TECHNICAL REPORTS: SERIES 'D'

CONSERVE WATER – SAVE LIFE

भारत सरकार

GOVERNMENT OF INDIA

जल संसाधन मंत्रालय

MINISTRY OF WATER RESOURCES

केंद्रीय भूजल बोर्ड

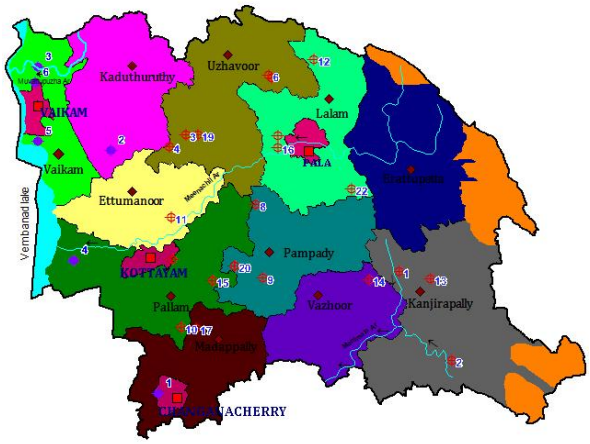
CENTRAL GROUND WATER BOARD

केरल क्षेत्र

KERALA REGION

भूजल सूचना पुस्तिका, कोट्टयम जिल्ला, केरल राज्य

GROUND WATER INFORMATION BOOKLET OF KOTTAYAM DISTRICT, KERALA STATE



तिरुवनंतपुरम

Thiruvananthapuram

December 2013

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

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GROUND WATER INFORMATION BOOKLET OF KOTTAYAM DISTRICT KERALA STATE

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DISTRICT AT A GLANCE

Sl. No.	ITEMS	STATISTICS
1.	**GENERAL INFORMATION**	
	i) Geographical area (Sq km)	2204.42
	ii) Administrative Divisions (As on 31-03-2011) Number of Tehsils/Blocks Number of Panchayats/Villages	 5 / 11 75 / 95
	iii) Population (As in 2011)	1979384
	iv) Average annual Rainfall (in mm)	3169.28
2.	**GEOMORPHOLOGY**	
	Major physiographic units	Lowland, Midland and Highland
	Major Drainages	Meenachil , Muvattupuzha and Manimala Rivers,
3.	**LAND USE (ha) as in 2009**	
	a) Forest area	8141
	b) Net area sown	166866
	c) Cultivable area	23003
4.	**MAJOR SOIL TYPES**	Laterite, Brown hydromorphic, river alluvium and Forest Loamy soil
5.	**AREA UNDER PRINCIPAL CROPS (ha) (2009-10)**	Paddy - 10969 Coconut - 35226 Rubber - 112035 Tapioca - 6027 Coffee - 1700
6.	**IRRIGATION BY DIFFERENT SOURCES(ha)(2009-10) (Areas and Number of Structures)**	
	Wells (Dug wells)	1958 / 79150
	Wells (Tube wells & Bore wells)	3/1250
	Tanks / Ponds	187
	Canals	768
	Other Sources	13874
	Net Irrigated area	16087
7.	**NUMBER OF GROUNDWATER MONITORING WELLS OF CGWB (AS IN 31-3-2011)**	
	No. of Dug wells No. of Piezometers	50 11
8	**PREDOMINANT GEOLOGICAL FORMATIONS**	Archaean Crystalline formation and (Gneiss, Schist, Charnockite) Tertiary sedimentary formation, Sub-Recent laterite and Recent riverine Alluvium.

9.	**HYDROGEOLOGY** Major Water bearing formations	Weathered fractured crystalline formations; semi consolidated Tertiary formations, laterites and Recent alluvium.
	Average Depth to water level (Pre-monsoon, 2002- 2011)	1.22 to 13.57 m.bgl.
	Average Depth to water level (Post-monsoon,2002- 2011)	0.91 to 11.22 m.bgl.
	Long term water level trend in 10 years (2001-2010) in m/yr	
	Pre monsoon	Rise 0.0081 to 0.4245 Fall 0.0027 to 0.2736
	Post monsoon	Rise 0.0004 to 0.2286 Fall 0.0003 to 0.1842
10.	**GROUND WATER EXPLORATION BY CGWB (As in 31-03-2011)**	
	No. of wells drilled (EW, OW, PZ, SH, Total)	EW – 16, PZ –11, Total – 26
	Depth Range (m)	Sedi. 35-169, Hard. 139.01-215.80
	Discharge (litres per second)	Sedi. 1.8 to 15.33 Hard 1.2 to 21.70
	Storativity(S)	2.9×10^{-3} (hard rock)
	Transmissivity (m^2/day)	0.48 to 104.8 (hard rock)
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limits(e.g. EC, F, As, Fe)	In general groundwater quality is good. Major chemical constituents are within the permissible limits.
12.	**DYNAMIC GROUNDWATER RESOURCES (2009) – in MCM**	
	Annual Replenishable Ground Water Resources	473.16
	Net Annual Groundwater Draft	125.97
	Projected demand for Domestic and Industrial Uses up to 2025/ 2029	107.4
	Stage of Ground Water Development	26.62 %
13.	**AWARENESS AND TRAINING ACTIVITY** Mass Awareness Programmes organized Date Place No. of Participants	 One December 2003 Kottayam 500
	Water Management Training Programmes organized Date Place No. of Participants	Nil

14.	**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**	
	Projects completed by CGWB	3 Numbers. i) Neezhur in (2000)Subsurface Dyke ii) Parinthanam in (2001) RTRWH iii) Chirakulam (2001) Percolation tank
	Projects under technical guidance of CGWB (Numbers)	Nil
15.	**GROUND WATER CONTROL AND REGULATION**	
	Number of Over Exploited blocks	Nil
	Number of Critical blocks	Nil
	Number of blocks notified	Nil
16.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	No severe problems noticed. Except water scarcity in high range area during summer

GROUND WATER INFORMATION BOOKLET OF KOTTAYAM DISTRICT KERALA STATE

1.0 INTRODUCTION

The Kottayam district is popularly known as land of latex and letters. This is one of the leading places in the country for production of rubber and most of the Malayalam dailies and weekly magazines are published from here only. Kottayam is the first town to acquire cent percent literacy in the State and first English school in the State was started here. The district is famous for the largest inland water body in the State i.e., Vembanad lake.

1.1 Administration

The Kottayam district is divided into two revenue divisions viz. Kottayam and Pala. There are five taluks in the district viz Kottayam, Changanacherry, Vaikom, Meenachil and Kanjirapally. There are four municipalities Kottayam, Changanacherry, Pala and Vaikom and 11 blocks namely Madapally, Pallom, Ettumanoor, Kaduthuruthy, Vaikom, Uzhavoor, Lalam, Erattupetta, Kanjirapally, Vazhoor and Pampady (**Figure 1**). The total number of grama panchayats and revenue villages are 75 and 95 respectively.

In 2011, Kottayam had population of 1,979,384 of which male and female were 970,140 and 1,009,244 respectively. There was change of 1.32 percent in the population compared to population as per 2001. The total population living in rural area is 1,413,773 and urban area is 565,611 and indicates that the people living in rural population is 71.42 %. The density of the population is 896 per sq.km.

