



(RESEARCH ARTICLE)



## Evaluation of groundwater status in Thekkumkara Grama Panchayat, Thrissur District, Kerala, India: A geospatial approach

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### Abstract

A study has been carried out in Thekkumkara Grama Panchayat of the Thrissur District, Kerala, India, to understand the groundwater status of the area. All hydrogeological information like the principal hydro geological units and their distribution, recharge and discharge areas, sources of water in different regimes, water level fluctuations in a given area over time, water potential, etc, have been collected and analysed to evaluate the groundwater development prospects in the study area. Physiographically, Thekkumkara Grama Panchayat is situated in the highland region. Geologically, the study area is characterised by Charnokites and Migmatites of Precambrian age, covered by Laterites and Lateritic soil. 60 dug wells were observed in the study area and the depth of these wells range between 3.14 to 9.92 m below ground level. Through integrated GIS analysis, it is estimated that about 36% of the study area comes under the very high to high category in terms of groundwater potential. The net annual groundwater availability in Thekkumkara Grama Panchayat is estimated as 8.69 MCM and the total annual groundwater draft for domestic as well as irrigation purposes is estimated as 1.87 MCM. The draft is only 22% of the annual available groundwater in the Thekkumkara Grama Panchayat. The agricultural operations are mainly rain fed and there are no major water consuming industries. For future groundwater development, the area can be categorized as 'Safe' based on the present level of groundwater utilization.

**Keywords:** Groundwater; Geospatial Information; Thekkumkara Grama Panchayat; GIS

### 1. Introduction

Groundwater development is less expensive compared to surface water schemes, especially for small scale consumptions like domestic or industrial. The first step in the development, conservation and optimum management of groundwater resources is a regional appraisal of the hydrogeologic condition. Drainage basins or watersheds should be the unit of study area for the better understanding of the hydrologic system and for accurate quantitative estimation of the resources [1, 2, 3]. However for implementation of any natural resources projects, the unit of focus has to be an administrative unit. It is in this context this study has been carried out within a Grama Panchayat to evaluate the current status of groundwater development, utilization pattern, groundwater draft, etc., and to determine the future prospects of groundwater development. The study has been carried out in the Thekkumkara Grama Panchayat, which falls within Thrissur District of Kerala State, India, and represents the humid tropics.

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## 2. Material and methods

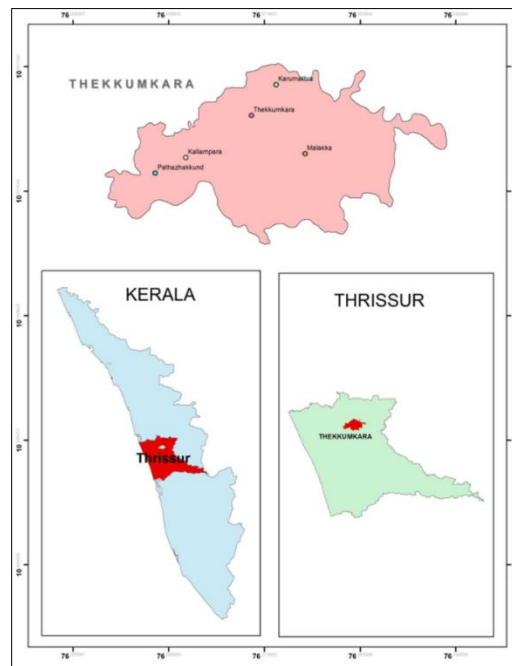
Topographic and drainage maps were prepared using toposheets of 1:50,000 scale to understand the morphometric characteristics of the Thekkumkara Grama Panchayat. Hydrogeological investigation was made to know the general groundwater occurrence, depth to water level, pattern of groundwater level fluctuation, etc. Well census was carried out in the area, to know the type of extraction structures, density of wells, persons / well, usage purpose, etc. All the available secondary data on rainfall, surface and sub-surface geology, hydrogeology, etc. were collected from various published reports and agencies. All this information has been analysed to evaluate the groundwater development prospects in the study area.

