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CONSERVE WATER – SAVE

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES

CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET OF KOLLAM DISTRICT, KERALA STATE

By

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GROUND WATER INFORMATION BOOKLET OF KOLLAM DISTRICT, KERALA STATE

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DISTRICT AT A GLANCE

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	ii. Administrative Divisions (as on 31.3.07)	
	Number of Taluks	5
	Number of Blocks	13
	Number of Municipalities	2
	Corporation	1
	Number of Panchayats	71
	Number of Villages	104
	iii. Population (As per 2001Census)	2584118
	iv. Normal Annual Rainfall (mm)	2428
2.	**GEOMORPHOLOGY**	
	Major physiographic Units	Coastal plain(0-6 m agl) Midland (6-80 m agl) High land (>80 m agl)
	Major Drainages	Achenkovil Kallada Ithikara
3.	**LAND USE (ha**	
	a. Forest area	81438
	b. Net area sown	131975
	c. Total cropped area	189475
4.	**MAJOR SOIL TYPES**	Laterite, Brown Hydromorphic, Grayish Onattukara, Coastal Riverine alluvium and Forest Loam.
5.	**AREA UNDER PRINCIPAL CROPS (ha)**	Paddy – 7218 Banana – 1772 Cashew – 4271 Coconut – 66134 Tea – 1258 Other Plantain – 4213 Pepper – 135.9 Rubber – 36860 Tapioca – 23814 Ginger - 676

6.	**IRRIGATION BY DIFFERENT SOURCES (ha)**	
	Govt. and private wells	1534
	Govt. and privateTanks	184
	Govt. and private Canals	493
	Major irrigation	1
	Other sources	405
	Net Irrigated area	2620
	Gross Irrigated area	5953
7.	**NUMBER OF GROUNDWATER MONITORING WELLS OF CGWB**	
	No. of Dug wells	47
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8.	**PREDOMINANT GEOLOGICAL FORMATIONS**	Archaean crystallines, Tertiaries, Laterite and Recent alluvium.
9.	**HYDROGEOLOGY**	
	Major Water bearing formation Pre-monsoon depth to water level Post-monsoon depth to water level	Crystallines, Tertiaries, Laterite and Alluvium 1.67-25.40 m bgl 0.07-22.32 m bgl
10.	**GROUNDWATER EXPLORATION BY CGWB (as on 31.3.2007)**	
	No. of wells drilled EW OW PZ	 29 in Hard Rock and 19 in Sedimentary. 6 20
	Depth range (m bgl)	114-301.89 in Hard Rock 30.1 - 416.00 in Sedimentary
	Discharge (lps)	0.61-23 in Hard rock 0.67-42.96 in Sedimentary.
11.	**GROUNDWATER QUALITY**	
	Type of water	Generally good except in localized pockets in coastal area.

12	**DYNAMIC GROUNDWATER RESOURCES (2004) MCM**	
	Net annual ground water availability	448.25
	Annual Ground Water draft	205.4
	Projected Demand for Domestic and industrial Uses upto 2025	98.52
	Stage of Ground Water Development (%)	45.82
13	**AWARENESS AND TRAINING ACTIVITY**	
	Mass Awareness Programmes organized	One
	Date	4.03.2008
	Place	Kollam
	No: of participants	220
	Water Management Training Program (WMTP)	One
	Date	08.02.2002
	Place	Anchal
	No of participants	100
14.	**EFFORTS OF ARTIFICIAL RECHARGE& RAIN WATER HARVESTING**	
	Projects completed by CGWB (No., Amount spent and year)	One, Subsurface dyke at Sadanandapuram Amount spent : Rs 7,36,405/- (1998)
	Projects under technical guidance of CGWB	NIL
15.	**GROUNDWATER CONTROL AND REGULATION**	
	Number of OE Blocks.	NIL
	Number of Critical Blocks	NIL
	Number of Semi Critical Blocks	4
	Number of blocks notified	NIL
16.	**MAJOR GROUNDWATER PROBLEMS AND ISSUES**	◆ Saline water ingress is observed in the shallow alluvial aquifer in the western part of the district which is in hydraulic connection with the back water. ◆ Acute water scarcity is seen along the eastern hilly areas and also along

