IDENTIFICATION OF GROUNDWATER POTENTIAL ZONES AT AMPRS, ODAKKALI USING REMOTE SENSING AND GIS

Adithyan Dileep[1], Justin Jacob[2], Rose Merin Martin[3], Thushara Jose[4], Geeja K George[5]

[1,2,3,4]Graduate Student, Dept of civil Engineering, Mar Athanasius College of Engineering Kothamangalam, Kerala, India
[5]Asst Profeser, Dept of civil Engineering, Mar Athanasius College of Engineering, Kothamangalam, Kerala, India

---***---

Abstract - *Aromatic and Medicinal Plants Research Station (AMPRS) at Odakkali is abundant in wide variety of plant species. This region receives sufficient amount of rainfall every year. But this precipitation flows out rapidly and does not contribute towards the groundwater recharge. Hence there is an impending need for substantial amount of water. So the objective of this study is to discover the groundwater potential zones in the vicinity of Aromatic and Medicinal Plants Research Station (AMPRS) at Odakali. The groundwater potential zones of this region is delineated by applying the techniques of Remote Sensing and Geographic Information System (GIS) which provide a necessary platform for this. The various maps (thematic) such as geology, geomorphology, drainage, lineament, Land Use/Land Cover (LU/LC), soil and slope were integrated with proper weightages to generate a map showing the potential zones of groundwater in the region. The weightage for each parameter is decided using Multi-Influence factor (MIF) method and then the different layers are overlaid using weighted overlay tool in ArcGIS 10.2. Finally the results obtained from the map is validated using the yield data collected through field survey from the various locations of the study area. Thus the outcome of this work can be used for resource identification in the regions of insufficient distribution or availability of groundwater and provide a solution for the water stress condition in the region.*

Key Words: groundwater potential zones, GIS, Remote Sensing, MIF, validation

1. INTRODUCTION

Groundwater is very valuable and precious natural resource and more suitable and continuously available than other sources. Groundwater is replenishable, less contaminated and can be easily extracted. Records shows that 80% of rural population and 50% of urban population use groundwater for domestic purposes. This rate may increase further in future. But nowadays due to drastic changes in climatic conditions and dynamic development on land surface features there are fluctuations in water levels and shift in ground water zones. Hence there is an increase demand for identification and assessing the groundwater potential zones.

Researches shows that remote sensing and GIS has opened new path in Groundwater studies. Remote sensing is the technology of acquiring information about the Earth's surface without actually being in contact with it. Geographic Information System (GIS) is a computer based information system designed to accept large volumes of spatial data derived from variety of sources and to efficiently store, retrieve, analyze, model and display (output) these data according to user defined specifications. In recent studies researchers such as Sumit das et. al., (2018), Shivaji Govind patel (2014). Chaudhary et. al., (2017), Yasanthkumar et. al., (2017), Magesh (2011) used Remote sensing and GIS for delineation of groundwater potential zones. Some researchers like Raju thapa et. al., (2017), Lazarus and Yadav (2014), Ramu et. al., (2010) has also checked the accuracy of the results through field verification. Hence all these results proved that remote sensing combined with GIS is a very efficient tool for identification of groundwater potential of any region with accurate results.

1.1 STUDY AREA

The Aromatic and Medicinal Plant Research Centre (AMPRS), Odakkali is a research station under the central zone of Kerala Agricultural University (KAU) in Ernakulam District of Kerala. It is situatied nearer to the edges of three micro watersheds. Those are watersheds with watershed codes 14P143b, 14P140c, and 13M38b. The study basin with an area of 62.0918 sq.km of lies between 10^{0}2'32.704"N to 10^{0} 9'4.671" N latitude and 76^{0} 31' 16.772" E to 76^{0} 38' 13.525" E longitude. The average temperature of the study area is 28^{0}C, humidity 83%, annual average rainfall of around 2900mm and wind 0.41 mt/sec towards South. Fig 1.1 shows the study area.

