

Sustainable Groundwater Potential Zones of Dudda Subwatershed, Mandya District, Using Remote Sensing and GIS

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ABSTRACT: Karnataka being predominantly a dry forming state, Irrigation development in the state as compare to other states and the country as a whole is low. Development the watershed area adopting integrated approach is only key answer and is on more secret. Dudda sub-watershed comes under Lokapavani watershed (4B3C) which lies in Bay of Bengal region, Cauvery basin, Krishna Rajasagar to Stanlay Reservoir catchment and Left Bank of Shymsa reservoir sub-catchment in Mandya District.

Present study area is facing shortage of water for domestic, irrigation and industrial, because of the inadequate surface water resource the demand for ground water resource is increasing every year to meet this growing demand for groundwater, it's essential to identify the ground water potential areas through scientific approach and using various thematic maps. (i.e. base map, hydrogeomorphological, geological structure, drainage, slope, land use and land cover and ground water prospect zone map) was prepared using remote sensing data along with existing maps. The ground availability of the study area is based on classified into very good, good, moderate, poor and nil Thus, the study also proves that remote sensing and GIS when synergistically used provide ample scope for the integration of spatial and non-spatial data can be successfully adopted to systematic approach deciphering the probable potential zone of ground water exploration any area to more scientific and unbiased manner.

KEYWORDS: Ground water potential of Dudda sub watershed using RS and GIS

I. INTRODUCTION

Groundwater is gaining more and more importance in India owing to the ever increasing demand for water supplies, especially in areas with inadequate surface water supplies. More than 85% of rural and nearly 50% of urban population depend on the groundwater for drinking purposes, while, it accounts for nearly 60% of the total irrigation in the country, an area defined by hydrological linkages where optimal management requires coordinated use of natural resources by all users. Thus, managing the available water resource for a sustainable progress is always a herculean task, and the governments spend substantial chunks of their economy in this sector. Such problems are much more severe in a country like India where the efficient management of any resource is pathetic. The population density, social and economic interfaces are adding to this problem. In spite of rapid advancements in technological know-how's, effective water management is still an area of great concern. Launching of satellites and probing of the earth remotely, by these satellites, is a hallmark feature of the last two decades, which has greatly enhanced our understanding of the surface dynamics and resources base. Hydrogeology has been an area of the biggest beneficiary of remote sensing. It has enhanced our understanding of local and regional, lithological, structural and geomorphological features more clearly, thus providing a better insight into surface and sub-surface dynamics of water and its utilization and management. For effective monitoring and management of any natural resource many methods are adopted. In this direction, lithology, lithologic contact zones, structures, landforms, geomorphology land use/land cover, soils, lineament and drainage network etc. are the essential inputs for the management of natural resources especially water resources[1] &[2]. In the present situation, there is an imbalance between recharge and withdrawal of ground water which needs to be overcome