		Laterite hillocks ◆ Water logging along the western border of the district bordering the back water lagoons during the rainy season. Eg) Munroe Thuruthu. ◆ Groundwater pollution is reported from Chavara, Kundara and from Pozhikara area

GROUND WATER INFORMATION BOOKLET OF KOLLAM DISTRICT

1.0 INTRODUCTION

Ground water is being increasingly recognized as a dependable resource to meet the demands of domestic, irrigation and industrial sectors all over the world. The need for increasing the food production, combined with rapid industrialization has been putting a severe stress on the limited groundwater resources of our country. Sustainable management of available resources has thus become vital for prevention of overexploitation and pollution of groundwater. The booklet on the groundwater conditions of the district is compiled to provide guidance to the people from all spheres of life.

Kollam (Old name Quilon), one of the famous trading towns of Kerala has a distinctive place in the mineral map of Kerala. It is located on the southwest part of Kerala State and extends from Lakshadweep Sea to the Western Ghats and is bordered by Trivandrum district on the South and Alleppey and Pathanamthitta districts in the North and Thirunelveli district of Tamilnadu State in the East and Lakshadweep sea in the west. It lies between North latitudes 8^0 45' and 9^0 07' and East longitudes 76^0 29' and 77^0 17'. It has a geographical area of 2491 sq km which is about 6.48% of the total geographical area of the State and falls in parts of Survey of India Toposheets 58C, D,G and H. Population of the district is 2584118 as per 2001 census and is about 8.12% of the total population of the State. Of the total population, 1248616 are males and 1335502 are females. The population density is 1038 persons per sq km.

The district receives an average 2555mm of rainfall annually. The district is underlain by crystalline rocks of Archaean age above which sedimentary formations of Miocene to Recent ages are seen. Groundwater occurs in all the geological formations from Archaean crystallines to Recent alluvium. The quality of water in the coastal aquifer is generally good however there is considerable change in the quality of groundwater along the coastal stretch. Groundwater pollution is being reported from two areas of the district namely Chavara and Pozhikara. Because of the highly porous nature of the laterite, the dug wells tapping laterite get recharged fast in the initial stages of monsoon showers itself, however this water escapes as sub-surface flow and the water level falls quite fast especially in wells located on topographic high and slopes. The shift in the pattern of crop cultivation from paddy to cash crops has also affected the pattern of natural recharge and consequent fall in water level. The deployment of pumps for irrigation and indiscriminate rampant construction of bore wells/dugwells has also added to the problem.

1.1 Administration

The district has a single revenue division with headquarters at Kollam. Pathanapuram, Kunnathur, Kottarakkara, Karunagapally and Kollam are the five Taluks in the district. The district is divided into thirteen development blocks, 71 panchayaths and 103 villages. Paravoor and Punalur are municipal towns and Kollam is the corporation.

1.2 Drainage, Irrigation practices

The district is drained by three west flowing rivers , viz Achenkovil, Kallada and Ithikara, originating in the eastern hilly region. These rivers together with their tributaries exhibit dendritic pattern of drainage.

The Ithikara basin has its elevation north of Madathara (271 m amsl) on the eastern side and slopes down to sea level west of Mayyanad. The Ithikara river originates from the Madatharaikunnu hills, south west of Kulathupuzha and drains into the Paravoor backwaters near Meenad. Ithikara river is a fourth order stream with a slope of 8.2 m/km. The length of the river is 56 km and the drainage area is 779 km^2.

The Kallada river basin has its highest elevation at Karimalaikodkal (1763 m amsl) on the eastern side and reaches almost sea level west of Karunagapally. The river originating from the Western Ghats drains into Ashtamudi backwaters near Kollam. The length of the river is 121 km and drainage area is 1996 km^2. Kallada river is a fifth order stream with a gradient of 12.6 m/km.

The Achenkovil river originates from the Western Ghats and covers a basin area of 1484 km^2 and the main channel length is 128 km. The River joins Pamba river at Veeyapuram and finally debouches into the Vembanad lake. The Achankovil river is set in a well known shear zone demarcating the boundary between Kerala Khondalite Belt and charnockites of Southern Granulite terrain.

The district is blessed with the largest fresh water lake in the State, Sasthamkotta lake and is one of the resources which caters to the drinking water needs of Kollam district. The lake occupies 440 hectares and the catchment area of the lake is 1269 sq km. Other major lakes (Kayals) in the district are.