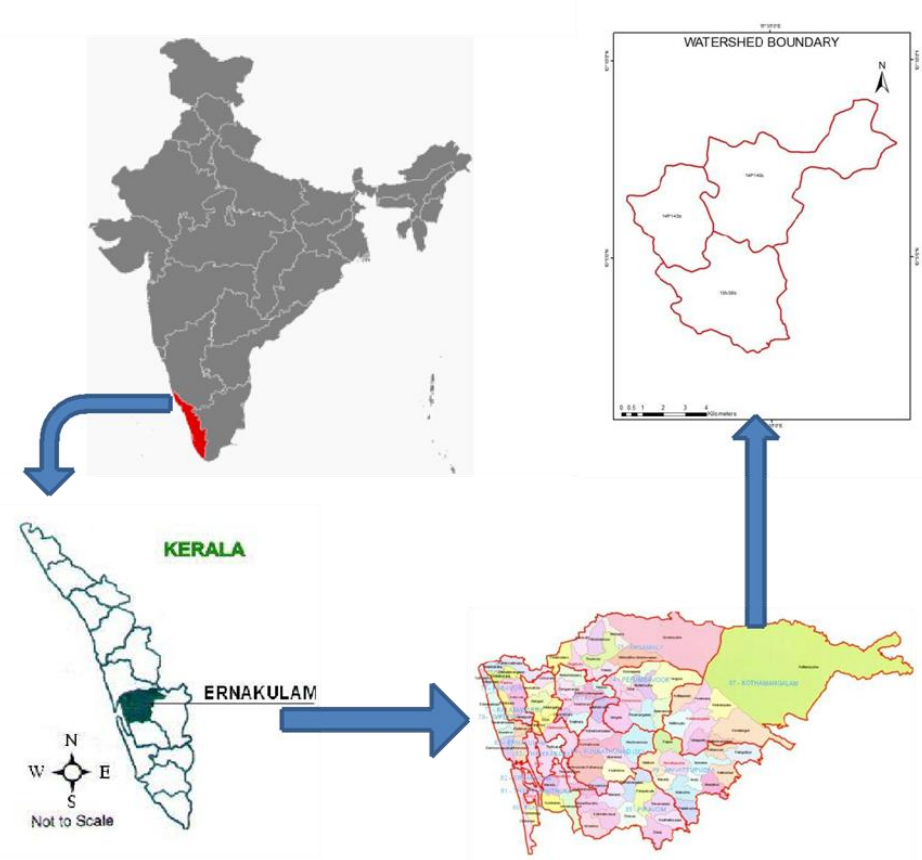

Fig -1.1: Map showing location of study area

2. METHODOLOGY

Table -2.1: Table of Methodology

SL.No	Data	Source	Objective / work done
1.	Watershead Boundary	KSLUB Thrisur	Digitilizing the boundary, Estimate the study area
2.	Parameters 1. Geology 2. Geomorphology 3. Soil type 4. Drainage density 5. Landuse/ landcover	KSLUB Thiruvanadapuram	Vector data are coverted to raster data and data are projected to UTM 1984
	6. Lineament density	Bhuvan	Creating thematic map and rasterization
	7. DEM	ASTER DEM	Generating slope (in raster)
3.	Ground water data	Field survey	Validation

Different data required for the study was collected from different sources which is described in table 2.1. Then weightages and ranks were assigned to different parameters and their classes based on their feasibility for groundwater occurence. Then the groundwater potential map produced by integrating these data with the help of GIS is verified with field data to ascertain the validity of the study conducted

