Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 07, July-2021

Construction of water table contour map and Geohydrological Studies in Pathanamthitta using GIS techniques

Ashna Beegum[1]
Assistant Professor
Department of Civil Engineering
Musaliar College of Engineering and Technology
Pathanamthitta, Kerala, India

Simi Monachen[2], Sandra K Shaji[3],
Anamika Chandra[4], Vishnu K[5]
Student
Department of Civil Engineering
Musaliar College of Engineering and Technology
Pathanamthitta, Kerala, India

***Abstract*— Pathanamthitta is a developing city in Kerala, India. Ground water is a major source of water supply for the town which is reflected by regular extraction of ground water through ever increasing no. of municipal industry and private bore wells. Water table contour map represent lines of equal elevation. Creation of a water table contour map will help in a variety of ways. Through this points with equal ground water levels can be easily identified. QGIS software helps in creating the map. Water levels from wells represent the ground water level in an area. Different zones can be identified from a water table contour map. Hydrogeology makes use of ground water contour maps in order to evaluate an aquifer. These maps indicate lines with equal ground water levels based on a reference level (masl). A ground water contour map provides important information about ground water movement and flow directions. Different regions facing water scarcity will be identified. The groundwater potential zones are identified to the help of study the geographical factors and groundwater availability.**

Keywords—Contour map, fluctuation map, ground water potential prospects)

I. INTRODUCTION

India is the largest user of groundwater in the world. Groundwater plays a significant role in the India's economy, environment and the living standard. Water table contour maps include water table contour lines (flow lines) which are similar to topographic lines on a map. Water table contour line can be used to tell which may ground water will flow in a given region. In the project the data collection is done by using GPS and water level is calculated by putting a rope tied by small weight at its end which touches the top surface and measured with the help of a tape. Fluctuation maps are also created in our project. It provides in the difference in the water levels in two different time periods. Identification of potential ground water aspects in Pathanamthitta district is also identified. It is calculated by using several influencing factors such as geomorphology, geology, drainage density, lineament density, soil slope land cover and land use.

II. OBJECTIVES AND SCOPE

A. Objectives

The objective of the study is to present the water table contour map and the water table fluctuation map of Pathanamthitta municipality using Geographic Information System (GIS). A water table-contour map is an important tool in groundwater investigations. Contour map also helps in estimating an approximate depth for a proposed well, the configuration of the water table provides an indication of the approximate direction of ground-water flow at any location on the water table.

The objectives are:

- To find out the water levels for various open wells in a selected area
- Mapping of study area using GIS
- To identify of potential groundwater prospects in the study area

B. Scope

Water table mapping is very important for future references and planning. Water table contour map shows the elevation and configuration on a certain date. It helps in knowing the availability of water level in the region and to adopt suitable methods to overcome the water scarcity. Difference between supply and withdrawal of ground water cause levels of fluctuations. The analysis and review of short term ground water level fluctuation in Pathanamthitta Municipality is done. The fluctuation map indicated that there is both general decline and rise in water table. The groundwater potential zones are identified to the help of study the geographical factors and groundwater availability of the study area.

III. METHODOLOGY

Based on field observation 32 Open wells were selected for groundwater depth measurement. The selected wells are situated throughout the city with one well located in each municipal ward. Spatial coordinates of the sampling bore wells were measured on site using a hand held global positioning system (GPS). In this method the depth of water is taken by inserting a rope attached with a weight at the lower end. This method is similar to the standard procedure for measuring the ground water depth using a steel tape. Depth to groundwater level was measured in meter with the casing of the well as reference point and then deduced to exact ground level. The groundwater level in Mean Sea Level (MSL) is obtained by deducting groundwater depth from the ground level in MSL.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 07, July-2021

The contour map, Fluctuation map and the identification of the ground water potential zone is carried out in the software. The water levels using the GPS is collected during December 2020 and April 2021.

