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Demarcation Of Ground Water Potential Zone Of Arunavati River Basin, Using Remote Sensing And GIS Techniques

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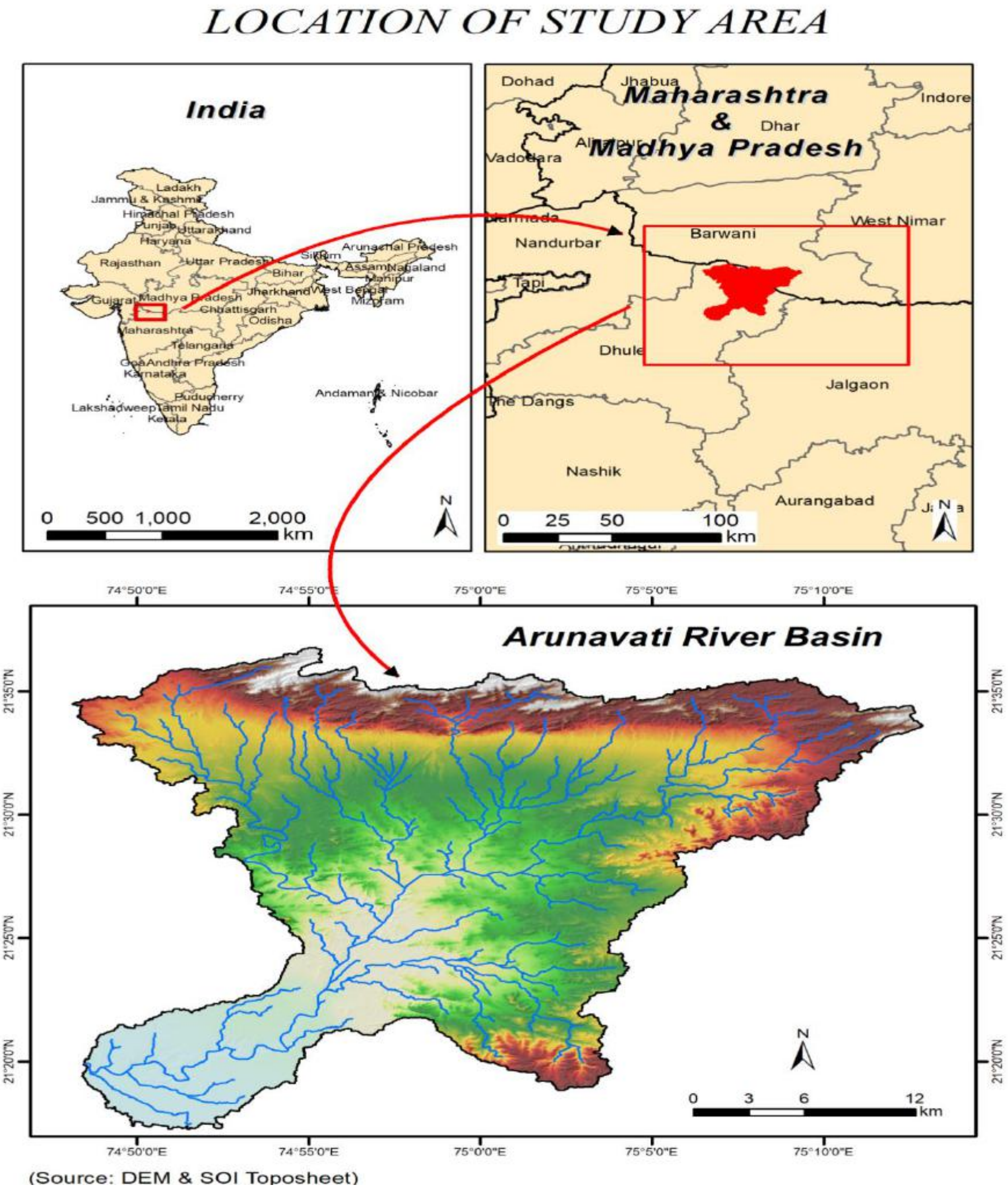
Abstract: *Groundwater is globally used for drinking and domestic purposes in both urban and rural areas .Ground Water is one of the prime sources of fresh water contributing significantly for the survival of mankind. As the demand and needs of the population towards water is growing, the value of water is felt in all sectors. At the same time, because of less rainfall surface water resources are becoming insufficient to fulfil the water demand. . In this context, There is a need of systematic planning of ground water improvement using modern techniques and there is a need to demarcate groundwater potential area for the proper management and utilization of water. Groundwater Resources have not yet been properly exploited. Keeping this in view, the present study has been undertaken to delineate the ground water potential zone in Arunavati River Basin (Watershed No. 53,54) sub watershed area using RS and GIS approach. The present study also demonstrates the use of the geospatial technique for mapping of groundwater quality of Arunavati basin area. Thematic layers of different parameters like geology, slope, land use, geomorphology, drainage density, lineament density was prepared. Based on the field condition, weight and rank values were assigned to respective themes and their classes. In this research project, demarcate groundwater potential zone in entire Arunavati basin and also find out the water quality have been discussed with the help of GIS and Remote sensing.*