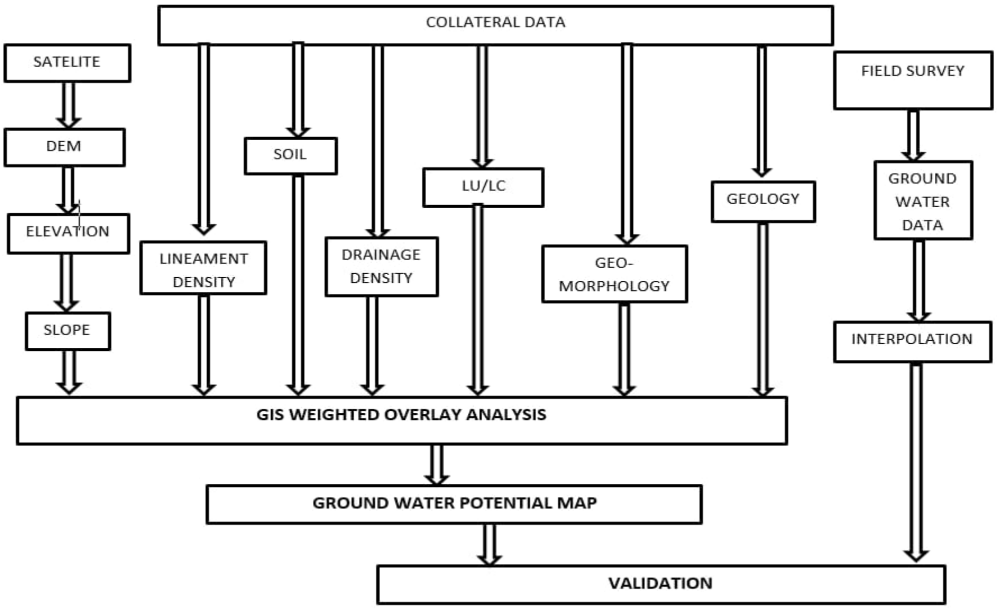

Chart -2.1: Flowchart of Methodology

2.1 Data integration through GIS

The collected data which was initially not in projected format was projected using project (data management) tool in ArcGIS 10.2 version. Also the data collected were in vector format, which is converted to raster using this tool. Polygon to raster (spatial analyst)' conversion tool is used for converting polygon feature to raster data. 'Line- density (3D analyst)' conversion tool is used for converting line feature to raster data. The parameters which influence the ground water potential zone are integrated into a table in 'weighted overlay analysis (spatial analyst)' tool. Percentage influence of each parameters are identified and applied accordingly. The sum of percentage influence of each parameter should be 100. The maximum value is given to feature with highest influence and minimum to the lowest influence on ground water. In each thematic map the input attributes are assigned with values 1-9, 1 being the greatest influence and 9 being the lowest.

2.2 Assigning weightage using MIF technique

The effect of various parameters like geology, geomorphology, slope, lineament density, land use/land cover, drainage density, and soil type on ground water potential zones were examined and assigned appropriate weightage to each parameter. Assigned a weightage of 1 for major effect and 0.5 for minor effect. The cumulative weightage of each factor were calculated and used for the calculation of relative rates. The suggested score for each influencing factor is calculated using the formula,

$$\frac{(a+b)}{\sum(a+b)} \times 100$$

Where 'a' is the major influencing factor and 'b' is the minor influencing factor between two parameters. Table 2.2 shows the effect of influence factors, relative rates and score for each potential factor

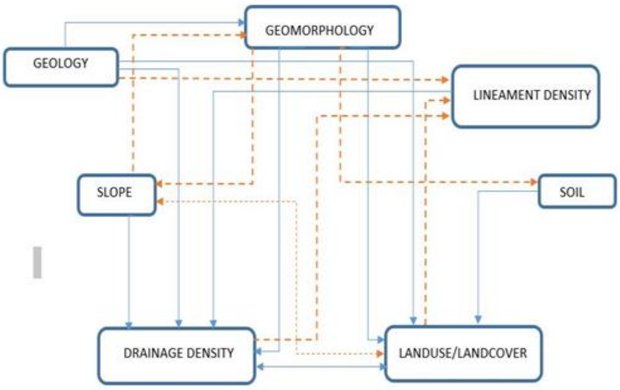

Fig -2.1: Interrelationship between multi- influencing factors concerning the ground water potential zones in AMPRS, Odakkali, Kerala

Table -2.2: Effect of influence factors, relative rates and score for each potential factor

Factor	Major effect(a)	Minor Effect(b)	Proposed Relative Rate (a+b)	Proposed score of each factor
Geology	1+1+1	0.5	3.5	22
Geomorphology	1+1	0.5+0.5	3	19
Landuse/Landcover	1+1	0.5+0.5	3	18
Lineament	1+1	0	2	13
Slope	1	0.5+0.5	2	12
Drainage density	1	0.5	1.5	9
Soil	1	0	1	7
			∑16	∑100

3. RESULTS AND DISCUSSIONS

The details of various thematic maps generated for the identification of groundwater potential zones are given below.