IV. STUDY AREA

Pathanamthitta is a municipality situated in the Central Travancore region in the state of Kerala, India, spread over an area of 23.50 km2 shown in *Fig 1*. It is the administrative capital of Pathanamthitta district. The town has a population of 37,538. The Hindu pilgrim center Sabarimala is situated in the Pathanamthitta district; as the main transport hub to Sabarimala, the town is known as the Pilgrim Capital of Kerala. Pathanamthitta has an average elevation of 18 meters above sea level. Pathanamthitta has a moderate climate. Annual temperatures range between 20 °C (68 °F) and 39 °C (102 °F). The district experiences three distinct weather conditions: winter, summer and the monsoon. The winter season is experienced from December to February and summer season from March to May. There are two rainy seasons: The South-West monsoon (June to September) and the North-East monsoon (October to November). The South-West monsoon is usually very heavy. About 75% of its annual rainfall is received during this season. Pathanamthitta constitutes 4 muncipalities. They are Thiruvalla, Pathanamthitta, Adoor, Pandalam. The municipality which we taken for our project is Pathanamthitta municipality. Pathanamthitta Municipality has total administration over 9,813 houses to which it supplies basic amenities like water and sewerage. There are 32 wards in the city, among them Pathanamthitta ward no. 11 is the most populated ward with population of 1654 and Pathanamthitta ward no. 09 is the least populated ward with a population of 845.

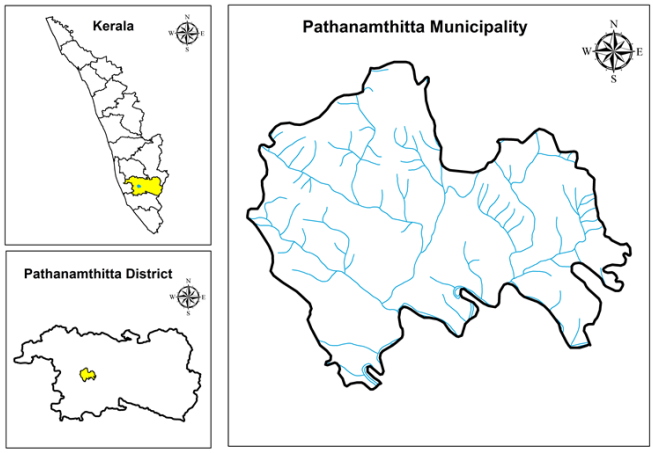

Fig 1. Location of Pathanamthitta Municipality

V. COUNTOUR MAP

Water table contour are drawn that to join area of equal heads, the lines are called equipotential lines. The success of any ground water study depends upon the availability and accuracy of measured data required for the study. Therefore, identifying data need and collection of data from an integral part of any ground water exercise. Pathanamthitta district consists of 4 Municipalities. The municipality selected is Pathanamthitta to carry out the project. The municipality consist of 32 wards, here well select each wells from each wards. Most household water wells range from 100 to 800 feet depth, but a few are over 1000 feet deep. The quality of the water depends on several factors including geology and water levels. In order to allow for maximum ground filtration to remove impurities, depth should be at least 100 feet. Spatial coordinates of wells are measured by using a handheld GPS system. The depth up to the level of water is take by using a rope tied with a small weight at its end and the length is measured up to the top surface of water is measured by measuring tape. From this map it is clear that the dark blue shade shows the area with higher level of ground water and the low blue shade shows the area with lowest level of ground water during December and is shown in *Fig 2* and during April is shown in *Fig 3*. The intermediate shades of blue colour shows intermediate levels of ground water. From the map it is clear that the highest ground water level in Pathanamthitta municipality is in ward no. 24 which is Valamchuzhy and the lowest ground water level in Pathanamthitta municipality is in ward no. 13, Anappara.