1. INTRODUCTION :

Assessing the ground water potential zone is extremely important for the protection of water quality and the management of ground water systems. In this context, There is a need of systematic planning of ground water improvement using modern techniques and there is a need to demarcate groundwater potential area for the proper management and utilization of water. Groundwater Resources have not yet been properly exploited. Keeping this in view, the present study has been undertaken to delineate the ground water potential zone in Arunavati River Basin (Watershed No. 53,54)sub watershed area using RS and GIS approach. The present study also demonstrates the use of the geospatial technique for mapping of groundwater quality of Arunavati basin area. The water quality data is analyzed in the geographic information system (GIS), and inverse distance weighting (IDW) method was used to draw continuous spatial surfaces.

2. STUDY AREA:

The Arunavati River is a right bank tributary to the river Tapi. The study area spreads over an area of North west corner of Maharashtra and covered between the 21°18' N to 21°37'N latitude and 74°49'E to 75°13'E longitude. Arunavati river basin covers an area of 738 sq.km. and lies in Madhya Pradesh and Maharashtra. The survey of India toposheet no. 46 0/2, 46 0/3, 46 k/14, 46 k/15 are used for present study. It flows in a South-Westerly direction over a length of 69.5 kms, joins the Tapi river at Vanaval Village. The north and north east part of the study area is occupied by the hilltrack. While the southern part of the study area is plain. The highest point of the hill ranges in near Jhirpan Village at 650 mts. altitude towards north eastern part of basin.The study area experiencestropical climate with very hot summer and cold winterconditions. The maximum temperature is recorded at 45 o C and minimum temperature about 27 o C. In winter season, the minimumtemperature varies from 3 to 8o C. The area receives ~90%of the total annual rainfall . 800-900mm averageannual rainfall from southwest monsoon from June to September. Arunavati enters in Dhule district and flows in ageneral south westerly direction. Further making its way through the outer ranges of the Satpuda and after passing by Shirpur it joins the Tapi. The northern parts of the River dis being hilly terrain are drought prone and faces the problem of acute water scarcity.



Map1.1Location Of The Study Area

3 OBJECTIVES: Keeping in mind the above objects it was decided

- To assess and demarcate ground water potential zone through various thematic maps of Arunavati Sub-basin.
- To prepare different thematic maps of the terrain within the catchment area.
- To develop a GIS model to identify ground water potential zones.