- Ashtamudi Kayal - 6424 ha
- Paravoor Kayal - 662 ha

The irrigation facilities in the district are limited. The major irrigation scheme is Kallada irrigation project and the target fixed for it was 61630 ha of land and 92806 ha of crops. There are also minor irrigation schemes through which 1500 ha of land is being irrigated. Among source of irrigation, ground water is the principal source of irrigation accounting for about 47% of the area under irrigation and the rest by lift and other methods of irrigation. The index

map showing location of block, boundary, drainage, location of EW, PZ and Groundwater monitoring wells (GWMW) are shown in Figure 1.

1.3 Works carried out by CGWB

Systematic hydrogeological work was carried out in 1959-60 and 1962-63. Further systematic surveys were done in 1970-71, 1974-75. Reappraisal survey was carried out during 1981. The SIDA assisted coastal Kerala Ground Water Project of CGWB carried out detailed hydrogeological studies with exploration in the entire district during the period 1983-88. Dr. E. Shaji carried out Ground water management studies of Kollam district (2000- 2001). The district report was compiled by Sri A. Subburaj (2002).

2.0 RAINFALL & CLIMATE

The district receives an average of about 2555 mm rainfall annually. The major source of rainfall is South West monsoon from June to September which contributes nearly 55% of the total rainfall of the year. The North East monsoon season from October to December contributes about 24% and the balance 21% is received during the month of January to May as premonsoon showers. Out of the total 119 rainy days, 70.1 rainy days occur in the southwest monsoon season. The normal monthly rainfall in mm for the period 1901-1999 is given below.

Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
24.4	32	74.8	165.8	242	421	428	272.5	211	340	216	60	2428

The monthly rainfall data for the period 1997-2006 is given in the Table 1 and Figures 2(a) and 2 (b).

Table 1: Monthly rainfall in Kollam district (Period 1997-2006)

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
1997	1	5	90	139	232	409	362	212	372	429	283	106	2640
1998	4	1	30	103	219	419	233	288	411	480	271	95	2554
1999	19	37	60	238	493	485	294	177	75	946	98	0	2922
2000	3	140	14	135	96	462	121	579	267	228	173	125	**2343**
2001	61	62	26	288	165	388	404	271	262	370	219	0	2516
2002	3	18	40	216	233	287	194	258	102	554	343	2	**2250**
2003	1	62	109	160	108	334	302	249	27	476	119	58	**2005**
2004	25	34	51	143	621	413	269	230	216	272	168	7	2449
2005	2	41	31	254	226	393	518	28	304	255	284	202	2538
2006	18	26	112	242	371	273	366	302	413	584	303	0	3010

From the above Table it is observed that the rainfall was below normal during 2000, 2002 and 2003. There was sufficient rainfall in the district for the rest of the years and it was above normal.

Meteorological Parameters

Temperature

The temperature is more during the months of March to May and is less during December and January. The average mean monthly maximum temperature ranges from 29.9 to 36.4^{0}C and minimum temperature ranges from 19.4 to 23.8^{0}C.

Relative Humidity

The Relative humidity is higher during the monsoon period and all through the year it is higher during the morning hours.

Evaporation

Evaporation is more during summer months of January to April and it is low during the rainy months May to August. The maximum rate of 4.8 mm per day is recorded in March and the lowest rate of 2.6 mm is recorded during July.

Sunshine Hours

Sunshine ranges from 4.3 to 9.7 hours/day. Maximum sunshine is during the month of February. The months of June to August record the minimum sunshine due to the cloudy sky. Generally good sunshine hours are recorded in the months of November to May.

Wind

The wind speed ranges from 1.3 to 2.1 km/hour. The wind speed is high during the months of March to June and less during the months of September to December

Potential Evapotranspiration (PET)

PET values are lower than the monthly rainfall during the month of May to October indicating water surplus for possible recharge into groundwater regime during these months. The monthly PET ranges from 119.3 to 177 mm.

