resource, Top priority should be given its development.

IV. RECOMMENDATIONS:

1) Based on above study the study area is suitable for the intensive agricultural, agro-forestry, fodder& fuel wood development of grazing land with economic trees and grasses. There is scope for the further expansion of the net sown area i.e by modernization of canals (k.c canal and TBP Low level canal) and implementing the water harvesting structures such as percolation tanks, check dams.

2)Farmers should be encouraged with regard to making form ponds and soil conservation measures.

3). The long-term solution to eradicate irrigation problems in the study area is to develop major irrigation schemes, in the form of diversion of Tungabhadra water and bring fourth layer ayacut area.

4. Interlinking of major tanks wherever physical terrain permits and diversion of excess flow water from one tank to another tank during monsoon periods could permit to store more surface water.

5. The concept of watershed development for integrated Resource utilization and land use development would bring good results in the basin.

6) The authorities should take measures to improve the plantation under social forest, optimum utilization of water resources like rain and ground water by using highly developed micro irrigation facilities (sprinklers and drip irrigation) to bring more area under net area to be sown and to minimize of follow lands.

7. Small and marginal farmers to be encouraged to look in to the alternative sources of income generation by taking up dairy development, poultry industry and sheep rearing with institutional financing to augment their income.

8. With the help of Latest technologies like remote sensing and GIS, areas may identified Ground water potential zones and artificial recharge zones and micro irrigation facilities for considerable decrease in fallow lands and cultivable waste lands.

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