## 3. Results and discussion

### 3.1. Study Area: General Characteristics

The Study area is Thekkumkara Grama Panchayat, located in the Thalappilly Taluk of Thrissur district, Kerala. This area lies between  $76^{\circ}13'10''$  E -  $76^{\circ}19'55''$  E Longitudes and  $10^{\circ}35'30''$  N -  $10^{\circ}39'15''$  N Latitudes (Figure 1). The Thekkumkara Grama Panchayat has about 55.20 square kilometers area and 18 wards. The Grama Panchayat consisting of the villages, namely, Thekkumkara, Manalithara, Karumathra, Viruppakka, and Punnamparamb. The Panchayat is bounded by Wadakkanchery Municipality at west, Mullurkkara Grama Panchayat at North, Mulankunnathkavu, and Madakkathara Grama Panchayats at South. The population of Thekkumkara Grama Panchayat is about 29516 as per 2011 census.

Physiographically, the Thekkumkara Grama Panchayat falls in the midland (8 to 75m above MSL) and highland (>75 m above MSL) region of Kerala State. Groundwater occurrence and movement is controlled by the lithology and geometry of the geological units. The Thekkumkara Grama Panchayat falls within the Midland region of Thrissur District of Kerala State. Geologically the area is characterized by Charnokites and Migmatites of Precambrian age and are mostly covered by Laterites and Lateritic soil [3, 4]. Charnockite is one of the important rock types in the area and covers about 80% of the Grama Panchayat. Geomorphologically, the study area is mainly divided into four, Pedi plain, Piedmont zone, Denudational Hills and Denudational Structural Hills. Piedmont zone occupies major portion of the study area.



**Figure 1** Location of the Study Area

Landuse describes how a parcel of land is used for agriculture, settlements or industry, Whereas Land cover refers to the material such as vegetation, rocks or water bodies, which are Present on the surface [5]. Based on ground truth verification, the landuse of the study area has been classified. Major portion of the Panchayat is characterized by agricultural land. Major landuse of the Thekkumkara Grama Panchayat is mixed crops with coconut dominant

cultivation practices. Around 25% of the area is Forest, and about 10% of the area is water bodies, mainly of reservoirs. Built up land is there in a small fraction of the total area.

In groundwater prospecting, the least weight is given to steep slopes whereas more weight is given to gentle slopes since slope plays a significant role in infiltration versus runoff [3, 6]. The area with less than 20% slope is covering about 85% of the Thekkumkara Grama Panchayat. As infiltration is inversely related to slope; a break in the slope (i.e., steep slope followed by gentler slope) promotes appreciable groundwater infiltration. According to the groundwater Estimation Methodology [7,8], areas having ground slope greater than 20% need not be considered as areas suitable for groundwater recharge. 85% of the entire area within this Panchayat is suitable for groundwater recharge measures.

### 3.2. Groundwater Status of the Study Area

The occurrence and movement of groundwater is controlled by several factors such as climate, hydrology, geology, ecology and soil distribution and out of which hydrogeological conditions plays a crucial role [3, 6, 9]. A total of 60 wells were surveyed and documented for the study. The depth to water level is found that varying from 3.14 m to 9.92 m below ground level (bgl) during Pre-monsoon season. The average water level in the study area is 4.85 m bgl. In the study area, groundwater occurs predominantly under phreatic condition in sedimentary, weathered and fractured rocks. In deep seated fractured rocks, groundwater occurs under phreatic, semi-confined or confined condition. The depth of these dug wells range between 3.14 m bgl to 9.92 m bgl in Thekkumkara Grama Panchayat, and it varies depending on the topography. Most of the dug wells are also used for irrigation purposes and the quality of groundwater is reported to be potable. The spatial variation of groundwater levels below ground level during this study in the Thekkumkara Grama Panchayat has been analysed in the Geographical Information System (GIS) software by employing the inverse distance weighted (IDW) method (Figure 2).

Groundwater is also extracted from the hard rock, which are fractured at deeper horizons. Ground water occurs under phreatic, semi confined or confined conditions depending on the thickness and permeability of the overlying lithomarge clay formation.