4. Methodology :

The methodology adopted for the present study is shown in Fig. 2. The base map of Arunavati River was prepared using a shape file of the Maharashtra for village level on a 1:50,000 scale. Different type of data sets were used for assessing the groundwater potential of the study area .i) Topographic sheets, ii) IRS-P6 LISS III data geo-coded on 1:50000 scale and iii) secondary data on hydrology, collected in field through well inventory studies. Thematic maps on lithology, geomorphology, structures (lineament), landuse/land cover on 1:50000 scales were prepared from the remote sensing data and toposheets.the data were processed and tabulated according to the requirements of various ingredients of the study. In order to achieve the objectives of the present study, the appropriate methods and techniques will be adopted. Weights to the thematic layer and rank to classes were assigned based on the field observation in basin area. Weighted overlay method was carried out to integrate the factor maps to demarcate groundwater positional zones. The thematic layers with weights and rank values assigned was overlain using the weighted sum method and the resulting map will be classified. The thematic maps were subsequently digitized in GIS environment using Arc-GIS 9.0 software. Units of different themes were classified and assigned with different weightages as per their groundwater storage and recharge characteristics.

Fig2. Flow chart showing the proposed methodology.

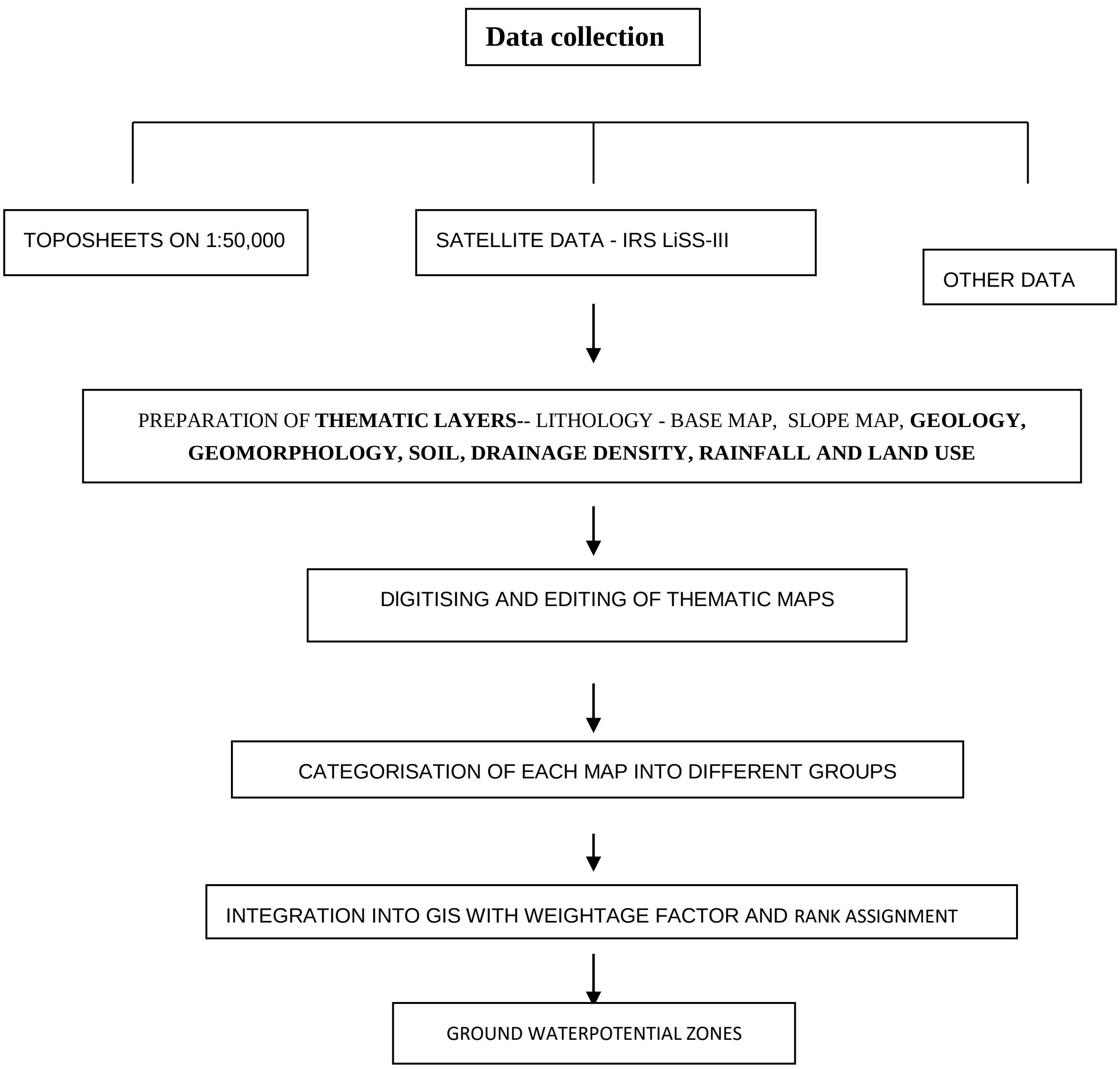