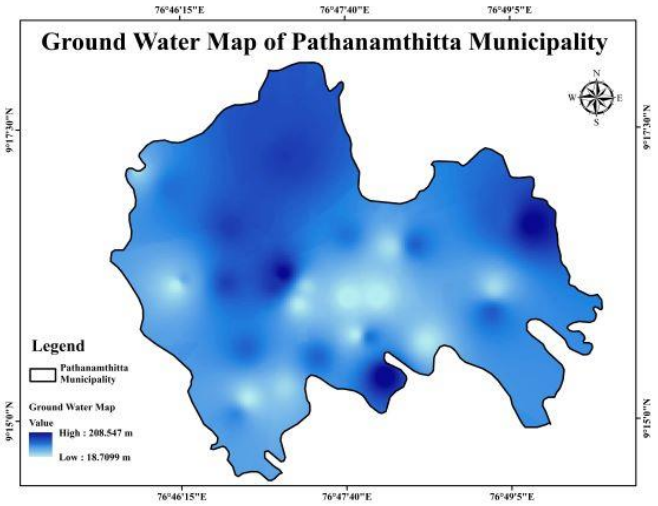

Fig 2 Ground water map of Pathanamthitta Municipality during December

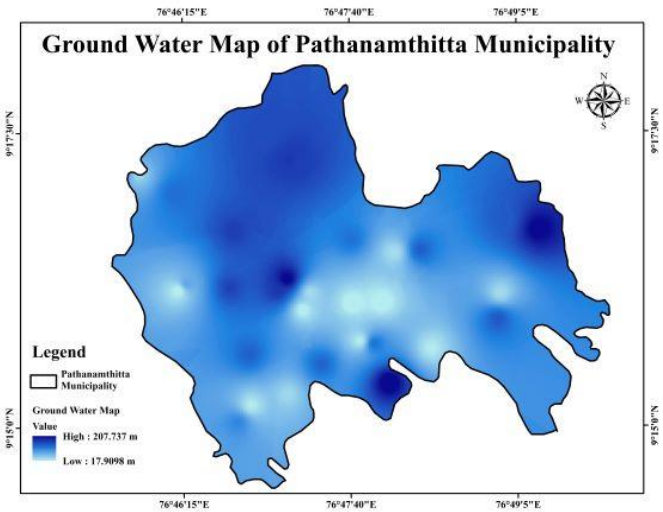

Fig 3. Ground water map of Pathanamthitta Municipality during April

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 07, July-2021

VI. FLUCTUATION MAP

Fluctuation map is a useful tool in the interpretation of drainage problems in area with large table fluctuations. It is also one of the important thematic maps for the study of occurrences of ground water. From the fluctuation, it is found that maximum recharge observed in the study area 3.5m. The occurrence of ground water generally depends upon the rainfall, drainage, topography and the geological conditions of the area. In the *Fig 4*, fluctuation map of water levels in meter between the months of December and April in the year 2020 and 2021 is shown. Water table fluctuation method provides an estimate of ground water recharge by analysis of water level fluctuations in observation wells. Here by considering 32 wells corresponding to 32 wards of Pathanamthitta municipality. The water level can vary in different areas and even within the same area. Fluctuations in the water table level are caused by change in precipitation between seasons and year or by months. Ground water variation with rainfall was assumed as a possible cause for ground water level fluctuations. The analysis and review of short term ground water level fluctuations in the municipality region is done. The fluctuation map with water level difference and drainage is shown in *Fig 5*. For explaining, taking a particular point for example well in the Mundukottykal area, the level of water during December is 143.2m and the level of water during April is 141.97m. from this it is clear that within 4 months the level of water in the Mundukottykal region decreased by 1.23m, it is shown in *Fig 5*. The negative sign shows that the water level is decreased and zero indicates there is no change in the level of water and the positive sign shows that the water level is increased. The zone which the water level is increased is depicted by a green color which indicates that it is a safe zone. When the change in the green color to the red indicates that the water level is decreasing, which represent that the area is more vulnerable or it is not that safe. From the *Fig 5* it is clear that the water level is highly decreased in the thycavu region by 3.82m which is more vulnerable and least vulnerable region is the Azhoor area with 0.7m, which is a safe zone.