### 3.3. Groundwater Availability

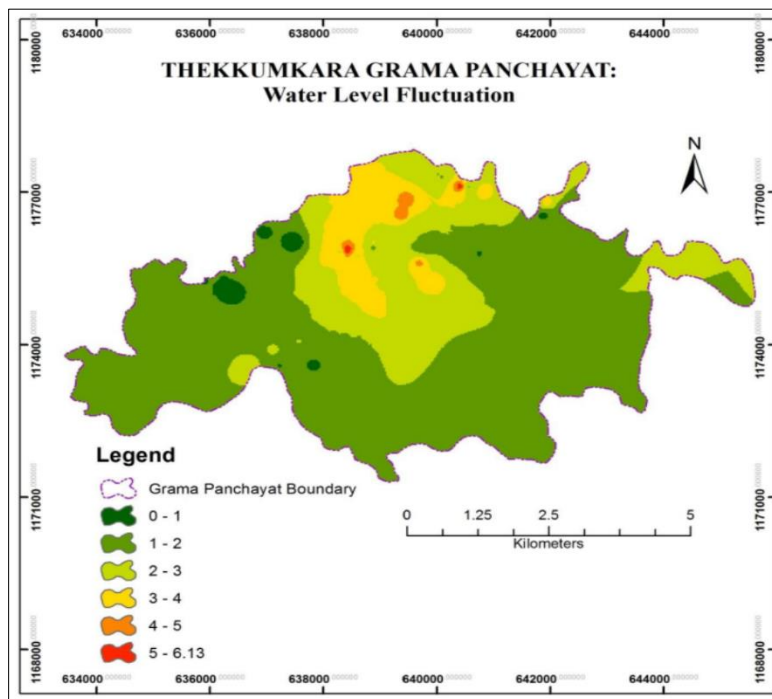


Figure 2 Water level fluctuation in the Study Area.

The effective area for recharge has been considered as 47.20 sq.km. Ground water estimation methodologies of central groundwater board [7, 8] have recommended a maximum rainfall infiltration factor of 7% for the similar formations seen in Thekkumkara Grama Panchayat. Considering the average annual rainfall of 2924 mm, the annual groundwater recharge in this Grama Panchayath will be 9.66 MCM (Million Cubic Meters). Considering 10% of this annual recharge

as unaccounted losses due to natural discharge, etc., as recommended by GEC, the net annual groundwater availability is 8.69 MCM.

### **3.4. Groundwater utilization**

The representative well census done by CWRDM in the different physiographic zones of Kerala, was used for the calculations [6, 9, 10, 11, 12, 13, 14]. 60 dug wells were selected in the study area and almost all the families having its own well. The depth of these wells range between 3.14 to 9.92 m below ground level depending on the ground elevation. The diameter of the dug wells varies from 1.01 m to 3.64m, with majority of the wells having less than 3m diameter. These open wells are mostly constructed in lateritic formations. The height of this lining of well wall is depended on the thickness, stability of the overburden, such as soil, lithomarge clay and weathered rock.

The density of dug wells in the study area can be estimated as 220 wells/sq.km as per several studies done by CWRDM in similar regions of Kerala as per physiography [6, 9, 10, 11, 12, 13, 14]. All the dug wells are used for domestic purposes only. The use of these wells for irrigation is limited to home orchards. Ground water withdrawal from the wells is made using pulley with rope and bucket or by using energized pump. Out of 60 dug wells, all wells are fitted with pulley and 57 wells are also fitted with energized pump for water extraction.

No major problem has been reported during the well census. However, water quality problems due to the manmade causes such as wells very close to leach pit/septic tank, washing of cloths near the wells, disposal of waste, etc., does exist. The overall ground water quality is good.

Based on the results of the well inventory, the ground water draft for different purposes has been estimated. Considering an average of 5 persons / well using 100 liters of water per day throughout the year, the total ground water draft per well will be about 180m<sup>3</sup>/ year. Thus, the total ground water draft from the wells, used exclusively for domestic purpose in 1 sq.km area is 0.0396 MCM/year. Irrigational use of groundwater in the area is almost zero and thus the total draft of groundwater from the 47.20 km<sup>2</sup> area of the Thekkumkara Grama Panchayat is 1.87 MCM annually.