Fig 1 : Flowchart for **Demarcation** GW potential zone

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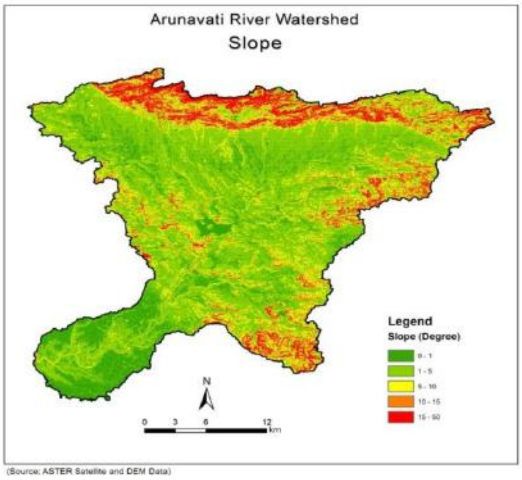
5. Results and Discussion:
Factor Maps for Groundwater Occurrence

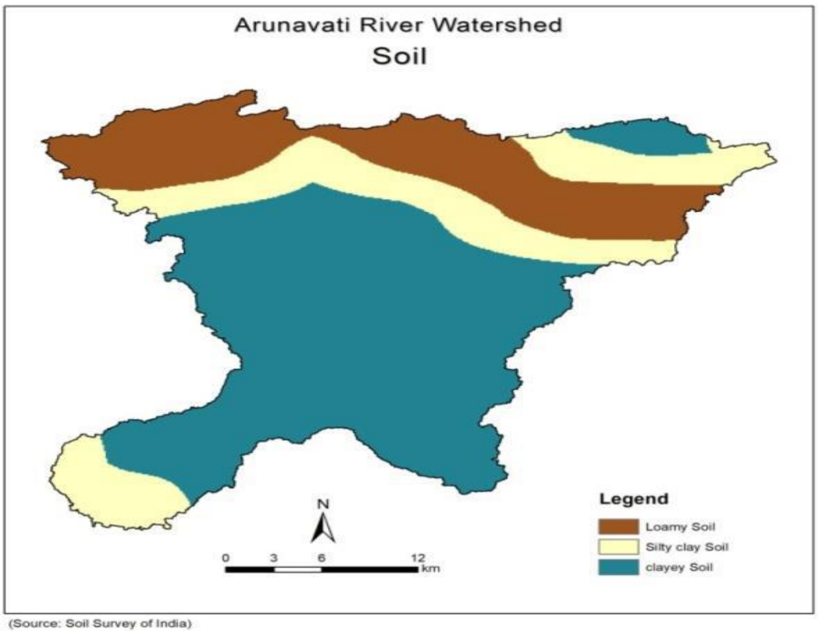
i) . Slope map



Map1. 2 **Slope map**

Slope is an important factor for the identification of ground water potential zones Slope is the rate of change of elevation and considered as the principal factor of the Imperfection water flow since it determines the gravity effect on the water movement. The slope is directly proportional to runoff and groundwater recharge will be lesser in the areas with steep slope. High
degree of slope results in rapid runoff and increased erosion rate with feeble recharge potential (Magesh et al., 2011 a). The water flow over the gentle slope undulating plains is slow and adequate time is available to enhance the infiltration rate of water to the underlying fractured aquifer which was obtained from contour or topo map. Whereas, steep slope area facilitates high runoff allowing less residence time for rainwater to percolate and hence comparatively less infiltration. The slope percentage in the area varies from 0 to 80%. On the basis of the degree of slope, the study area is divided into five slope classes. The area with 0-1 and 1- 5° slope falls in the 'very good' category due to the nearly flat terrain and relatively high infiltration rate. The area with 5-10and 10-15 degree falls in the 'moderate infiltration category and the area more than 15 degree receives insignificant infiltration.