1.2 Drainage and Irrigation practices

The major rivers in the district are the Meenachil River, the Muvathupuzha River and the Manimala River. The Meenachil River flows through Meenachil, Vaikom and Kottayam taluks. The total catchment area of Meenachil River is 1272 sq km and is formed by several streams originating from the Western Ghats in Idukki district. The Poonjar river join at Erratupetta, the Chittar River join at Kondur and the Payapparathodu join at Lalam. Finally the river confluences with Vembanad Lake.

The Muvattupuzha River originates from Idduki district flowing mostly through vaikom taluk and joins with Vembanad Lake. The Manimala river flows through Kanjirapally and

Chanaganacherry taluks. The Chittar joins it on its course further down the west as it flow towards Alappuzha district.

There is no major irrigation projects in this district, however, the Meenachil medium irrigation project is having a net ayacut of 9960 hectares and a catchment area of 155 sq .km. The minor irrigation is by tanks, dug wells and bore wells etc.

1.3 Works carried out by CGWB

A number of scientific studies have been carried out by various scientific agencies in this district. Central Ground Water Board has carried out systematic hydrogeological survey in the district during 1976-77 and 1978-79. The detailed groundwater balance studies were carried out during 1983-88 by SIDA assisted Coastal Kerala Ground Water Project (CKGWP). The ground water exploration studies were carried out in western portion of district particularly at Kallara, Pyarattubhagm, Udayanapuram and Kuleseakaramangalam during the CKGWP project and ten numbers of bore well were drilled in the hard rock formation. The reappraisal hydrogeological studies were carried out in several phases and the recent study was carried out during 1996-97 and 2005-2006.

2.0 RAINFALL & CLIMATE

The normal rainfall of the district is 2931 mm based on 1901-1999 data and the major contribution of rainfall is during South West monsoon followed by the North East monsoon. The analysis of rainfall data reveals that the distribution of rainfall increases from west to east. The highest rainfall recorded at Pala while the lowest recorded at Ettumanur. The annual rainfall ranges from 2435.9 to 3755.2 mm and the average annual rainfall of the district is 3169.28 mm.

In general the district has wet type of climate and four seasons are seen in this district. The hot summer season from March to May, the South West monsoon season from June to September, the North East monsoon season from October to December and cool climate prevails during January and February. The South West monsoon contributing nearly 59 % of the total rainfall and 21 % from North East monsoon. The monthly rainfall data from 2006-2010 is given in **Table 1**.

Table 1: Rainfall data of Kottayam district in mm

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2006	15.1	0	114.7	200.5	553.4	525.1	605.1	407.8	453.3	509.8	367.8	2.6	**3755.2**
2007	0	24	6	245.4	250	637.2	921.1	326.4	521.6	378.9	147.9	9.5	**3468**
2008	0	49.4	235.7	202.8	50.4	341.6	555.4	268.6	370.5	284	103.8	53.6	2515.8
2009	7.5	1.8	78.6	69.9	204.9	460	553.1	225.6	280.8	188.6	278.7	86.4	2435.9
2010	9.6	1.4	96.7	201.5	354.1	664.7	568.9	294.4	366.9	559.4	456	97.9	**3671.5**

The normal monthly rainfall in mm is given below.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Normal	13	25	39	179	242	625	622	380	271	317	177	41	2931

The five years rainfall data analysis indicates that during 2006, 2007, 2010 the rainfall was above the normal rainfall.

Meteorological Parameters

Temperature

The temperature is more during the months of March to May and less during November, December and January. The maximum temperature ranges from 23.8°C to 26.0°C. The average annual maximum temperature is 29.8°C and the minimum temperature is 24.4°C. The average mean monthly maximum temperature ranges from 29.2 to 33.4^{0}C and minimum temperature ranges from 19.7 to 25°C.

Relative Humidity

The relative humidity is generally high, during the morning hours it goes up to 79 % and during evening hours it is around 76%.

Wind

The general direction of wind is from east to north east during morning hours and west to northwest direction during evening hours. The wind speed ranges from 6.7 to 10.9 km/h.

Potential Evapotranspiration (PET)

The annual Potential Evapotranspiration is 1424.1 mm based on Penman's method at Cochin meteorological station which is close to the district boundary. In general Potential Evapotranspiration is less during April to November while compared to the other months

and hence possibilities of recharge are more during these months. The monthly Potential Evapotranspiration ranges from 119.3 to 177.0 mm.

3.0 GEOMORPHOLOGY AND SOIL TYPES

The district is divided into three well defined physiographical units namely lowland, midland and high land. The lowland is the area with an elevation of less than 7.5 m amsl which covers around 398.4 sq km and midland area having an elevation of 7.5 to 75 m amsl covers around 1287.75 sq km and the highland area with an elevation of more than 75 m amsl covers around 508.8 sq km and are mainly found in the eastern part of the district. The low lands are seen along the western portion of Vaikom, Changanassery and Kottayam taluks where as the Meenachil and Kanjirapally taluks fall in the highlands. Major part of Kottayam, Changanassery and Vaikom taluks fall in the midland region. Around upper Kuttanad (part of Changanassery taluk) particularly Pallom, Ettumanoor and Kaduthuruthy the ground elevation is generally 1 to 1.5 m below mean sea level. The maximum elevation is 1193 m amsl at Kursimudi.

Soils

The soil types occurring in Kottayam district can be broadly grouped into four types on the basis of their physico-chemical properties and morphological features. They are (a) Lateritic soil. (b) Riverine alluvium, (c) Brown hydromorphic, and (d) Forest loams.

a) The lateritic soil

The lateritic soil is the pre-dominant soil type, which covers almost the entire midland areas of the Katya district. The surface soil is mostly reddish brown to yellowish red in colour and the texture ranges from gravelly loam to gravelly clay loam. Heavy rainfall and high temperature prevalent in the area are conducive to the process of formation of this soil type. It is well drained and the presence of organic content is low. This soil is poor in nitrogen, phosphorous and potassium. It is acidic in nature with a pH value ranging from 5.0 to 6.2.

b) Riverine alluvium

The occurrence of these soils is restricted along the river courses and their tributaries. They show wide variation in their physico-chemical properties depending on the nature of the alluvium that is deposited and the characteristics of the catchments area drained by the river. They are very deep soils with surface textures ranging from sandy loam to clay loam. These

soils are characterised by moderate amount of organic matter, nitrogen and potassium. Presence of mica flakes has been observed in the alluvial soils.

c) Brown hydromorphic soil

These soils are mostly confined to valley bottoms between undulating topography in the midland and in low-lying areas. They have been formed as a result of transportation and sedimentation of material from adjoining hill slopes and also through deposition by local streams. These soils are very deep and brownish in colour and exhibiting wide variation in physico-chemical properties and morphological features. The surface soil texture varies from sandy loam to clay. Their pH value ranges between 5.2 and 6.4 and are acidic in nature.

d) Forest loam

These soils are the products of weathering of crystalline rocks under forest cover. They are occurring in the eastern hilly areas. These are dark reddish brown to black in colour. The surface texture varies from loam to silt loam. They are characterised by a surface layer very rich in organic matter. Generally they are acidic, rich in nitrogen and their pH ranging from 5.5 to 6.3.