3.1 Geology

Ground water holding capacity of rocks depends on compactness of the rocks. Compactness in turn depends on the presence of pore spaces within the rocks (porosity) and permeability. The study area consists of basic rocks, Charnokite, and Migmatite complex. The water-bearing properties vary from one rock type to another rock type. The geology influences both the permeability of aquifer rocks and the distribution of fracture pattern. Fig 3.1 shows that the major part of study area is comprised of charnokite. Ranks are assigned according to its water holding capacity.

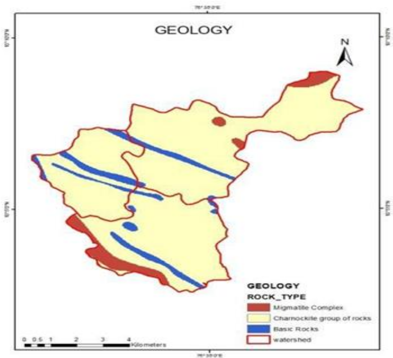

Fig -3.1: Geology map

3.2 Geomorphology

Geomorphology is the study of the form of the earth (landform). Geomorphology of an area depends upon the structural evolution of geological formation. Geomorphology reflects various land form and structural features. Many of the features are favorable for the occurrence of groundwater and classified in terms of ground water potentiality. The different types of land form are residual hill, pediplain and plateau. The study area consist mostly of plateau. Fig 3.2 shows the map of geomorphology. Ranks are assigned according to its water holding capacity.

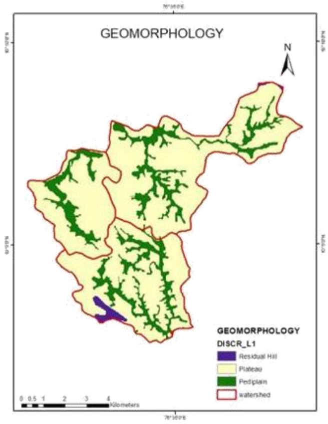

Fig -3.2: Geomorphology map

3.3 Soil

Soils are derived from rocks due to weathering. Soil characteristics have a considerable role on the infiltration of water. The rate of infiltration largely depends on grain size of soil. Different types of soils identified from the study area are clay, sandy clay, sandy clay loam and sandy loam. Sandy clay soil is the most extensive soil type found in the area. The movement and infiltration of water in these three types of soil is not same so based on its property the weightages have been assigned. Sandy loam soil is given more rank and clay soil has less rank. Fig 3.3 shows the soil map of the study area.

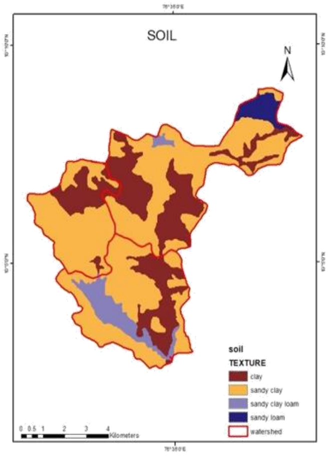

Fig- 3.3: soil map

3.4 Drainage Density

A drainage basin is a natural unit draining runoff water to a common point. Drainage map consists of water bodies, rivers, tributaries, perennial & ephemeral streams, ponds. Drainage density is defined as the closeness of spacing of stream channels. It is the measure of total length of stream segment of all orders per unit area. Drainage density is an inverse function of permeability. The less permeable a rock is, the less the infiltration of rainfall which conversely tends to be concentrated in surface runoff. Slope affects the drainage density and it produces differences from place to place. The line density tool of spatial analyst is used to get density map from the drainage map according to drainage density, study area is divided into 9 classes. Fig 3.4 shows the drainage density map of the study area.