Ii)Soil map:



Map1. 2 **Slope map**

Soil is an important factor for delineating the ground water potential zones. The soil map shows different soil series and phases like clayey, silty clay, and loamy skeletal. The analysis of the soil type reveals that the studyarea is predominantly covered by Black soil (in deeply buried pediments and moderately buried pediments) with black soil and alluvial soil (in the flood plains) at some places as shown in Fig. 9. The soil map was prepared using remote sensing techniques and satellite emagery of 1:50000 scales. A physiography map was prepared using the information of SOI toposheets, geology, slope maps and image characteristics. Pedants were studied in the field for each physiographic unit. The soils were classified using the USDA system of classification upto series level. Study area has alluvium and loamy soil is 38% and 19% and 41% are is of soft rock surface with mixed soils. These are mostly found in Northern part of watershed. It has almost no settlements in this region.

iii).Geology:
Groundwater potential is substantially related to geology. Apparently, the amount of alluvial formation constituting 11.36% of the area is considerable and highly permeable. The permeability of basalt formations was lesser; however, there existed fractures with secondary porosity. Both the zones of alluvium and fractured basalt seem to be priority storage areas for groundwater.

iv)Geomorphology:
Geomorphological analysis indicated that the groundwater potential of older alluvial plains, pediplains, and valleys is good. These landforms have high permeability and favourable topography, and thus greatly contribute to groundwater recharge. The dissected plateaus and ridges showed very low recharge potential, whereas localized recharge occurs along fault lines and fractures.

v). Lineament Density and Frequency:
Lineament density and frequency have a direct relation with groundwater potential. Higher level lineament density, particularly regions where more fractures overlap, bears a higher level of groundwater potential because it is the region of increased permeability. The probability of recharge or storage of water recharges high in areas of lineament densities between 2-3 km^2 with high fracture frequency.

vi)Slope:
Slope affects water infiltration as well as runoff. The total amount of sloping established that areas with slight slopes of 0-5 degrees favoring recharge as the runoff is low and more time of water residence. It has been observed that the sloping steep result in high runoff, which decreases the infiltration. Of the total basin area, approximately 69.79 percent was found with slight slopes which favors recharge.

vii). Rainfall:
Rainfall is one of the sources of groundwater recharge. Locations in the basin with high levels of rainfall, such as in the north and northeast sections of the basin, are ranked at the highest level of groundwater potential. Low rainfall areas rank low with regard to groundwater recharge.

viii). Land Use:
Land use patterns have a strong influence on groundwater potential in the Arunavati basin. Forest and agriculture land have good recharge potential because of efficient infiltration, but urbanized and barren land has less recharge potential due to impervious surfaces. The forest area forms 32.06% of the basin and has strong infiltration properties. Agricultural land occupies 63.97% and has moderate recharge potential, owing to soil management. Low potential for groundwater recharge will be found in the urban areas at 3.04% and barrens at 0.01%, and managed intensively to enhance infiltration.

Groundwater potential is affected by human activities, the change in land use and urbanization has altered the recharge pattern. In this regard, proper management of land use- particularly those areas such as agricultural and urban regions characterized with impervious surfaces-increases the potential for groundwater recharge.