4.0 GROUND WATER SCENARIO

Groundwater occurs under water table conditions in alluvium, laterites and weathered mantle of the crystalline rocks whereas in the deep fractured crystalline rocks the groundwater occurs under semi confined to confined conditions.

Weathered crystalline (Shallow Aquifers)

The shallow aquifer consists of weathered crystalline and highly fractured crystalline rocks which occur immediately below the weathered zone. The depth of these zones is restricted within 8 to 15 m bgl. The movement of groundwater is through existing joints and fractures and it follows the topographical slopes. The depth of the well in this formation is 5 to 12.0 m bgl and yield of dug wells ranges from 2 to 9 m^3 per day.

Fractured crystalline (Deeper Aquifers)

The exploratory drilling carried out by Central Ground Water Board reveals that the deep potential fractured aquifers are yielding good amount of water.

The drilling details indicate that the occurrences of potential fractured zones are up to 112 m bgl. The yield of bore wells in deeper aquifers goes up to 20 lps (72, 000 lph) at some places.

The analysis of drilling data in this district supports the tectonic model developed during Coastal Kerala Ground Water Projects by Central Ground Water Board that the East West lineaments are more productive followed by NE-SW, NNW-SSE and NW-SE. The pump test conducted in the bore wells indicate that the aquifers in this area are confined and semi confined aquifers. The transmissivity ranges from 0.48 to 104.8 m^2/day and storativity is 2.98 x 10^{-3}. The exploratory wells drilled in hard rock area of Kottayam district is given in **Annexure 1a.**

The Tertiary Sediments (Vaikom Beds)

Ground water occurs under phreatic condition in the shallow zone and confined condition in the deeper zones. The Vaikom beds are exposed in the western part of the district which overlie the crystalline basements. These formations are made up of course to very course sands, gravel and pebble beds with alternating clay layers. Ground water is developed by dug wells tapping the Vaikom beds and the water level in these formation ranges from less than a meter to 15.0 m bgl. The deeper water levels are seen in and around Kurichi area of Kottayam town. Six exploratory wells were drilled tapping the sedimentary formation in the district. The formation water in all the bore holes except Udayanapuram was found to be brackish on electric logging. The exploratory wells drilled in sedimentary area are given in **Annexure 1b**.

Laterites

Laterite form potential aquifers along valleys and topographic lows where the saturated zone is more and can sustain large diameter open wells for irrigation and other purposes. In general the laterites are seen in the midland region of the district and the average thickness varies from few meters to 16 meters. The depth of wells in this formation range from 3.5 to 15.0 m. The yield of the wells in this formation range from 0.5 to 6.0 m^3/day. The annual water level fluctuation in laterite ranges from 0.6 to 5.0 m. The laterite formation occurring along hill tops and slopes get de-saturated on the onset of summer and water scarcity is experienced during summer months.

Alluvium

This is one of the most potential shallow aquifers and is extensively developed by dug wells for domestic and irrigation needs. The Recent alluvial formation includes river alluvium, and valley fills are also seen along the river courses and valleys. The deposits are mostly

flood plain of Kuttanad area which is consisting of black clay, fine to medium grained sand and silt sands. The depth to water level in this formation ranges from a few centimetres to 2.0 m during post monsoon (April) period. The seasonal water level fluctuation in the formation ranges from 0.75 to 3.5m. The yield of the wells in these formations ranges from 5 to 20 m^3/day.

Depth to Water level

The average depth to water level in pre-monsoon period ranges from 1.22 to 13.57 m bgl and in post-monsoon period ranges from 0.91 to 11.22 m bgl. In general the water level is shallow during both monsoons particularly in valleys and topographically low land areas. The ground water monitoring well data shows that nearly half of the wells (48 %) indicate fall in water level in the range of 5.00 to 10. 0 m bgl and 36 % of the wells indicate fall in water level in the range of 2-5 m bgl during pre-monsoon period. The post monsoon data reveals that monitoring wells are equally distributed in different depth categories like 0-2 and 5-10 m bgl, 49 % wells falls in 2-5 m bgl and only one well falls in 10.0 to 20.00 m bgl category. The decadal average depth to water level maps during pre and post monsoon (April, November 2002-11) are shown in **Figures 2** and **3**. The average depth to water level ranges of pre & post monsoon and water level fluctuation are presented in **Table 2**. The average fluctuation data analysis indicates that 62 % of wells representing rise in water level is in the range of 0-2 m/year.

4.1 Hydrogeology

There are four types of hydrogeological units encountered in the district viz., Crystallines (shallow & deeper), Tertiary sediments, Laterites and Alluvium. The Hydrogeological map is shown in **Figure 4**. The crystalline rocks consist of charnockite gneisses of Archaean age intruded by dolerite/gabbro dykes and pegmatite and quartz veins.

Table 2: Average Depth to Water level - Pre and Post monsoon (April & Nov 2002-2011)

	DTW ranges in GWMW			
	0.0-2.0m bgl	**2.0-5.0m bgl**	**5.0-10.0m bgl**	**10.0-20.0m bgl**
Pre monsoon	4 (8 %)	18 (36%)	24 (48 %)	4 (8%)
Post monsoon	12 (24%)	24 (49 %)	12 (25 %)	1 (2 %)

Fluctuation data of April (2002-2011) - November (2002-2011)

Rise (m/yr)		Fall (m/yr)		Rise (m/yr)			Fall (m/yr)		
Max.	Mini.	Max.	Mini.	0-2	2-4	>4.0	0-2	2-4	>4.0
4.52	0.09	1.44	0.83	31 (62 %)	15 (30 %)	2 (4%)	2 (4 %)	-	-

The long term trend of pre-monsoon and post-monsoon water level of groundwater monitoring wells (GWMW) were analyzed between 2001 and 2010. The trend shows that there is no considerable change in the water level however the pre monsoon rise and fall ranges from 0.0081 to 0.4245 m/year and 0.0027 to 0.2736 m/year respectively where as the post monsoon rise and fall ranges from 0.0004 to 0.2286 and 0.0003 to 0.1842 m /year respectively.

4.2 Ground Water Resources

The ground water resource assessment was done block wise as per GEC-1997 methodology. The net annual groundwater availability is 473.16 MCM where as the draft for all uses is 125.97 MCM. All the blocks fall under Safe category. The block wise ground water resources of Kottayam district as on March 2009 is given in **Table 3**.