3.0 GEOMORPHOLOGY AND SOIL TYPES

Physiographically the district can be divided into three distinct units viz. the coastal plains, the midlands and the eastern highland regions. The coastal plains with an elevation ranging between 0-6 m amsl occur as narrow belt of alluvial deposits parallel to the coast. To the east of coastal belt is the midland region with altitude ranging from 6-80 m amsl. The midland area is characterised by rugged topography formed by small hillocks separated by deep cut valleys. The midland regions show a general slope towards the western coast. To its east is the high land region. Major parts of the catchment of river Kallada and Ithikara fall within this unit. This unit occupies the maximum area of the district. The Western Ghat fringes is bounded by 300 to 600 m contours. The highest elevation is noticed at Karimalai (1758 m amsl).

There are five major soil types encountered in the district. They are Lateritic , Brown Hydromorphic , Greyish Onattukara , Riverine and Coastal Alluvium and Forest Loam. Lateritic soil is the most predominant soil type of the district and it occurs in the midland and hilly areas and it is derived from laterites. Brown hydromorphic soil is confined to the valleys between undulating topography in the midlands and in the low lying areas of the coastal strip. They have been formed as a result of transportation and sedimentation of materials from adjoining hill slopes. The alluvial soil is seen in the western coastal tract of the district. The coastal alluvium is characterised by secondary soils which are sandy and sterile with poor water holding capacity. Riverine alluvium is seen along the river beds. The width of the zone increases towards the southern part of the district. Greyish onattukara soils are purely marine deposits extending to the interior and are generally coarse in texture. Forest loamy soils are found in the eastern hilly areas of the district and are characterised by a surface layer rich in organic matter.

4.0 GROUNDWATER SCENARIO

4.1. Hydrogeology

Ground water occurs in the porous granular formations such as alluvium, laterite, the Tertiary sediments and weathered and decomposed crystalline rocks as well as in the fissures, joints and fractures in the fresh crystalline rocks. The aquifers in the district can be grouped into four distinct geological formations in which they occur viz alluvial aquifers, laterite aquifers, the Tertiary sedimentary rock aquifers and crystalline rock aquifers.

Crystalline Rocks

On the basis of depth of occurrence, the potential aquifers in the crystalline rocks can be classified into shallow aquifers and deep aquifers.

Shallow aquifers

The crystalline formations occurring in Kollam district are khondalites, charnockites, granite gneisses and intrusives. The shallow aquifers of the crystalline rocks occur within a depth of 20 m in the district. They are made up of highly decomposed weathered zone and partly weathered and fractured rock occurring just below the weathered zone.

Wells in the Khondalitic terrain have depth varying from 5.0 to 20 m bgl and water levels varying between 4 to 20 m bgl during premonsoon and from 3 to 12.5 m bgl during post monsoon period. The yields of these wells are of the order 6 to 12 m^3/day. In the charnockites the wells have depth from 6 to 13m bgl and the depth to water level from 5 to 12.0 m bgl during premonsoon and from 3.0 to 9.0 m bgl during post monsoon. The yield of the wells range from 4 to 5 m^3/day. The wells piercing the charnockite are generally dry during summer months. The specific capacity of dugwells range between 1.50 to 82 lpm/m/dd.

Deeper Aquifers

The SIDA assisted Coastal Kerala Ground Water project explored the potentialities of the deep fractured rocks in the district. During the project 14 exploratory bore wells were drilled. Subsequently 15 bore wells were drilled by CGWB in the Field Season programs during the year 2007-08 in the hard rock terrain, the locations of which are cited in the hydrogeological map (Figure 5) of the district and the details are given in Annexure 1a.

The aquifer parameters of the wells drilled in the formations are given below

Formation	Depth , m bgl	SWL, m bgl	Discharge, lps	Transmissivity m^2/day
Granite Biotite gneiss	114.71 to 301.89	0.20-65.37	0.61-23	0.83 to 80.6
Khondalites	175.67 to 200.5	9.1 to 18.24	0.85-11.0	0.43 to 52.835

An analysis of the yields of the 29 bore wells constructed indicate that 5% of them yield more than 20 lps, 19% yield between 10 to 20 lps and 57 % yield between 1 and 10 lps and 19% yield less than 1 lps. The yield of bore wells drilled in granite biotite gneiss is better compared to Khondlite group of rocks.

The Tertiary Sediments

Ground water occurs under phreatic condition in the shallow zone and confined condition in the deeper zones in the Tertiary sedimentary rocks. The sedimentary formation of the area comprises of Alleppey beds, Vaikom beds, Quilon beds and Warkali beds. Of these four Tertiary formations, Vaikom and Warkalai beds contain the most potential aquifers.