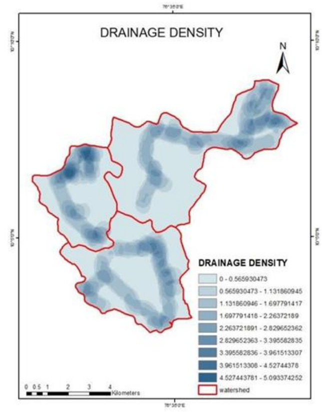

Fig -3.4 Drainage density map

3.5 Slope

Slope is the rate of change of elevation and it is considered as the principal factor of the superficial water flow since it determines the gravity effect on the water movement. Slope is directly proportional to run-off. In steep slopes ground water recharge will be less. The water flow over the gently undulating plains is slow and adequate time is available to enhance the infiltration rate of water to the underlying fractured aquifer. The slope was estimated from the Digital Elevation Model (DEM). Fig 4.5 shows the slope map of the study area.

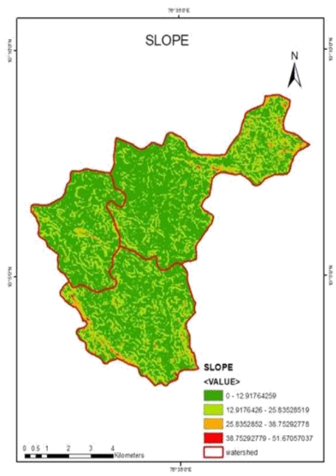

Fig -3.5 Slope map

3.6 Lineament Density

Lineaments are structurally controlled linear or curvilinear features which are identified from satellite imagery by their relatively linear alignments. Lineaments represent zones of faulting and fracturing resulting in increased permeability. They are hydro-geologically very important since they act as path ways for ground water movement. Lineament density of an area can directly reveal the ground water potential since the presence of lineaments usually denotes permeable zone. Area with high lineament density are good for ground water potential zones. Fig 4.6 shows the lineament density map of the study area.

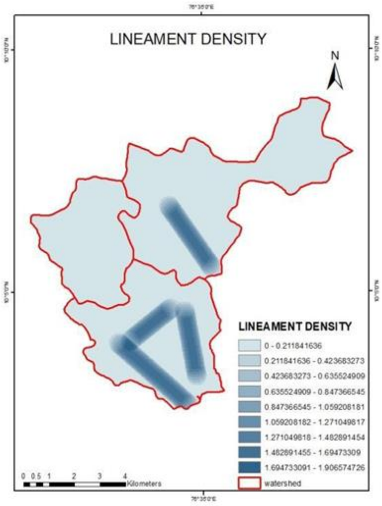

Fig -3.5 Lineament map

3.7 Land Use/Land Cover (LU/LC)

Land use refers purpose for which the land is used. Land cover denotes the type of land. LU/LC affects evapotranspiration volume, timing and recharge of ground water system. It is observed that spatial variation in the amount of groundwater storage occurs due to changes in land use and vegetation cover, hence proper understanding of LU/LC is necessary to estimate the water resources, and it has therefore been included in this study. Identified features from the study area are built up land, paddy area, rocky area, mixed crop, forest, agricultural fellow land and water body. Forest and agricultural ecosystem together occupy major portion of the study area. Fig 3.6 depicts the land use pattern of the study area.