Table 3: Ground Water Resources of Kottayam District as on 31st March 2009

S.No.	Name of the Block	Total Annual GW recharge (mcm)	Natural discharge during non-monsoon season (mcm)	Net annual GW availability (mcm)	Existing gross ground water draft for all uses (mcm)	Allocation for domestic and industrial water supply up to next 25 years (mcm)	Net GW availability for future Irrigation development (mcm)	Stage of Development in %	Category
1	Erattupetta	30.28	3.03	27.25	9.86	6.49	16.79	36.16	Safe
2	Ettumanoor	34.39	3.44	30.95	11.60	10.46	18.37	37.49	Safe
3	Kaduthuruthy	52.11	5.21	46.90	14.39	8.32	31.73	30.69	Safe
4	Kanjirappally	50.73	5.07	45.66	13.61	10.37	31.08	29.8	Safe
5	Lalam	44.28	4.43	39.85	7.92	6.43	31.34	19.86	Safe
6	Madappally	51.86	2.59	49.26	16.55	13.65	31.44	33.59	Safe
7	Pallom	69.71	6.97	62.74	16.99	16.03	44.25	27.08	Safe
8	Pampady	35.41	3.54	31.87	6.72	10.46	20.76	21.08	Safe
9	Uzhavoor	49.52	4.95	44.57	9.78	10.46	31.26	21.95	Safe
10	Vaikom	78.43	7.84	70.59	10.21	8.38	59.59	14.47	Safe
11	Vazhoor	26.13	2.61	23.52	8.35	6.00	14.60	35.51	Safe
	Total	**522.85**	**49.69**	**473.16**	**125.97**	**107.04**	**331.21**	**26.62**	

4.3 Ground Water Quality

The ground water samples were collected during April 2009 and analysed. The data reveals that the chemical quality of groundwater is generally good in both phreatic as well as in deep fractured aquifers. All the GWMW samples except one (Vaikom) are showing EC less than the 500 µs/cm at 25°C. In general EC ranges from 29 to 608 µs/cm at 25°C and the total hardness ranges from 8 to 182 mgl /litre. The chloride ranges from 4.30 to 102 mgl/litre. All the water samples show fluoride concentration within the permissible limit. The result of chemical analysis of water samples is given in **Annexure 2.**

4.4 Status of Ground Water Development

The stage of ground water development in this district is 26.62 % as on 2009 which is only 6 % less when compare to 2004 data. The maximum stage of development is seen in Ettumanoor block i.e. 37.49 % while minimum development is 14.47 in Vaikom block. The lifting device of water is by centrifugal pumps and jet pumps for dug wells and submersible pumps and compressor for bore wells. Water is also being lifted by bucket and rope from dug wells for domestic purposes. The stage of groundwater development reveals that huge amount of water is available for future development. All the blocks in the district are safe category. Hence further development is possible in all the blocks, of the district.

5.0 GROUND WATER MANAGEMENT STRATEGY

Groundwater in the district is abundantly developed through dug wells, dug cum bore wells, and bore wells for domestic and irrigation needs In the valley fill and lateritic areas, groundwater is developed mostly through dug wells. Due to technological developments in recent days the groundwater is developed through bore wells for irrigation and domestic purposes particularly midlands and in eastern uplands.

Ground water development should be coupled with conservation of ground water resources and management. The existing water resources such as dug wells, ponds, tanks etc should be renovated and protected for future uses. Artificial recharge schemes should be practiced in large scale along with rain water harvesting. The springs seen in Tekoy, Vellikulam and eastern hilly areas of the district can be developed.

5.1 Ground Water Development

Groundwater can be developed through construction of dug wells in alluvium with depth of 3 to 5 metres and diameter of 1.5 to 2.50 metres. In the valley fill areas, the dug wells are

feasible with depth range of 4 to 8 metres with a diameter of 2 to 3.0 metres. In the laterite terrain, dug wells are feasible in the valley portion with a depth range of 4 to 10 metres and diameter of 2.0 to 3.5. Around 35000 additional structures can be constructed by developing 70 % of the balance resources. In the crystalline formations dug wells are feasible within a depth range of 5.0 to 15.0 metres with a diameter of 2.0 to 3.00 metres. The bore wells are feasible in crystalline and crystallines covered by laterite which can be drilled at a depth range of 50 metres to 75 metres bgl. The favourable bore well sites are along the lineaments, fractures, shear zones etc. The block wise stage of development, ground water draft, availability and categorisation of blocks are presented in **Table 3**. **Figure 5** shows the categorisation of blocks.

5.2 Water Conservation and Artificial Recharge

Though all the blocks are in safe category the water conservation should be implemented wherever possible to avoid water scarcity in future. The artificial recharge structure like Roof Top Rainwater harvesting shall be adopted in urban areas where major structure is not possible. The structures like contour bunding and trenching can be constructed where the topography is gently sloping. The structures feasible for artificial recharge in this district given in **Figure 6**. The prominent structures like sub surface dyke / sub surface dam can be constructed along the narrow valleys where the thickness of over burden is 5 to 10 m. CGWB has implemented the following artificial recharge structures in Kottayam district **(Table- 4)**

Table 4: Artificial Recharge structures in Kottayam district

S.No.	Location	Type of Structure	Year
1	Neezhur	Sub surface Dyke	2000
2	Parinthanam	RTRWH	2001
3	Chirakulam	Percolation tank	2001

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

The water scarcity being faced in the hilly areas in summer period is due to drying up of dug wells. Dug wells in midland region get dried up if monsoon is delayed or if there is no summer showers. The increased dependence on bore wells in midland areas leads to drying up of dug wells in lateritic mounds and slopes which affects the drinking water needs of farmers and poor people.

7.0 AWARENESS AND TRAINING ACTIVITY

Mass Awareness Programme (MAP) and Water Management Training Programme (WMTP) by CGWB

One Mass awareness programme had been conducted during the year 2003 at Kottayam which is the headquarters of Kottayam district and around 500 people attended the function. The main aim of the programme was to convey the importance of rain water harvesting in rural areas.

8.0 AREAS NOTIFIED BY CGWA/SGWA

Since all blocks are under safe category, no area has been notified by the State Authority.

9.0 RECOMMENDATIONS

- The present estimation of groundwater resources as in March 2009 reveals that all the blocks are under safe category.
- The average stage of groundwater development is only 26.62%. So vast scope of ground water development is possible for all uses.
- Most of the area in this district is covered by crystalline formation. The yield of dug wells and bore wells in this formation depends on secondary fractures. An attempt has to be initiated to study the deeper potential fracture zone by integrating different scientific methods for mitigating drought in the upland area.
- The artificial recharge projects like construction of sub surface dyke, contour bounding and roof top rain water harvesting to be initiated in drought prone areas.
- People participations should be implemented for water supply schemes to know the importance of vital and valuable resources of groundwater.
- Advanced irrigation methods such as sprinkler irrigation and drip irrigation should be adopted to save water.