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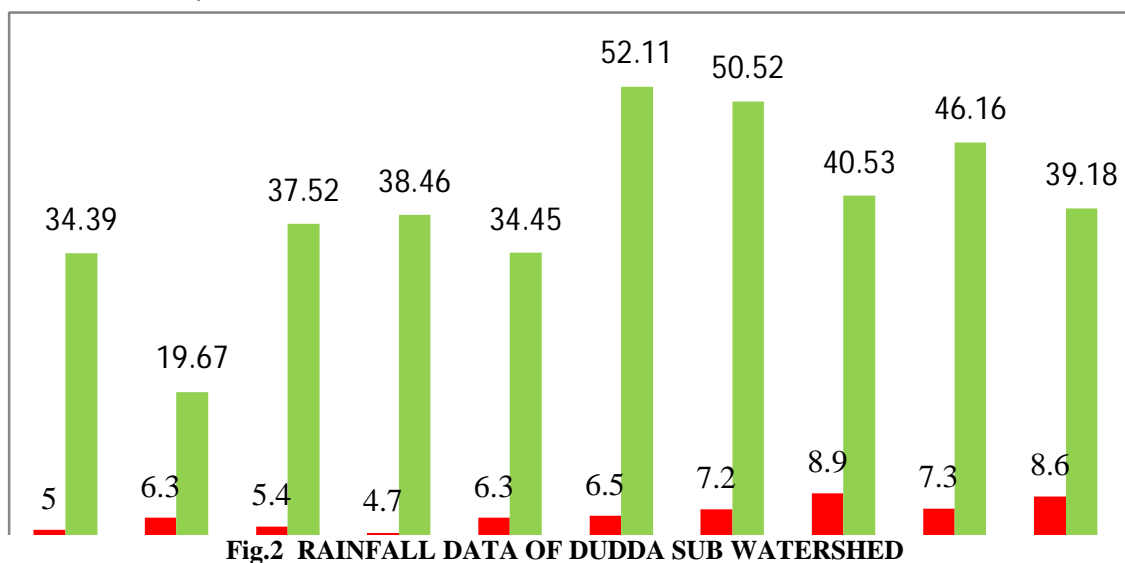
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The Mandya district located between N 12° 13' to 13° 4' and E 76° 20' falls in the survey of India degree sheet No 57H or 57D .The district is bounded on northwest by Hassan district ,on the northwest by Tumkur district ,on the east Bangalore district, on the south by Mysore.

RAINFALL:

Mandya district receives an average rainfall of 691.25 mm. There are 53 rainy days in the district on an average about 50% of annual rainfall occurs during the southwest monsoon period (table). The rainfall generally decreases from west to east. The coefficient of variation is around 30% in the west to above 35% in the east, indicative of consistent rainfall in the west as compared to the east. The pre- monsoon rainfall is more consistent than the post-monsoon rainfall. The southwest monsoon had been normal from 1994 onwards till 1999, excessive during 2000 and deficient thereafter. The northwest monsoon is much better comparatively being excessive to normal during the recent past. Over all on an annual basis, there are more normal to excessive rainfall years than deficient ones. While during 1997, 1999, 2000 and 2005, the district received Excess rainfall, 1998, 2001, 2002, 2003 and 2004, it was Normal and only during 2006, the district received Deficient rainfall.

Rainfall Pattern last 10 years



III. DUDDA SUBWATERSHED

Subsequently all the thematic maps have been converted into coverage using ARC/INFO commands and these maps referenced to ground units. For this purpose they were transformed to polyconic projection to eradicate the errors of snap tolerance and weed tolerance in the Arc GIS setting. Then corrected are the nodes and dangles errors. After editing process is completed, commands like clean build are used to build topology. The attribute data which are the non – geographical features are checked once again for the missing polygon. Further, different toposheets are edge-matched for preparing the final coverage. Subsequently different thematic maps have been generated by using Arc-GIS software. Characters like legend, text, north direction, scale bar etc have been created using appropriate scales.

ROAD NETWORK

The Base Map is prepared for each District using the Survey of India topographical map and the satellite data. The base details such as State, District, Taluk boundaries, roads, railways, and river / stream and settlement locations are