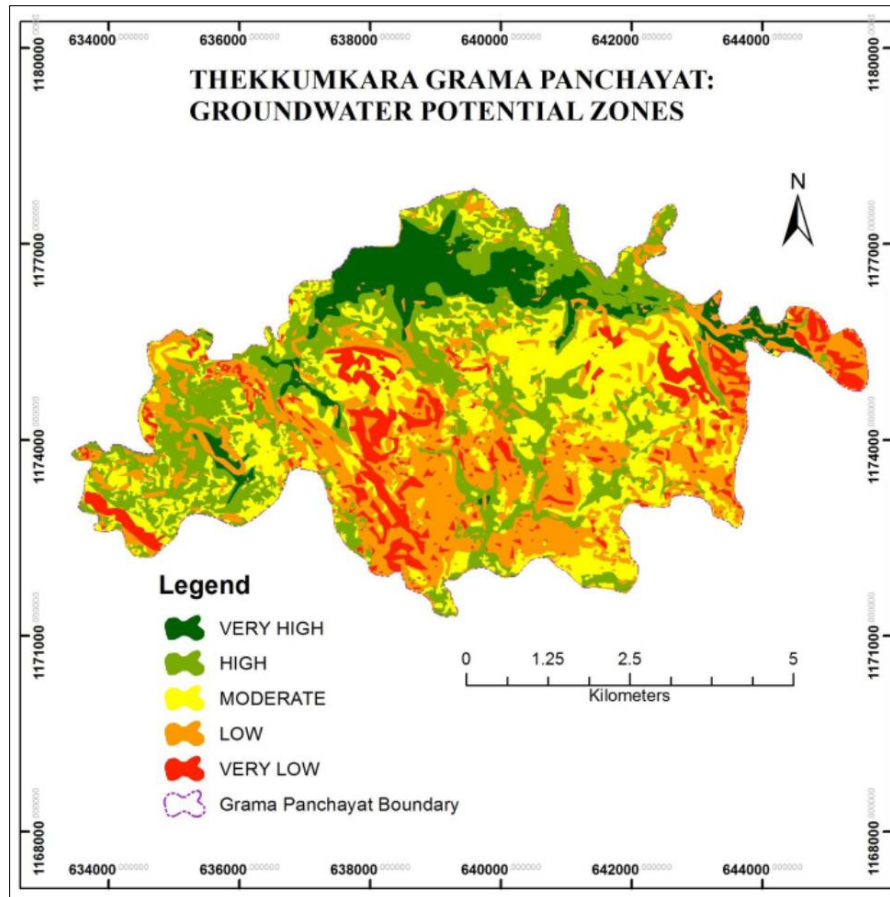
### **3.5. Status of Groundwater Development**

The net annual groundwater availability is estimated at 8.69 MCM and the total annual groundwater draft for domestic as well as irrigation purposes is estimated at 1.87 MCM. This draft is only 22% of the annual available groundwater in Thekkumkara Grama Panchayat. There are no industries in the study area with groundwater utilization and the agricultural operation is mainly rain fed. Considering the present level of ground water utilization, the Thekkumkara Grama Panchayat can be categorized as “SAFE” for future groundwater development activities.

### **3.6. Groundwater Potential**

Integrating all the gathered information such as geology, geomorphology, drainage, slope, lineaments, aquifer parameters, ground water level fluctuation and saturated thickness, the Thekkumkara Grama Panchayat has been classified into different groundwater potential zones viz VERY HIGH, HIGH, MODERATE, LOW and VERY LOW using overlay analysis tools in Geographical Information System. This can form the base map for the concerned authorities to take necessary decisions as well as actions for the future groundwater development in this basin (Figure 3).

Valley fills, pediments and moderately dissected plateaus of the basin are found favorable geomorphic units for groundwater exploration and development, whereas structural hills, residual hills, residual mounds, and linear ridges are poor groundwater potential zones. Through this integrated hydrogeological study, the northern portion of the Thekkumkara Grama Panchayat is categorised as very high to high groundwater potential zones whereas the Southern and Western portions of the basin is categorized as poor to moderate groundwater potential zones. It is estimated that about 36% of the Thekkumkara Grama Panchayat comes under the very high to high category in terms of groundwater potential. 26% of the area comes under the moderate potential category and the remaining area belongs to low and very low categories in terms of groundwater potential.



**Figure 3** Groundwater Potential Zones of the Study Area

#### 4. Conclusion

The Thekkumkara Grama Panchayat is a typical representation of highland region of Kerala State. Groundwater is the main source of drinking water and dug well is the main groundwater extraction structure in this Grama Panchayat. 60 dug wells were observed in the study area and the depth of these wells range between 3.14 to 9.92 m below ground level. Through integrated GIS analysis, it is estimated that about 36% of the study area comes under the very high to high category in terms of groundwater potential. The net annual groundwater availability is estimated as 8.29 MCM and the total annual groundwater draft is estimated as 2.65 MCM. This draft is only 22% of the annual available groundwater in this Grama Panchayat. There are no industries in the study area and the agricultural operations are mainly rain fed. Considering the present level of ground water utilization, the Thekkumkara Grama Panchayat can be categorized as "SAFE" for future groundwater developmental activities.

#### Compliance with ethical standards

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##### *Disclosure of conflict of interest*

No conflict of interest is associated with this work.

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