Figure 1: Index Map of Kottayam District, Kerala State

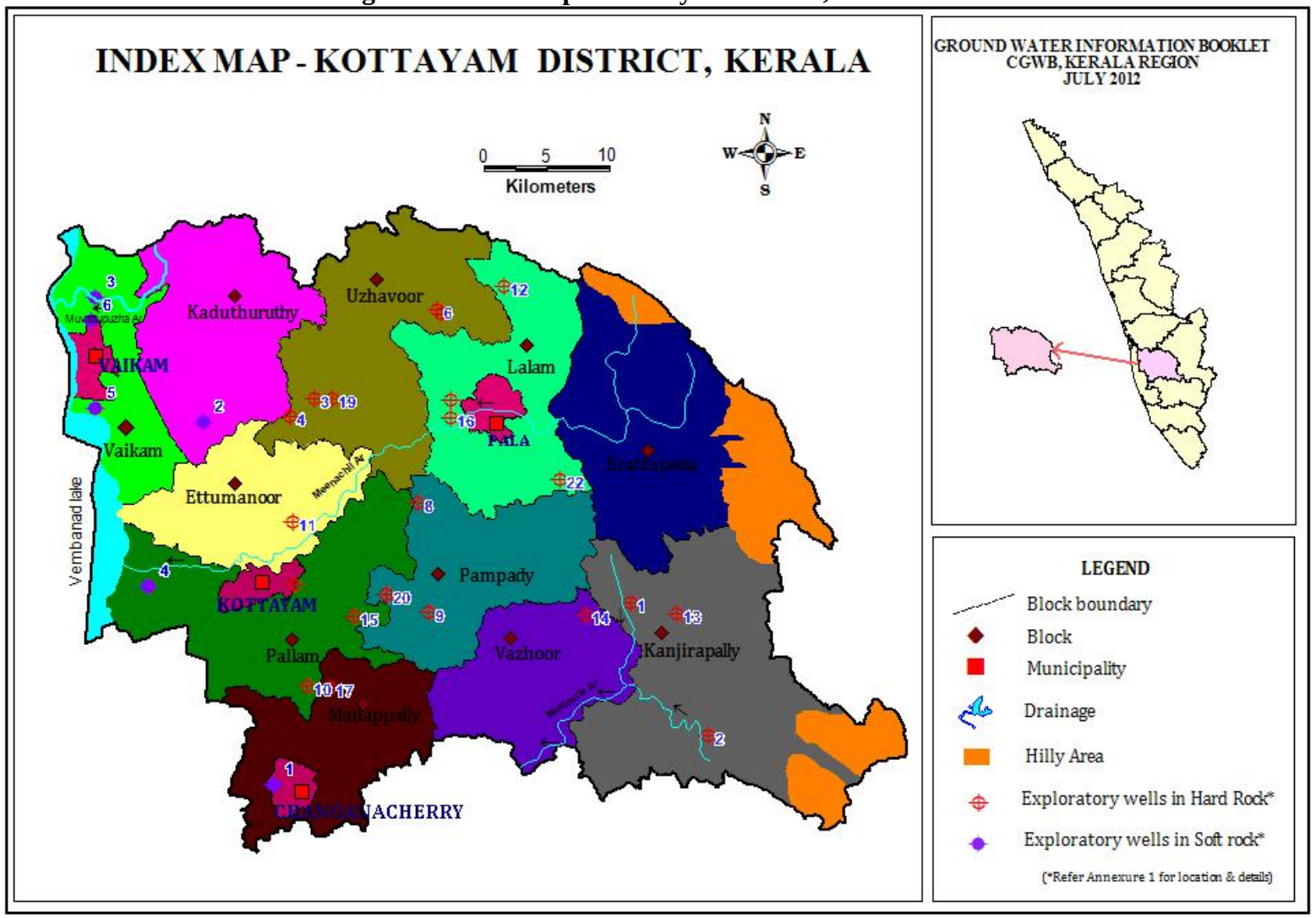


Figure 2: Depth to Decadal Average Water Level – Pre monsoon (April 2002-11)

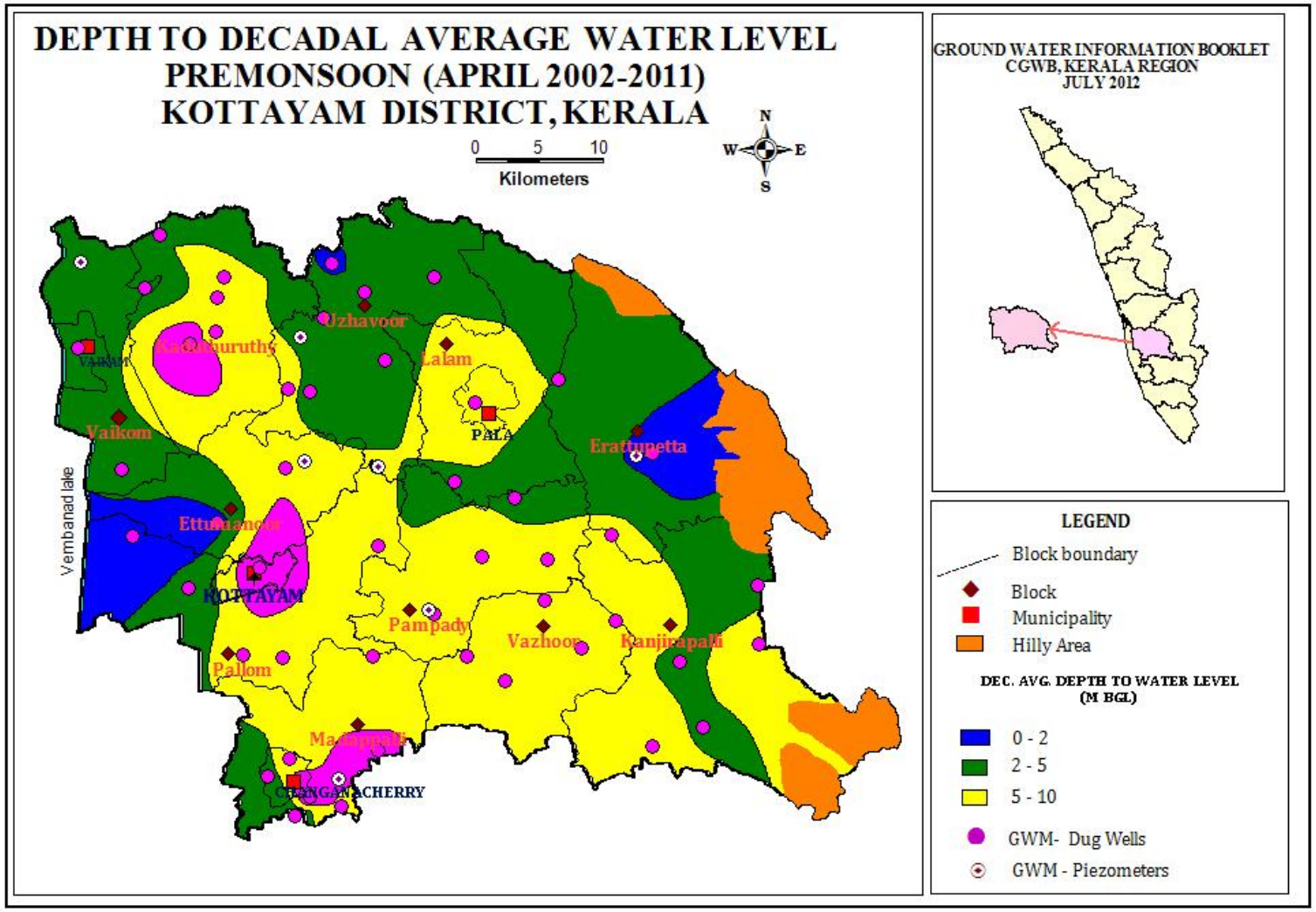


Figure 3: Depth to Decadal Average Water Level – Post monsoon (November 2002-11)