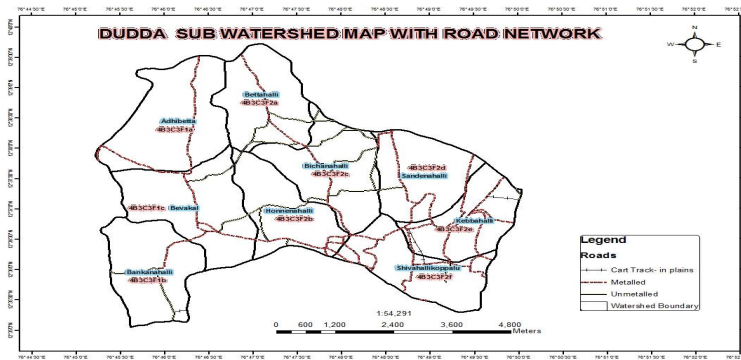


FIG.3. ROAD NETWORK MAP OF DUDDA SUB WATERSHED

extracted from the topomaps. Multi-date IRS geocoded satellite data (which includes PAN +LISS III data also) is used for interpretation and for the preparation of road maps. categories are interpreted and delineated based on tone, texture, shape, pattern, association, location, etc. using on screen digitization. The interpreted maps are verified through ground verification and modified accordingly. Based on the field information the map is finalized.

DRAINAGE

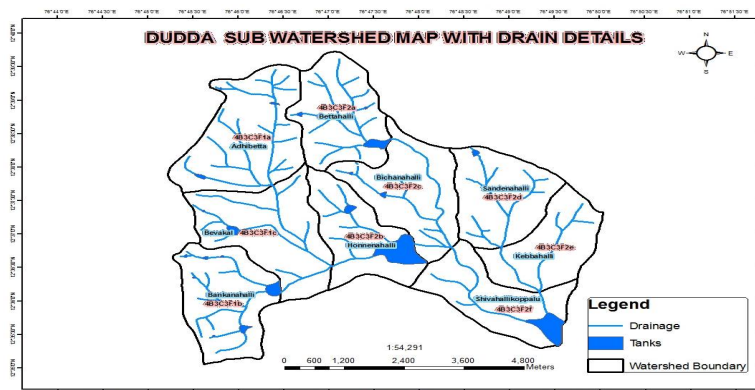


FIG.4. DRAINAGE MAP DUDDA SUB WATERSHED

Drain is a natural depression of the land surface. It's vertical, horizontal and length of depression depends on bedrocks, topography, geological structure and the nature of the soil etc. Many other factors like slope, rainfall and vegetation etc. also contribute for the development of a drain. The study area is represented by dendritic to subdendritic type of drainage pattern. The dendritic drainage pattern is the most common drainage pattern characterized by branching or tree like drainage pattern. Drainage net work in the present study was prepared by toposheets and PAN+LISS merged data, in which the spatial resolution of the data is 5.8 m. For this interpretation keys like tone, texture, pattern and association were used. After visual interpretation of the drainage map of the study area, it was scanned and digitized using AUTOCAD 2000 and ERDAS IMAGINE and finalized after field validation for the doubtful drainages.

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LITHOLOGY

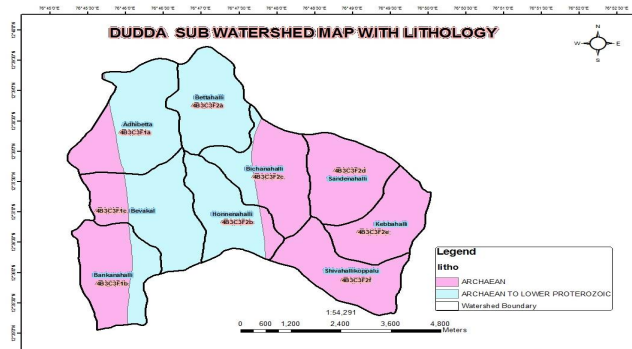


FIG.5. LITHOLOGY MAP OF DUDDA SUBWATERSHED

This study area mainly made up of gneiss, amphibolites and some places granite rocks are intruded into gneiss , near Dudda quartz vein are intruded into the gneissic rock Among them gneiss which are predominant in the southern Karnataka

LINEAMENT

Lineaments are natural, linear surface elements, interpreted directly from satellite imagery. Lineament analysis using satellite imageries has an advantage in that a regional area can be investigated synoptically with high accuracy. Lineament usually appears as straight lines or edges on the images which in all cases are contributed by the tonal difference within the surface material. Lineaments are evaluated in order to extract further information on the distribution and nature of the lineaments. In the hard rock areas. The movements and occurrence of groundwater depends mainly on the secondary porosity and permeability resulting from folding, faulting, fracture etc. the most obvious structural features that are important from the ground water point of view are the lineaments. The remote sensing data which offer synoptic view of large area, helps understanding and mapping the lineaments both on the regional and local scale. The lineaments analysis of the area from remote sensing a synoptic view of a large areas and aids in understanding and mapping of the lineaments both regional and local scale.