Shallow aquifers

Ground water is developed by dug wells tapping the Tertiary sediments wherever these formations outcrop. The depth to water level in these formations ranges from 4.3 to 26.5 m bgl and the depth of the wells ranges from 6.0 to 28.5 m bgl. The yield of the wells ranges from 500 to 10000 lpd.

Deeper Aquifers

The sedimentary formation of the area comprises of Alleppey beds, Vaikom beds, Quilon beds and Warkali beds. Of these the Warkali and Vaikom beds form the most potential aquifers. 5 tube wells were constructed by CGWB during the SIDA project. Rest 14 tube wells were constructed by CGWB prior to SIDA project. These wells were constructed to tap the aquifers in each of the geologic formations namely Vaikom, Quilon and Warkali beds. The details of these wells are given in Annexure 1b. Of the four formations tube wells have been constructed tapping Vaikom, Quilon and Warkali beds. Since no tube wells was constructed tapping the Alleppey beds the hydrogeological data and aquifer parameters for these beds are not available.

Vaikom Aquifers

This is the most potential aquifer system in the Tertiary group. It is the most extensively developed aquifer in Kollam district. The piezometric head ranges from 19.22 m bgl at Vayyankara and 1.63 m bgl at Sooranad. The piezometric surface is around 18 m above msl in and around Poruvazhi-Pallickal area in Kollam district and it slowly reduces towards west and northwest. Around Kollam the piezometric surface is 5.0 m below mean sea level. The yield of the wells constructed tapping this formation ranges from 0.67 to 36 lps. The thickness of granular zones in the formation ranges from 6 to 65 m. The transmissivity value ranges from 6 m^2/day in the eastern area to 467 m^2/day at Mainagapally and 529 m^2/day at Sooranad. The storativity ranges from 2.5 x 10^{-9} to 4.1 x 10^{-3} indicating confined to semi confined conditions. The specific capacity of the wells ranges between 5.79 and 436 lpm/m.

This aquifer is largely developed for the Kollam Town Water supply and nearby villages for rural water supply.

Quilon Aquifers

The hydrogeological particulars of this aquifer are very limited as only one tube well was constructed by the project and one by CGWB tapping this formation. The type area of this formation is at Padappakara area of Kollam district. Compared to the underlying Vaikom beds the Quilon bed is not very promising. The thickness of granular zones tapped in this aquifer is between 6 and 10 m and is composed of fine sand. No tube wells were constructed tapping exclusively the Quilon aquifers like Warkali and Vaikom.

Warkali Aquifers

This is the most potential extensively developed aquifer in the Tertiary sediments. They form semi confined to confined aquifers. The thickness of the granular zones varies from 5 and 40 m and the yields of the wells range from 3 to 13.7 lps. The transmissivity value ranges from 130 m^2/day to 710 m^2/day. It is minimum around Kollam and eastern parts and maximum at Karunagapalli and northern parts. The specific capacity of tube wells ranges between 22 and 562 lpm/m.

Laterites

The occurrence and movement of ground water in laterite are mainly controlled by the topography. Laterite forms potential aquifers along valleys and topographic lows where the thickness of saturated zone is more and can sustain large diameter open wells for domestic and irrigation use. The depth to water level in this formation ranges from 1.6 to 27.6 m bgl and the depth of the wells ranges between 5.6 to 28 mbgl. The yield of the well ranges from 0.5 to 6 m^3/day. The seasonal water level fluctuation in laterite range from 0.4 to 10.20 m. The laterite formations occurring along hill tops and slopes get desaturated on the onset of summer and water scarcity is experienced during summer in such area. The laterites along the recharge area of the sedimentary formation

show a deep water level of the order of 15.00 to 28.0 m bgl as seen around Kumbalam, Kottiyam, Sasthamkotta, Poruvazhi and Sooranad.