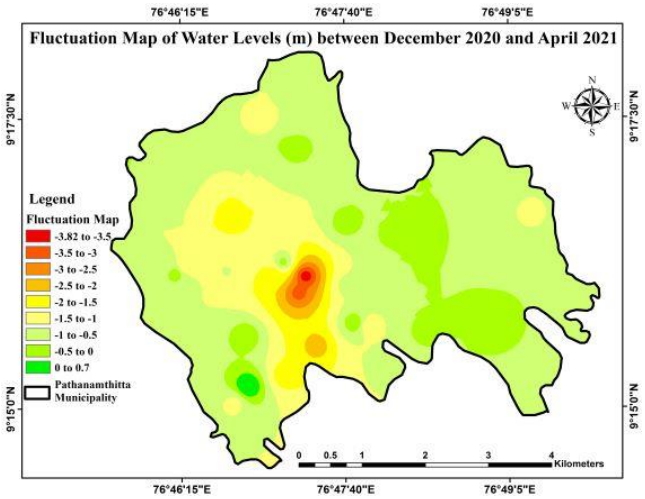

Fig 4. Fluctuation Map

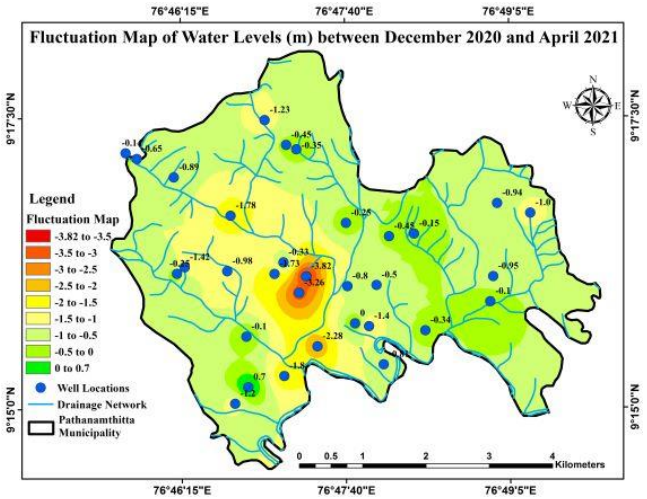

Fig 5. Fluctuation map with water level difference and drainage

VII. IDENTIFICATION OF POTENTIAL GROUND WATER PROSPECTS

Groundwater is the most widely crucial substance in our planet, the distribution is largely unbalanced. It is found in beneath the surface of the earth in fracture and pore space of soil. The different hydrological, geological and geomorphic parameters play vital role in the movement and occurrence of groundwater in various areas. The chief objective of sustainable development and management of groundwater is the identification of prospective ground water zones enabling their development for societal, agricultural and industrial uses. Different thematic layers such as geomorphology, slope, drainage density, geology, lineament density and soil act as indicators of occurrence of ground water. The normalized weight and rank for each feature and sub-feature have been used to identify groundwater potential zones in coastal groundwater basins. The groundwater potential zones are identified to the help of study the geographical factors and groundwater availability of the study area. The Weightage and ranks were assigned to the themes and units depending upon their influence over recharge. Overlay analysis technique was used for identification of ground water potential zones.

VIII. MULTI-INFLUENCERS OF GROUND WATER PROSPECTS

A. Geomorphology

Geomorphologic map shown in *Fig 6* depicts important geomorphic units, landforms and reflects underlying geology so as to provide an understanding of the processes, materials/lithology, structures and geologic controls relating to aquifers as well as GW prospects. The geomorphologic units identified in the Pathanmthitta Muncipality in the increasing order of GW prospect are: Water Body, Valley Fill, Linear Ridge Lateritic Dissected, Linear Ridge Lower Plateau, Residual Mount, Residual Hill. A tract with Residual Hill is normally considered as poor source of GW; hence, chances of occurrence of GW depend on the geologic structures in this tract. The geomorphologic features such as residual mounds, Linear Ridge Lower Plateau, Waterbody, Valley Hills are also 'poor' in respect of GW storactivity. On the other hand, Linear

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 07, July-2021

Ridge Lateritic Disected are considered as good prospects for GW exploration.