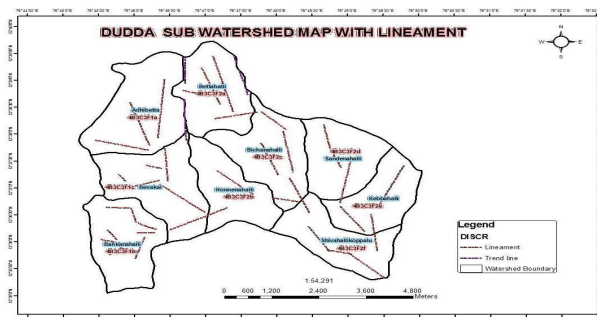


FIG.6. LINEAMENT MAP OF DUDDA SUB WATERSHED

IV. SOIL TEXTURE

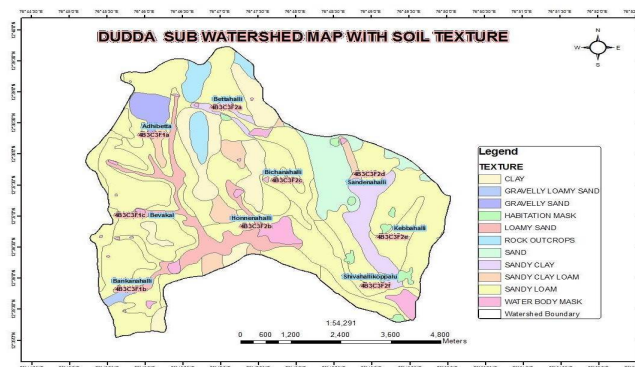


FIG. 7 SOIL MAP DUDDA WATERSHED

The soils on any map unit differ from place to place in their characteristic and management. The brief description of soil series and phases mapped are given. The soil map can be used for identifying the suitable areas for specific uses, viz., agriculture, articulture, sericulture, agro forestry, etc, the standard soil map has been interpreted for various themes like soil availability water capacity, soil depth , surface gravel, soil erosion, slope, land capability, land irrigability, soil salinity, land suitability etc. The soil information from the study area were classified into several type, like clayey, clayey skeletal, fine, fine loamy, loamy, loamy skeletal, sandy skeletal. The erosion of top soil decrease the productivity of land and leads to failure of crops

SLOPE

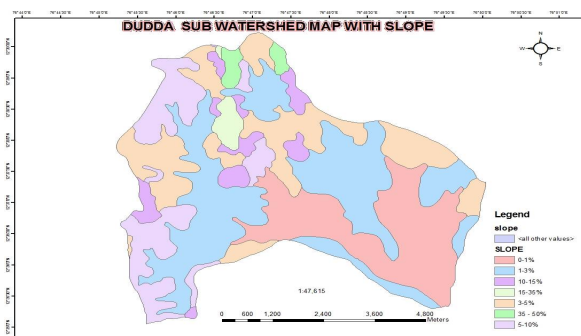


FIG. 8 SLOPE MAP OF DUDDA SUB WATERSHED

The most of the terrain causes rapid runoff and does not store water easily. Slope of any terrain is one of the factors allowing the infiltration of groundwater into subsurface or in other words groundwater recharge. In the gentle slope area, the surface runoff is slow allowing more tome for rainwater to percolate. Whereas steep slope areas facilitates high runoff allowing less residence time for rainwater to percolate and hence comparatively less infiltration the slope of the study area is classified into seven classes which is as per the diagram above. The rank is assigned to the individual slope class, according to its respective influence of groundwater occurrence, holding and recharge as per the table is shown below:

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Table.1 General slope category guideline

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

For general slope analysis survey of India toposheet in 1:50,000 scale has been used which gives 20 m contour interval. The closely spaced contour indicate higher order slope. The slope categories are given below in the Table 3.