Alluvium

This is the most potential phreatic aquifer in the district and is extensively developed by dug wells and filter point wells for domestic and irrigation needs. The depth to water level in this formation ranges from 0.50 to 5.9 m which is 1 to 6 m above msl. The depth of the wells ranges from 2.76 to 10.6 m bgl. The yield of the shallow dug wells ranges from 15 to 50 m^3/day. The area around Iravipuram, Chavara, Karunagapally where the saturated thickness exceeds 5.0 m form promising area for filter point wells. The filter point wells are constructed to a maximum depth of 12.0 m bgl and the yield ranges from 20 to 60m^3/day. The seasonal water level fluctuation ranges from 0.5 to 4.34 m.

Water level

Block wise distribution of groundwater levels during premonsoon (April 06) and post monsoon (Nov 06) are presented in the following Tables 2 & 3. The premonsoon depth to water level ranges between 1.67 to 25.40 m bgl. The minimum depth to water level occurs in Oachira block and the maximum occurs at Kumbalam(Chittumala block) and during post monsoon it ranges between 0.07 to 22.32 m bgl.

Table 2: Block wise distribution of ground water levels (April 2006)

Name of Blocks	No. of wells analysed	Depth to water level, mbgl		No./ % of wells showing DTWL in the range of				
		min	max	0-2	2-5	5-10	10-20	20-40
Anchal	10	2.04	12.73	0	2 20	7 70	1 10	0
Chadayamangalam	6	4.66	9.76	0	1 16.67	5 83.33	0	0
Chavara	2	1.78	2.80	1 50%	1 50	0	0	0
Chittumala	2	8.51	25.40	0	0	1 50	0	1 50
Karunagapally	1	2.87	2.87	0	1 100	0	0	0
Kollam	1	3.48	3.48	0	1 100	0	0	0
Kottarakkara	3	3.92	6.92	0	1 33.33	2 66.67	0	0
Oachira	1	1.67	1.67	1 100%	0	0	0	0
Pathanapuram	4	2.42	9.76	0	1 25	3 75.00	0	0
Punalur	1	9.97	9.97	0	0	1 100	0	0
Sasthamkotta	1	5.58	5.58	0	0	1 100	0	0
Vettikavala	2	4.90	7.42	0	1 50	1 50	0	0

Table 3: Block wise distribution of ground water levels (November 2006)

Name of Blocks	No. of wells analysed	Depth to water level (m bgl)		No. % of wells showing DTWL in the range of				
		min	max	0-2	2-5	5-10	10-20	20-40
Anchal	10	0.07	9.25	3 30	1 10	6 60	0	0
Chadayamangalam	6	4.39	8.41	0	1 16.67	5 83.33	0	0
Chavara	2	0.44	0.61	2 100%	0	0	0	0
Chittumala	3	2.42	22.32	0	1 33.33	1 33.33	0	1 33.3
Ithikara	1	14.46	14.46	0	0	0	1 100	0
Karunagapally	1	0.16	0.16	1 100	1 100	0	0	0
Kollam	1	0.93	0.93	1 100	1 100	0	0	0
Kottarakkara	3	1.36	4.29	1 33.33%	2 66.67	0	0	0
Oachira	1	0.48	0.48	1 100	0	0	0	0
Pathanapuram	4	1.76	6.37	1 20	2 40.00	2 40.00	0	0
Punalur	1	7.86	7.86	0	0	1 100	0	0
Sasthamkotta	2	3.52	7.84	0	0	1 50	0	0
Vettikavala	2	2.82	3.13	0	0	0	0	0

Depth to water level in pre monsoon period (April 06) is shown in Figure 3 and post monsoon period (Nov 06) in Figure 4 and the Hydrogeological map is given in Figure 5.

Long term water level trend (1997-2006)

The long term trend of premonsoon and post monsoon water level between 1997-2006 indicate a falling trend as well as rising trend in the district. The hydrographs of Chavara, Ezhukone, Kadakkal, Ailara, Aryankavu, Avaneswaram, Channapetta, Edamon, Kottarakara, Punalur, Tadicaud, Thenmala, Ithikara and Perinad showing falling trend in the water levels. These areas are facing acute water shortage during summer periods.

Trend analysis of groundwater level from 1997-2006 shows 66% of the wells are in rising trend in the water levels (0.001 to 0.33 m/yr). The trends of the remaining wells are in the falling side and it is observed that the fall is in the range between 0.002 to 0.13m/yr.

4.2 Ground Water Resources

Ground water recharge

Rainfall is the major source of recharge to groundwater in the district. The average rainfall of the district is about 2555 mm.