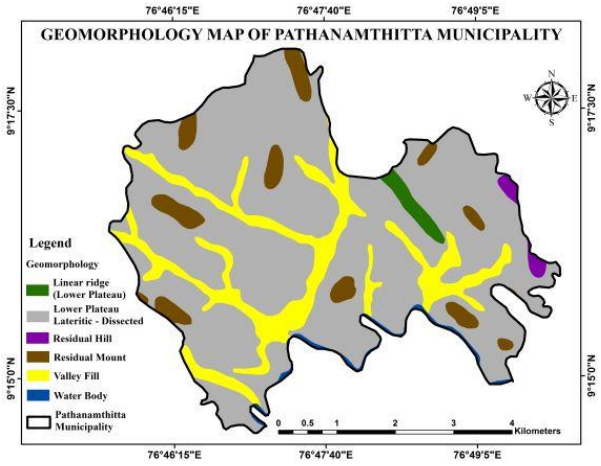

Fig 6. Geomorphology Map

B. Geology

Four distinct tyoes of rocks are found in Pathanamthitta Muncipality. They are Charnockite Group of Rocks, Sand And Silt, Khondalite Group Of Rocks, Basic Rocks. About 92% of Pathanamthitta Munciplaity is covered by Charconite group of rocks which have less penetration compare to sand and silt, the ground water recharge occurs highly n sand and silt is shown in *Fig 7*.

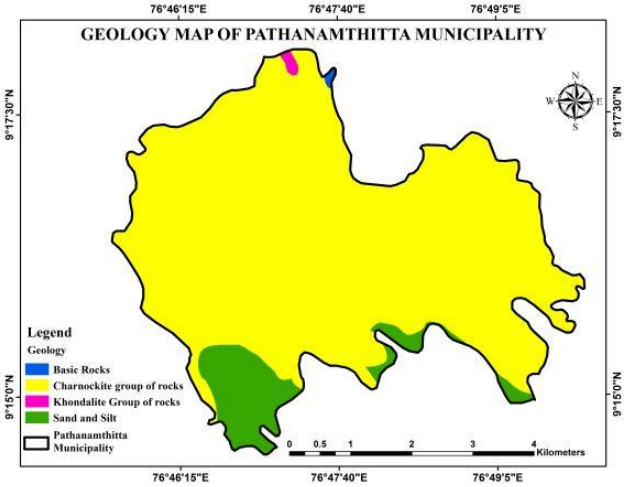

Fig 7. Geology Map

C. Drainage density and lineament density

Drainage density, Dd, shown in *Fig 8* is a useful quantitative measure of degree of landscape dissection, runoff and infiltration capacity of surface cover, vegetation cover and climatic conditions. Dd is defined as the total length of streams of all orders per unit drainage area (km/km2) and is a measure of proximity of channels. In the Pathanamthitta municipality the drainage density is classified into 5 categories ie, 0-17.43, 17.43-34.86, 34.86-52.30, 52.30- 69.73, 69.73-87.16. Higher rating is assigned to areas of very low Dd, whereas areas of higher Dd are assigned low rating considering aspect of recharge Areas having high density are not suitable for GW prospect because of the greater surface runoff. The extreme upstream part of the study area shows a high drainage density. Similarly, lineament density shown in *Fig 9* of a terrain is an indirect signature of the GW prospect, as the lineaments usually denote permeability. Areas of high lineament density go with good aquifers. The highest lineament density, 8.24 occurs only on an area of 1.2123 km2 in Pathanamthitta Muncipality, while the lowest of 1.65 on the area 22.7979 km2.