Table.2 Slope category of Contour spacing on 1: 50,000 (IMSD tech. guideline 1995)

Slope category	Lower and upper limit of slope percentage	Lower and upper Limit of contour Spacing
1.	0-1 %	More than 4 cm
2.	More than 1% upto 3%	More than 1.33 cm and upto 4cm
3.	More than 3% upto 5%	More than 0.8 cm and upto 1.33 cm
4.	More than 5% upto 10%	More than 0.4 cm and upto 0.8 cm
5.	More than 10% upto 15%	More than 0.26 cm and upto 0.4 cm
6.	More than 15% upto 35%	More than 0.11 cm and upto 0.26 cm
7.	More than 35%	0.11cm and less

GEOMORPHOLOGY

Geomorphology is the science of the landforms and their systematic study is important so as to interpret them as signatures of the past and ongoing geological processes. These geomorphic features have great bearing on water resources of any area. Certain agents like rivers, glaciers, winds, etc relentlessly operate on the earth crust to bring about the changes of degradation and aggradation and these features are important from the point of understanding surface and subsurface water movement. Landforms like plateaus, residual hill, pediment, pediplain, piedmont, valleys and other landscape features are critical for evaluation of the water resources of any basin or region. The rainfall pattern is a strongly influencing factor in the landform evolution and as well in hydro geomorphology. Rainfall pattern is also key for evaluating the terrain for water replenishment, storage and losses. Obviously critical and intelligent rainfall

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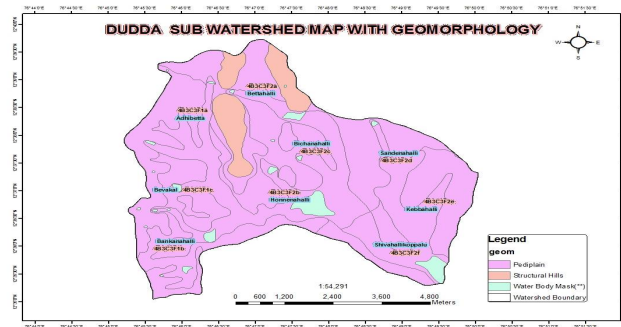


FIG.9 GEOMORPHOLOGY MAP OF DUDDA SUB WATERSHED

pattern analysis is vital for predicting droughts, cycles of surplus rainfall and runoff pattern, which are all ultimately necessary for comprehensive planning of any watershed.

Pediments :Gently sloping smooth surfaces of eroded bedrocks between hills and plains with veneer of detritus lithology like gneisses constitute pediments. Fractures have played important role in their formation Fig. The Pediments are gently sloping, smooth rocky surfaces exposed between hill and plain with thin covering of thin soil.

Pediplain shallow :They are formed by coalescence of buried pediments, where a thick overburden of weathered materials accumulates. The intensely weathered areas of granitoids constitute these landforms. Varying thickness of shallow over burden can be observed in such areas.

Pediplain moderate : Flat and smooth buried pediplains and pediments with moderately thick overburden are called pediplain moderate