The groundwater resources of the district were computed as per the guidelines of the Ground Water Estimation Methodology 1997. The total annual recharge of groundwater has been computed block wise using average water level fluctuation in GWMW and Specific Yield of the respective aquifers. The net groundwater availability is 448.25 MCM. The resources available varied from block to block and ranges from 7.87 to 152.96 MCM. The block wise details of total recharge and net available recharge are presented in Table 4a.

The ground water assessment was done block wise as per GEC 1997 methodology as on March 2004.

Table 4a: Ground Water Resource of Kollam district (As per GEC 1997) as on March 2004

Sl No.	Name of the Block	Total Annual Rechrge MCM	Net annual GW Availability (MCM)	Existing gross GW draft for irrigation (MCM)	Existing gross GW draft for domestic and industrial water supply (MCM)	Existing gross ground water draft for all uses (MCM)	Stage of Ground Water development %	Categorization for future GW development
1	Sastamkottah	31.02	29.47	13.07	5.78	18.85	63.96	Safe
2	Karunagapally	25.51	22.96	9.11	5.77	14.88	64.79	Safe
3	Chavara	20.9	18.81	6.39	6.15	12.54	66.67	Safe
4	Anchalamoodu	8.75	7.87	4.29	3.27	7.56	96.06	Semicritical
5	Chittumala	20.26	18.23	7.38	3.76	11.14	61.08	Safe
6	Vettikavala	31.00	27.90	17.39	7.09	24.48	87.74	Semicritical
7	Pathanapuram	47.65	42.88	6.80	6.15	12.95	30.20	Semicritical
8	Anchal	169.96	152.96	9.71	8.19	17.90	11.70	Safe
9	Kottarakara	28.98	26.08	11.18	6.22	17.40	66.72	Safe
10	Mukhathala	25.35	22.81	14.39	6.48	20.86	91.46	Semicritical
11	Ithikkara	31.79	28.61	8.33	7.75	16.07	56.17	Safe
12	Chadayamangalam	40.91	26.82	12.38	8.28	20.66	56.11	Safe
13	Oachira	13.53	12.85	4.89	4.87	9.76	75.95	Safe
	Total	**495.61**	**448.25**	**125.29**	**79.75**	**205.04**	**45.82**	

Comparison of gross draft for all uses of 1999 with 2004 is given in Table 4b and is shown in Figure 6.

Table 4b: Comparison of gross draft for all uses of 1999 with 2004

Sl No.	Name of Blocks	Net annual Ground Water availability (MCM)	Existing gross GW draft for irrigation (MCM)		Existing gross GW draft for Domestic and industrial purposes (MCM)		Existing gross GW draft for all uses (MCM)	
			As on 31.03.04	As on 31.03.99	As on 31.03.04	As on 31.03.99	As on 31.03.04	As on 31.03.99
1	Sastamkotta	29.47	13.07	11.54	5.78	5.78	18.85	17.32
2	Karunagapally	22.96	9.11	8.48	5.77	7.37	14.88	15.85
3	Chavara	18.81	6.39	5.73	6.15	6.21	12.54	11.94
4	Anchalamoodu	7.87	4.29	3.88	3.27	6.50	7.56	10.38
5	Chittumala	18.23	7.38	6.72	3.76	4.82	11.14	11.54
6	Vettikavala	27.90	17.39	14.77	7.09	7.19	24.48	21.96
7	Pathanapuram	42.88	6.80	5.52	6.15	6.38	12.95	11.90
8	Anchal	152.96	9.71	9.29	8.19	8.55	17.90	17.84
9	Kottarakara	26.08	11.18	10.65	6.22	6.30	17.40	16.95
10	Mukhathala	22.81	14.39	13.85	6.48	10.32	20.87	24.17
11	Ithikara	28.61	8.33	7.94	7.75	7.51	16.08	15.45
12	Chadayamangalam	36.82	12.38	11.14	8.28	8.29	20.66	19.43
13	Oachira	12.85	4.89	4.52	4.87	3.53	9.76	8.05

The draft figures have increased in all the blocks especially in Vettikavala block.

Categorization for groundwater development of the blocks as on 31st March 2004 is in Table 4a and presented in Figure 7.