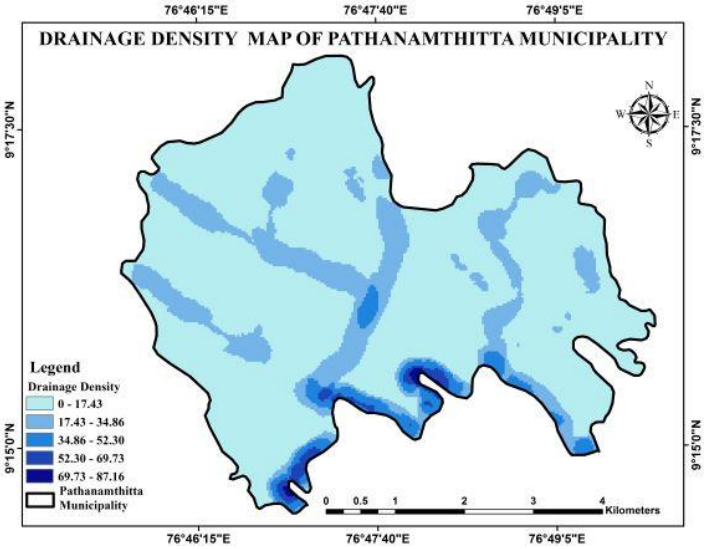

Fig 8. Drainage Density Map

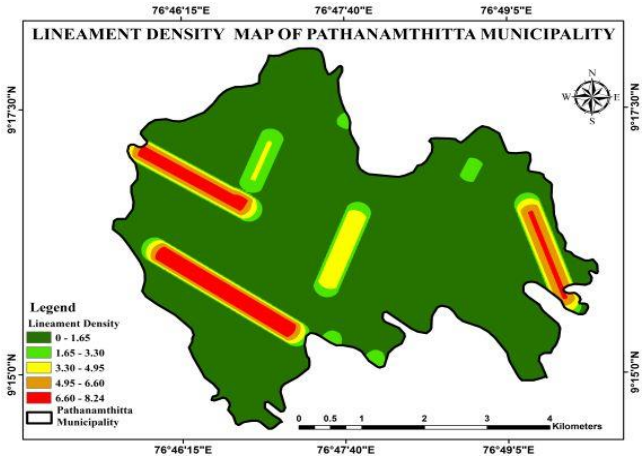

Fig 9. Lineament Density Map

D. Soil

The chief soil types of Pathanamthitta Muncipality are clay and gravelly soil. Water penetrates highly through the gravelly soil which is about 26.2053 sq.km. Ranking of the oil is assigned based on the infiltration rate which is shown in *Fig 10*.

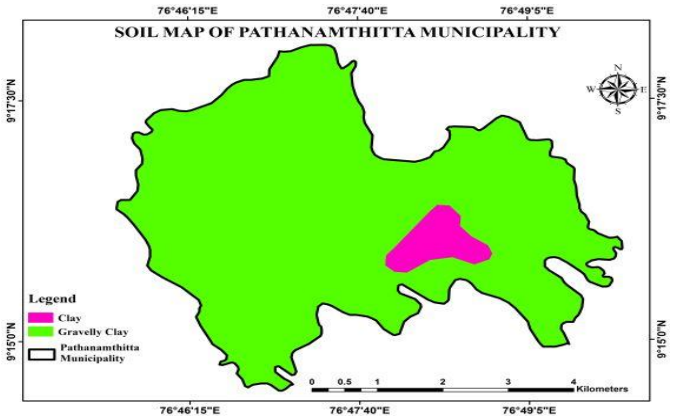

Fig 10 Soil Map

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 07, July-2021

E. Slope

Cartosat-1 high-resolution stereo data are used to extract DEM and slope map shown in *Fig 11* of the Pathanamthitta Muncipality. In the study area the slope is lower for about 12. 336 sq.km which has the highest ground water potential. Almost 45.15% is of low sloped area. Highest slope is 35-70% which is covered by 4.50 sq.km area where the infiltration rate is very low.