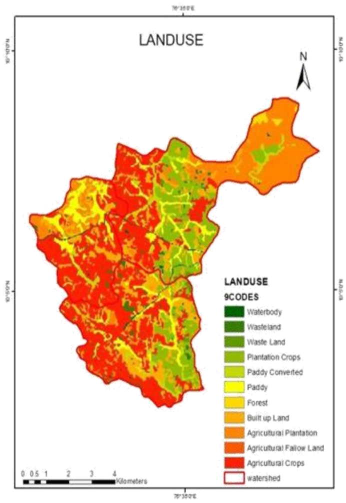

Fig -3.6 Landuse map

3.8 Identification of Ground- water potential zones

Fig 3.7 shows the groundwater potential zones map of the study area

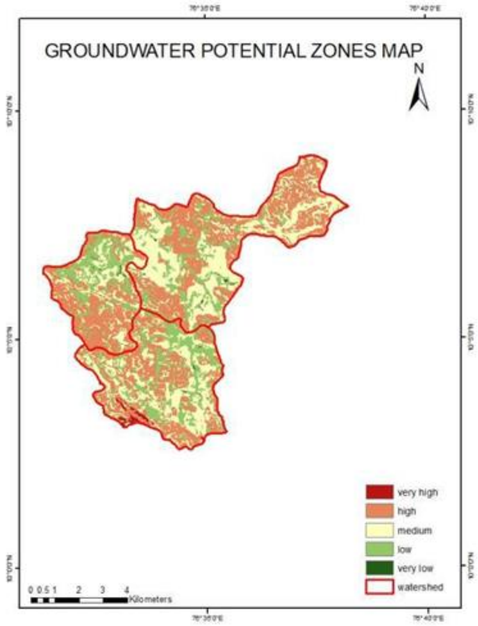

Fig -3.7 Groundwater potential Zones Map

When the different parameters are overlaid after assigning proper weightage and ranks the above result was obtained. Based on the feasibility of potential zones for the groundwater the study area is broadly classified as very high, high, medium, low, very low. To validate the trustworthiness of final result well inventory survey was conducted on various locations of the study area. The depth of the water table in wells is used as an indication of the groundwater yield. Well inventory data is used for the verification of the results. Wells fall in high potential regions have high water table depth even in summer season.

4. CONCLUSION

Identification of groundwater potential zones is very essential for the efficient and controlled development of the groundwater resources. In the present study, the combined use of remote sensing and GIS with MIF technique is proved to be a powerful tool for the delineation of groundwater potential zones in AMPRS, Odakkali. The final map matches with the ground truth data indicates the validity of the model. Hence outcome of this study is highly reliable and can be served as guidelines planning and future resource identification in the study area.

REFERENCES

[1] B.S Chaudary and sanjeevkumar (2018);" identification of ground water potential zone watershed by using remote sensing and GIS of Koshalya-jhajhara watershed, India," Journal geological society of india vol-91, June 2018, pp.717-721

[2] Aathira Santhosh, Devika Varma (2018) "Identification Of Ground Water Potential Zones Using Gis And Remote Sensing" International Journal Of Current Engineering And

[3] Y. Yaswanth Kumar, D.V. satyanarayanaMooorthy and G. Shanmukasrinivas (2017); 'Identification of ground water potential zones using remote sensing and Geographical information system' IJCIRT Vol-8 issue-3 March 2017

[4] Debu Mukherjee (2016); Review on artificial ground water recharge in India. SSRG-IJCE Vol-3, Issue-1, January 2016

[5] ShivajiGovindPatil and Nitin Mahadeomohite (2014); International journal of geomatics and geo science vol-4, no-3, 2014.

[6] Lazarus G. Ndatuwongetal and Yadav G.S (2014); 'integration of hydrogeological factors for Identification of Groundwater Potential Zones using Remote sensing and GIS technique'. Journal of geosciences and geomatics 2014, vol.2 No.1, 11-16.

[7] M.L Waikar and Aditya P. Nilawar (2014); 'Identification of ground water potential zone using remote sensing and GIS technique' Vol 3 issue 5, May 2014

[8] N.S Magesh, Chandrasekarn and John Prince soundranayagam (2012) 'Delineation of ground water potential zones in Theni district, Tamilnadu, using remote sensing and GIS and MIF techiques. Geoscience Frontiers, 2012,pp. 189-196