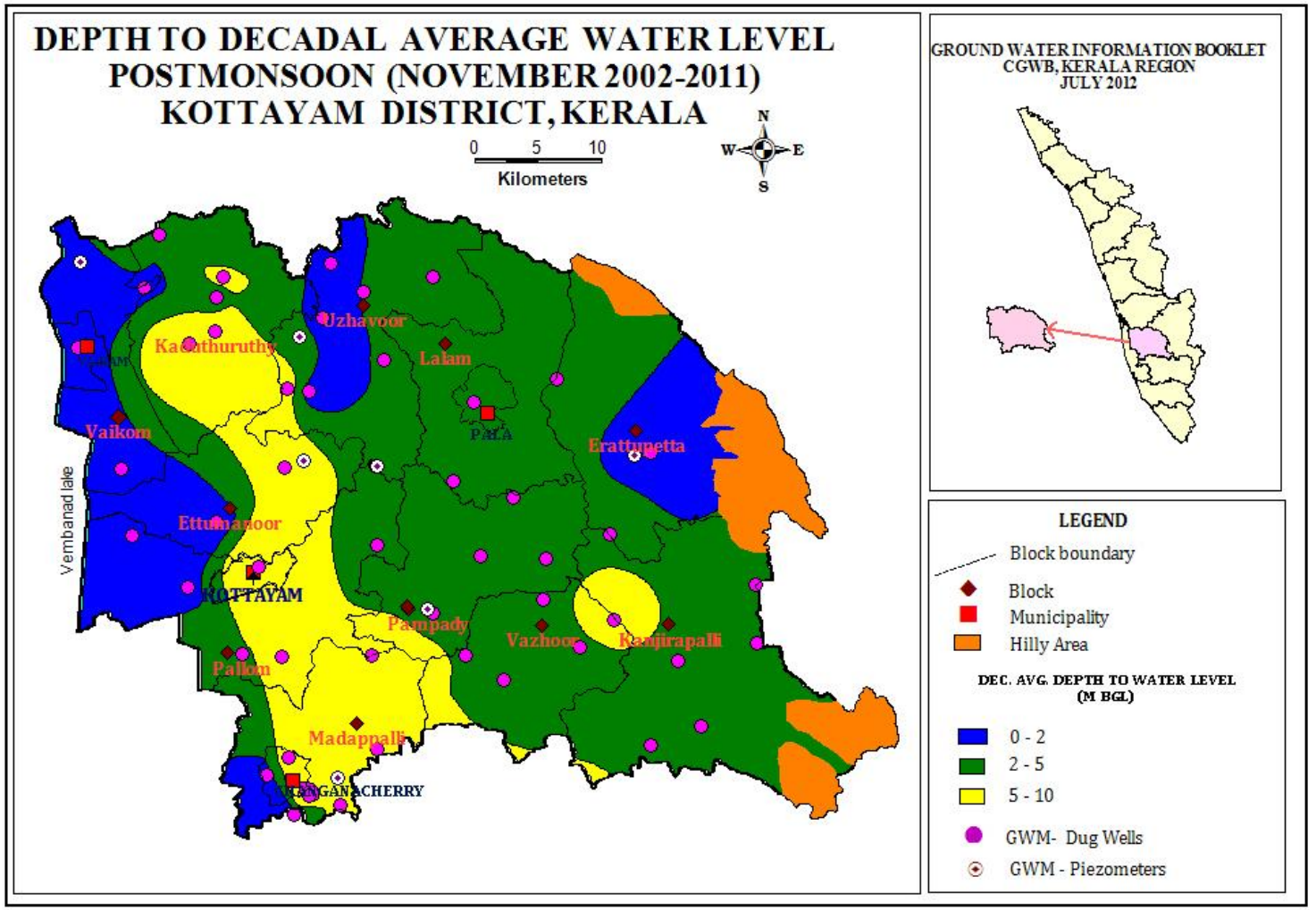


Figure 4: Hydrogeology of Kottayam District

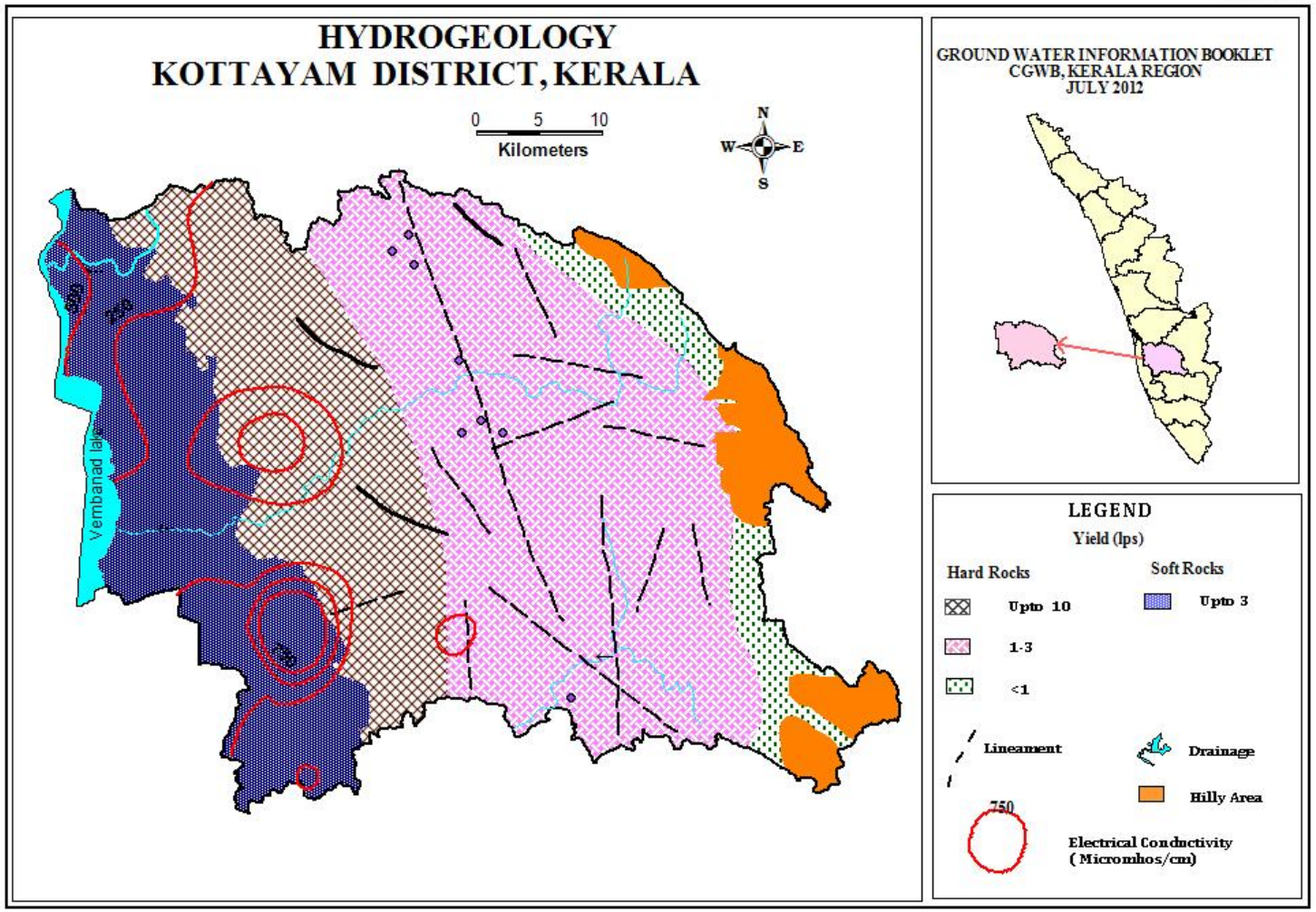