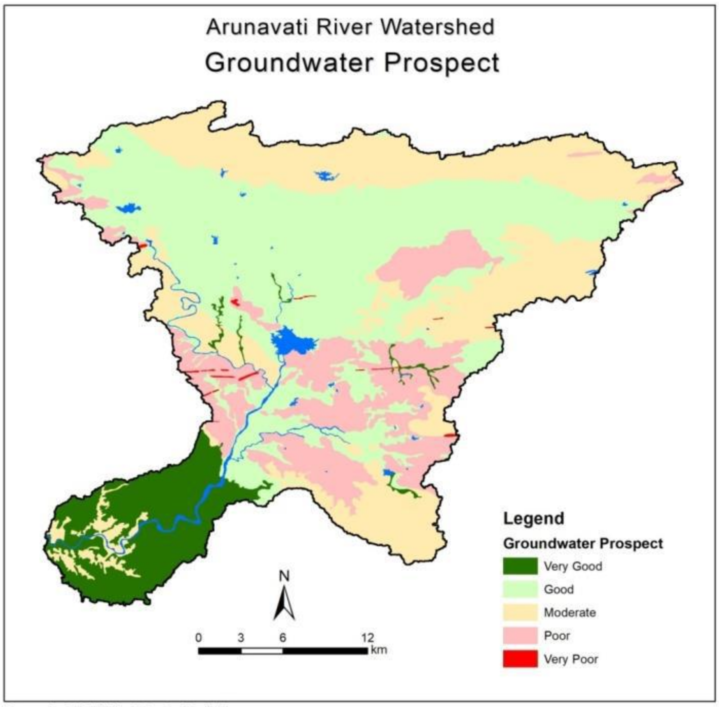
ix). Groundwater Potential Zones:

Table 1 Ground water potential Zones of Arunavati basin.

Category	Area (sq.km.)	Area (%)
Very Good	144.202	19.54
Good	263.423	35.69

Moderate	224.927	30.48
Poor	103.813	14.07
Very Poor	1.635	0.22

Map1.4: **Ground water potential Zones of Arunavati basin**



(Source: ArcGIS Weighed Overlay Analysis)

The groundwater potential zones of Arunavati River basin are classified into five classes, ranging from very good to very poor. This was done after considering a combination of factors like geology and geomorphology, density of lineaments, slope, soil type, rainfall, and land use along with the application of GIS and AHP techniques.

Very Good: 19.54% of the area; mainly in the forest-covered southwestern portion, where the infiltration rate is high as a result of the presence of both vegetation and permeable subsurface materials such as fractured rocks and alluvium.

Good: 35.69%; widespread in the western and central agricultural regions, where although the runoff on the surface is moderate, still it has good potential for recharge, especially under effective management of irrigation practices.

Moderate (30.48%): Areas of infiltration are only limited in the central and northeastern parts of the country, mainly due to less permeable soils and compacted geological layers. This category is moderately wet, depending on rain.

Poor (14.07%): Mainly the southern and southeastern parts show indications of the poor areas, in urbanized areas, and compacted soils leading to lesser permeability and a lesser charge.

Very Poor (0.22%): Extremely small area in the extreme south of the state with very poor conditions for storage of ground water and with very few vegetation developments.

These results are of utmost importance to tackle the sustainable use of ground water in the state, wherein emphasis is on artificial recharging techniques combined with conservation ones in areas of poor potential.

6. Conclusion :

In the present study, groundwater potential zones in Arunavati basin were delineated using geospatial technology and analytical hierarchical processes. Based on the literature review and expert opinion, nine parameters were identified, namely: geology, line density, geomorphology, soil, rainfall, drainage density, slope, relief, LULC were measured, different thematic layers were generated using remote sensing data in ArcGIS 10.8.1. Satty's multi-criteria scoring is used to calculate the weights of different features and thematic levels. Based on the composite assessment obtained after aggregation of thematic layers, the catchment area is divided into zones of very poor, poor, moderate, good and very good groundwater potential. The majority of the basin (66.17% of the area) lies in zones with good and medium groundwater potential, zones with very good groundwater potential occur on 19.54% of the area, zones with poor and very poor groundwater potential occur on 14.29% of the area area. To understand the relative importance of different parameters, a map distance sensitivity analysis is performed. Geology, geomorphology and line density are the three most influential parameters, precipitation and slope have the least influence. Overall, remote sensing, GIS and AHP technology hypothetically provide powerful tools for studying groundwater potential. The final map obtained can be used for sustainable development of groundwater in Arunavati basin.

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