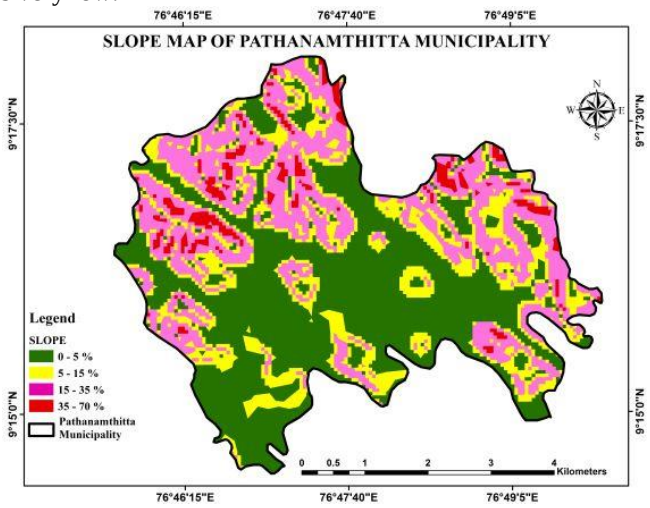

Fig 11 Slope Map

F. Land use/land cover

Land use/land cover (LULC) shown in *Fig 12*, classes of Pathanamthitta municipality is derived from interpretation of IRS-1D (LISS III) satellite imagery, primarily include built up land, waste land, agricultural land, waterbodies. The LULC data, important indicators of the extent of groundwater requirement and groundwater utilization are a proxy of infiltration and runoff characteristics. Here it is an important parameter in the assessment of ground water potential zone. Agricultural land is more in Pathanamthitta municipality which is about 15.3657 sq.km and covers an area of about 56.25%. The infiltration rate is also higher in the water bodies and agricultural land. The lowest penetration occurs in the built up land. But almost 11.03 sq.km is covered by the built up land.

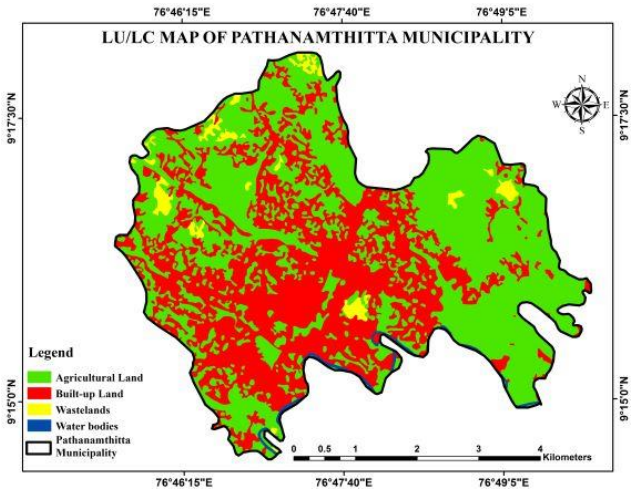

Fig 12 Land use/Land cover Map

G. Demarcation of groundwater prospect zones

A systematic analysis using ANP on weighted parameters produced a useful groundwater prospect (GWP) zone map in raster format using overlay tools in spatial analyst extension in ArcGIS platform. In Pathanamthitta municipality, the GWP group under good, moderate and poor is determined by their physical makeup to store GW. From the figure it is clear that the good zone is located all around the municipality with a low area of about 1.6605 sq.km. The moderate area is covered by 21.4353 sq.km area and the poor zone is covered by an area of 4.2210 sq.km is shown in *Fig 13.*