Figure 5: Categorisation of Blocks – Kottayam District

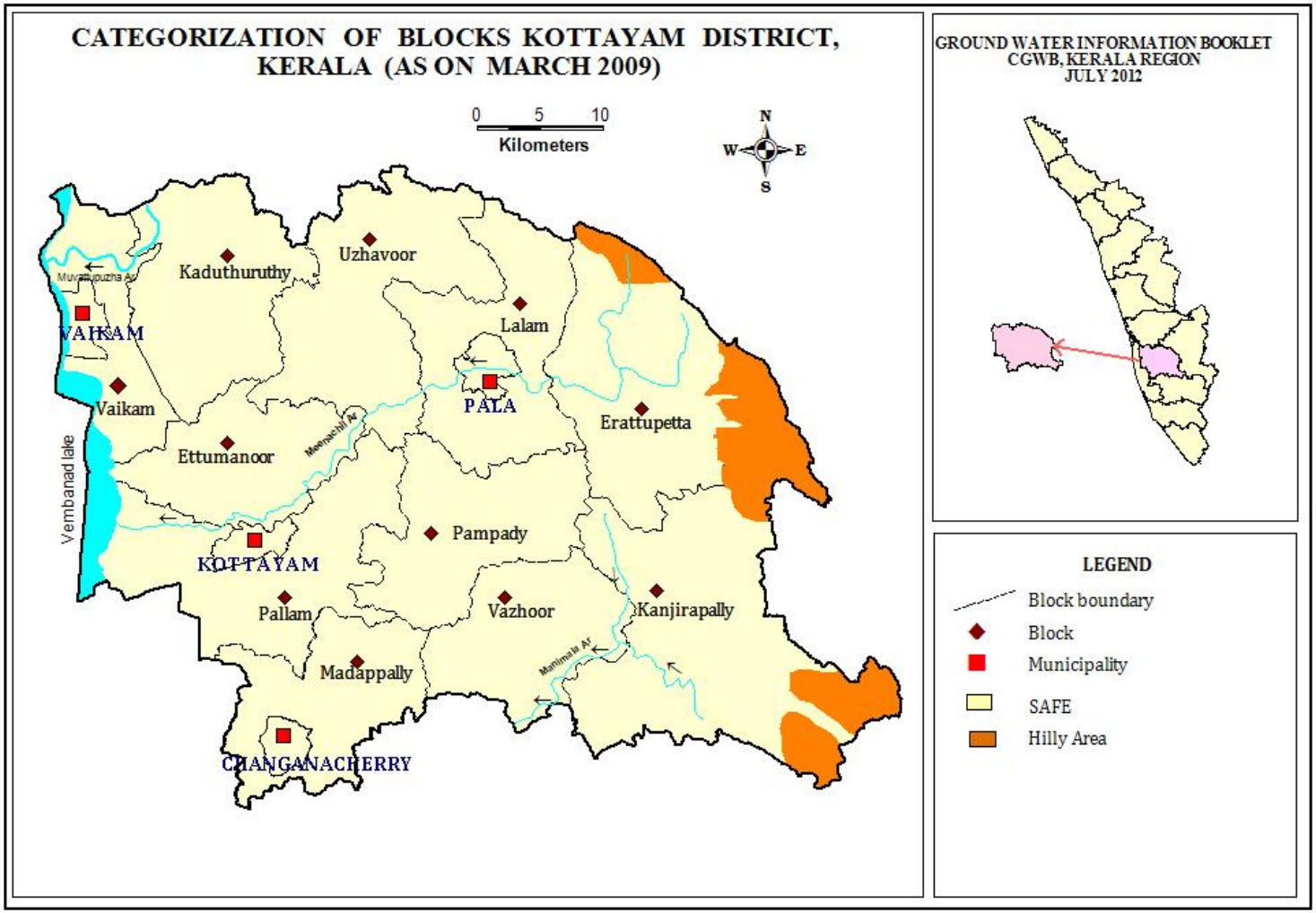
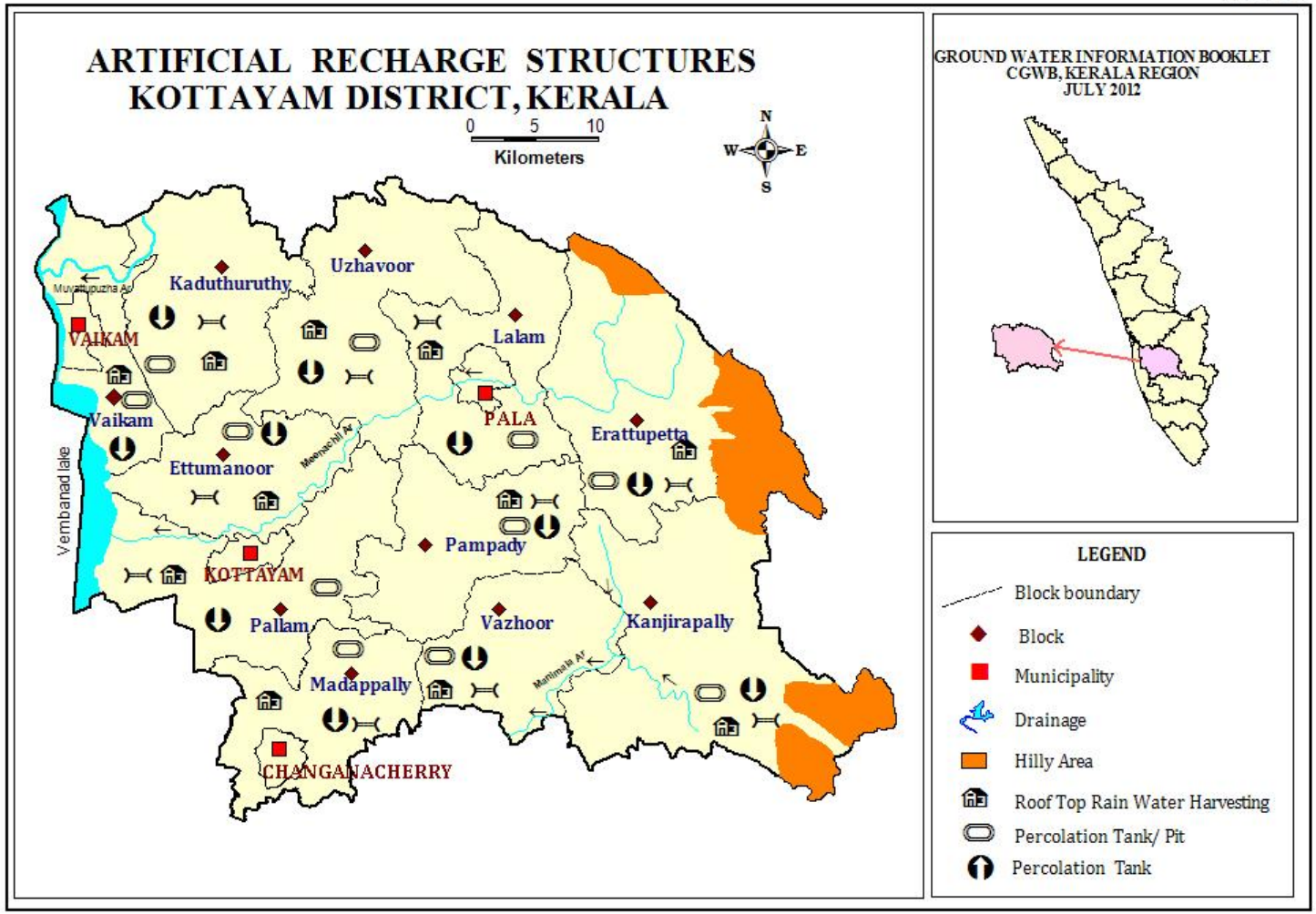