LAND USE LAND COVER

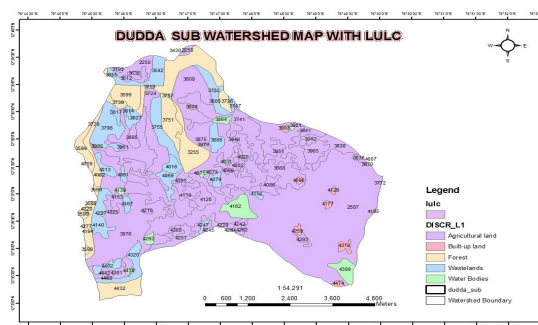


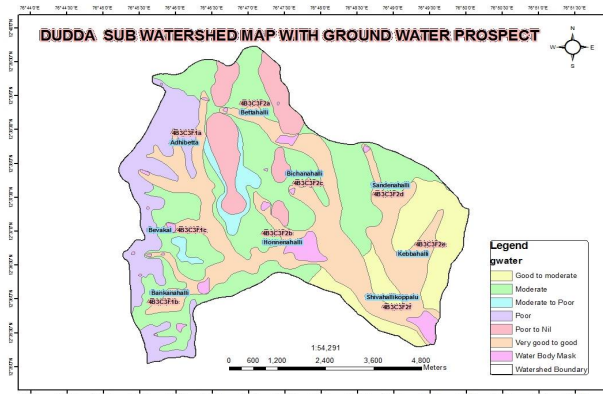
FIG. 10. LAND USE LAND COVER MAP DUDDA SUBWATERSHED

Built-up Land: Built-up land comprises all types of structures, houses, playgrounds etc. The major urban settlements are identified and mapped as towns and cities. It has been further classified as residential, Commercial, Recreation, Industry, etc. Other smaller settlements are identified and mapped as villages.

Agriculture Land: Cropping activity is seen throughout the year, mainly in the valley regions of the study area. There are three cropping season viz., Kharif from June to September/October, Rabi from October to February and Summer from March to May. Different categories of croplands identified in the area.

GROUNDWATER PROSPECT

FIG .11. GROUNDWATER PROSPECT MAP OF DUDDA SUB WATERSHED



Selection of potential zones of ground water exploration in Gneiss and schistose terrain requires detailed hydrological study. Water resources in such terrain depend on the network of fractures and thickness of the soil cover a part from other parameters like rainfall and climate. Ground water exploration method includes: Geomorphologic analysis, Assessment of hydro metrological elements. Geological and structural mapping, remote sensing and image interpretation, Soil cover and land use pattern, Hydro geological investigation etc. The integrated approach can be deciphering the probable potential zone of ground water exploration any area to generate level of success. The occurrence and movement of ground water in any terrain is mainly controlled by factors such as geology, geomorphology, structures, soil and land use pattern. Depending on the terrain characteristics, one or several of these parameters contribute to the localization of ground water. Most applications of remotely sensed data permit us to make indirect inferences regarding the sub-surface through surface expression of the aquifers. They deal with boundary conditions relating to the ground water system such as areas of recharge and discharge. A study was taken up to identify and suggest suitable digital enhancement techniques for extraction of ground water controlling features which are characteristic of hard rock formations

Prepare a ground water prospective zone map of parts of Dudda sub watershed of Mandya district, Karnataka by integrating details derived from the output generated by different enhancement techniques. By integrating, both hydrogeological and hydrogeomorphological details derived through visual interpretation of the different enhanced products, a ground water prospective zone map of the study area was prepared.

V. CONCLUSION

The present work was taken up in order to approve the area hydrologically by employing Remote Sensing and its techniques, as there techniques would provide quicker, more precise and holistic view of any basin. The data must commonly available for ground water study are geological, geomorphological, and hydrological formation .In this

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study we attempted to identify ground water potential zones using Remote Sensing and Geographical Information techniques in the area. To demarcate the ground water available in the area various thematic maps such as base map, lithological map, geological structural map, geomorphology map and hydrological map were prepared from the Remote sensing data.

Topographic maps, geology map and hydrogeomorphology map are prepared using GIS and ERDAS software and then maps are integrated for preparing ground water prospects maps. The hydrogeomorphological units such as valley fills and pediplain are prospective zones for ground water exploration and development in the study area. Presence of fault and lineaments in the study area enhance the potential of their units and generate level of success.

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