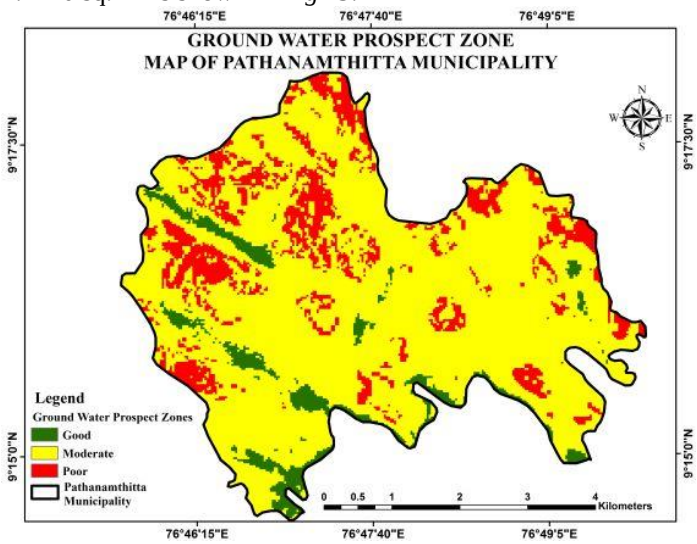

Fig 13. Ground Water Potential Zone Map

IX. CONCLUSION

Water level data from open wells in the 32 different wards of the Pathanamthitta Municipality were collected during the months of December and April. Using these two sets of readings, two different water table contour maps were created. From these data, it was found that Valamchuzhy, ward number 24 has the highest ground water level and Anappara, ward number 13 has the lowest ground water level using the QGIS software. Based on the two water table contour map, the ground water level fluctuation maps were created using inverse distance weighted interpolation technique. Then overlay analysis was carried out to find out the various ground water potential zones. It was done by using seven different thematic layers of the area and their features. It was found that absent 90% of the households in the area have private wells. From the geomorphology map, it was identified that the potential zones are near the waterbodies (0.28 sq.km). From the slope map, it is identified that in areas having slope 0-5%, water penetration is very high that is, about 12.33 sq.km of area. From the geology map, it is clear that sand and silt (2.2 sq.km area) contributes the most ground water recharge. In areas with lineament density range 6.60-8.24(1.21 sq.km) area, water penetration is much higher due to the more no. of cracks present, this clear from the lineament density map. In areas with low drainage density, run off will be less and penetration will be high. In the drainage density map, the areas with drainage density 0-17.43 range (0.05 sq.km) have higher

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 07, July-2021

rate of penetration. From the land use and land cover map, it is also found that about 56.25% of the total municipality area is agricultural land. Also gravelly clay is the most commonly found soil in the area (26.29 sq.km) From the ground water potential zone map, the various ground water potential zones can be identified as good potential zone (6.08% of total area), moderate potential zones (78.47% of total area) and poor potential zones (15.45% of total area). Altogether the various ground water level maps are created for the area and geo-hydrological studies have been conducted.

REFERENCES

[1] Saleem A, Dandigi M. N(2011), Groundwater quality mapping using GIS ; a case study of Gulbarga city Karnataka India , African journal of environmental science and technology.

[2] T. V. Swetha, Girish Gopinath, K. P. Thrivikramji, N. P. Jesiya (2017) : Geospatial and MCDM tool mix for identification of potential groundwater prospects in a tropical river basin, Kerala, Springer

[3] T. Subramani, S. Mathilagan(2018), Construction of water table contour map and geo hydrological studies on Krishnagiri using GIS techniques, International journal of engineering and technology.

[4] Mungase Avinash M(2018), Monitoring and GIS mapping of ground water level, Nategaon area, kopargaon, International Journal of Advance Engineering and Research Development.

[5] O.A.Adeyeye(2018), GIS-based groundwater potential mapping with Dengi area, North Central Nigeria, Elsevier

[6] T. Subramani, G. Kaliappan(2016), Water table contour for salem district tamilnadu using gis, International journal of engineering trends and technology in computer science (IJETTCS).

[7] Saleem A, Dandigi M.N(2013), Monitoring and gis mapping of groundwater level Variations in gulbarga city, International Journal of Research in Engineering and Technology

[8] T. Subramani, S. Krishnan, P.K Kumaresan(2012), Study of ground water quality with GIS application for Coonoor taluk in Nilgiri district, International journal of modern engineering research(IJMER).