Figure 6: Artificial Recharge structures feasible in Kottayam district



Annexure 1a: Salient feature of EWs drilled in the hard rock terrain of Kottayam district

Sl No	Location	Lineament Direction	Aquifer	Depth (m bgl)	Casing Depth (m bgl)	SWL (m bgl)	Drill time Discharge (Lps)	Fracture zones
1	Anakallu	NNW-SSE	Charnockite Gneiss	215.8	5.3	1.89	Nil	36-50
2	Erumeli	N-S	Charnockite Gneiss	175.7	4.1	1.73	2.5	76-84, 92-96
3	Kalattur	NW-SE	Charnockite	200.5	12.4	51	Nil	Nil
4	Kanakkary		Massive Charnockite	172	9.5	Nil	Dry	Nil
5	Kanjikuzhi		Massive Charnockite	200	18	9.2	0.5	19, 60 & 110
6	Kondadu		Charnockite intruded by dolerite dyke.	150	9	10	8	38,90,138 & 150
7	Kondadu		Charnockite intruded by dolerite dyke.	118	9.5	12		50, 59,62, 68, 74
8	Manalu	NW-SE	Charnockite	200.5	9.5	2.4	3	42-85
9	Pampadi		Massive Charnockite	200	7.9	6.73	0.2	Nil
10	Pattamuttam	Nil	Charnockite	200.5	8.4	-	Nil	Nil
11	Perumbaikadu		Massive Charnockite	200	19.5	10.15	0.2	Nil
12	Pizhaku	NNW-SSE	Charnockite	200.5	4.2	2.84	Nil	8.37-35.23
13	Podimattam	NE-SW	Charnockite Gneiss	139.1	5.8	5	21.7	Full
14	Ponkunnam		Massive Charnockite	200	7	Nil	Dry	Nil
15	Pudupalli		Massive Charnockite	200	9.5	Nil	Dry	Nil
16	Puliyanoor		Massive Charnockite	200	1.75	Nil	Negligible	Nil
17	Vakathanam		Charnockite gneiss	80.5	52.5	18.6	3	70
18	Vallichira	NNW-SSE	Charnockite	200.5	8.3	1.54	1.2	39-61
19	Vayala		Massive Charnockite	200	7	5.67	Negligible	Nil
20	Velloor		Massive Charnockite	200	12	6.8	0.2	19
21	Vellur	NNW-SSE	Charnockite	200.5	6.8	12.64	0.5	38-85
22	Vilakumadam	NNW-SSE	Charnockite	183.3	5	2.24	20	7-130

Annexure 1b: Salient data of the EWs drilled in Sedimentary area

Sl. No.	Location	Depth drilled (m bgl)	Depth constructed (m bgl)	Zones tapped (m bgl)	Discharge (lps)	SWL (m bgl)
1	Changanasseri	35.6	Nil	19.81-22.86 28.95-32	---	---
2	Kallara	37.5	Nil	7.62-12.19 15.89-24.38	---	---
3	Kulasekharamangalam	54.86	Nil	13-17 30-33 39-48	---	---
4	Kumarakom	169	127	112-124	1.8	0.62
5	Pyrattubhagam	91.44	Nil	NA	---	---
6	Udayanapuram	69.5	67.97	54.9-59.7 64.6-66.5	15.33	2.16

Annexure 2 : Chemical Analysis data of Water samples of GWMW

Sl.No	Location	Date of Collection	EC in µs/cm at 25^0C	TH as $CaCO_3$	Ca	Mg	Cl	F
				<----------concentration in mg/L->				
1	Anandasram	22-04-2009	98	22	8.8	0	14	0.13
2	Aranootimangalam	22-04-2009	47	10	3.2	0.49	7.1	0.6
3	Changanacherry	22-04-2009	498	96	27	6.8	71	0.36
4	Ariparambu	23-04-2009	149	28	10	0.49	16	0.33
5	Edinjillam	22-04-2009	273	40	16	0	27	0.59
6	Elamkulam	23-04-2009	88	32	11	0.97	2.8	0.17
7	Erumeli	27-04-2009	108	16	4.8	0.97	16	0.34
8	Iykarakunnam	22-04-2009	99	16	3.2	1.9	21	0.1
9	Kalakatty	23-04-2009	115	26	9.6	0.49	11	0.18
10	Kalattur	22-04-2009	61	12	4	0.49	9.9	0.08
11	Kangazha	21-04-2009	176	34	12	0.97	23	0.27
12	Kanjirapally	21-04-2009	124	28	9.6	0.97	9.9	0.2
13	Kidangur	23-04-2009	80	14	4	0.97	11	0.09
14	Kottayam	22-04-2009	62	12	4	0.49	8.5	0.22
15	Kozha	23-04-2009	98	20	4.8	1.9	13	0.09
16	Kozhuvanal	23-04-2009	65	12	4	0.49	8.5	0.1
17	Kuttikal(new well)	27-04-2009	363	66	21	3.4	41	0
18	Kuvapalli	27-04-2009	194	30	6.4	3.4	28	0.05
19	Marangatupalli	23-04-2009	83	16	4	1.5	11	0.12
20	Monipalli	23-04-2009	136	28	8	1.9	20	0.04
21	Mukkada	27-04-2009	139	38	11	2.4	9.9	0.35
22	Mundakayam	27-04-2009	64	14	3.2	1.5	7.1	0.01
23	Mundukuzhi	21-04-2009	46	14	4	0.97	5.7	0.11
24	Paippad	21-04-2009	249	44	14	1.9	36	0
25	Palamkadavu	22-04-2009	368	38	14	0.97	75	0.04
26	Pallikathodu	23-04-2009	84	16	4	1.5	7.1	0.26
27	Pallom(Nattagam)	22-04-2009	103	18	6.4	0.49	13	0
28	Plakkalpadi	21-04-2009	158	18	4	1.9	30	0.04
29	Pulikkuttisseri	22-04-2009	160	62	19	3.4	11	0
30	Punjar	23-04-2009	60	12	4	0.49	5.7	0
31	Ramapuram	23-04-2009	97	30	8.8	1.9	9.9	0
32	Tiruvarpu	22-04-2009	325	44	9.6	4.9	47	0
33	Thottakkad	21-04-2009	69	14	5.6	0	7.1	0
34	Vaikom	23-04-2009	3380	605	212	18	981	0.23
35	Vazhur	21-04-2009	89	22	5.6	1.9	5.7	0
36	Vechur	22-04-2009	167	42	11	3.4	14	0
37	Vempalle	23-04-2009	97	12	3.2	0.97	17	0