During the earlier computation as per 1999 data Anchalamoodu and Mukhathala were categorized as critical and the rest of the blocks were safe but the 2004 computations indicate these two blocks fall in semi critical and an additional two blocks Vettikavala and Pathanapuram also in semi critical (Figure 7). The difference observed is due to the change in methodology adopted in the present estimation. The parameter long term trend of water level was considered in the GEC 2004 estimation.

Ground Water Quality

Groundwater quality in general is potable except along seacoast, backwaters and in areas polluted by industrial effluents. The quality is excellent in hilly tracts and most of the midland regions. Intermediate quality waters are found in the lower midland and coastal stretches. About 32% of GWMW samples show Electrical conductivity less than 100 µs/cm at 25^0C and about 37% show Electrical conductivity less than 250 µs/cm at 25^0C. Only in areas very near to the coast and tidal zones, the water samples having EC above 1000 µs/cm at 25^0C. A well located at Chavara recorded an EC value of 1370 µs/cm at 25^0C and a chloride value of 298 mg/l. Chloride in phreatic groundwater is below 60 mg/l in major part of the district. Higher values of chloride are observed as localized patches in the coastal plain to the close vicinity of the backwaters. The chloride content is observed in the range of 5.7 (Location: Ayur; Ayur block) to 298 mg/l (Location: Chavara;Chavara block). In the borewells, the quality of water is generally good, mostly the EC is in the range of 50 to 250 µs/cm at 25^0C. Fluoride value is also within permissible limit.

The result of chemical analysis of GWMW samples collected from phraeatic aquifers during April 2006 is given in Annexure 2.

4.3 Status of Groundwater Development

The shallow phreatic aquifers in alluvium are developed through dugwells and filter point wells. Filter point wells are more economical in the alluvium areas in comparison to dug wells. However, filter points can be constructed only in very restricted areas where the saturated sand thickness in the shallow zone exceeds 5 m.

Filter point wells are feasible in coastal areas especially along Chavara, Karunagapally and Oachira blocks and the yield from these wells ranges from 20 to 60m^3/day.

The yield of wells in laterite ranges from 0.5 to 6 m^3/day. The depth ranges of wells are 5.6 to 28 m bgl. Generally large diameter wells are constructed in laterite terrain.

Development of Vaikom aquifer is extensive in the district. The present draft from this aquifer is estimated to be less than 4 MCM leaving bright scope for future development. Maximum development has taken place in this aquifer catering to the dense coastal population. Many piezometers have been constructed in this aquifer by Central Ground Water Board to monitor the groundwater development. Vaikom aquifer caters to both drinking and industrial needs of the district.

The Quilon aquifer is comparatively less potential than that of underlying Vaikom aquifer. Hence this aquifer is not widely developed in the district.

The Warkali aquifers are the topmost potential aquifer in the Tertiary sediments. This aquifer has not been developed to the extent of those in Vaikom aquifers. Hence future development can be resorted to, from this aquifer to diminish the stress of development in Vaikom aquifers.

The depth of dugwells in the Tertiary formations ranges from 6-28.5 m bgl. The average yield of the wells ranges from 500 to 10000 lpd.

14 tube wells were drilled in the sedimentary area by CGWB prior to SIDA project and 5 during the SIDA Project. The depth of these wells ranges from 30 m at Pallickal to 416 m at Marudurkulangara. Discharge ranges from 0.75 lps at Poruvazhi to 56.9 lps at Mainagapalli.

In the fractured crystallines, the bore wells constructed to the depth ranging from 114.71 to 301.89 m. Yield ranges from 0.61 to 23 lps. The general potential zones are between 40 to 75 m. Below 100 m depth only in limited areas high yielding zones are encountered. CGWB drilled wells of 200 m depth under Ground Water Exploration Programme. The yield of borewell ranges from 50 lpm at Ezhukone, Kottarakara block to 1000 lpm at Valiyakavu, Pathanapuram Block. The data from exploratory drilling carried out by CGWB were analysed. The E-W followed by NE-SW lineaments is found to be potential in the district. The borewells in the northern and north eastern parts of the district have comparatively higher discharges. The high yielding wells are

constructed at Kulathupuzha(660 lpm), Aryankavu(1220 lpm), Kottarakara(1380 lpm) and Valiakavu (1000 lpm).

In the recent years due to fall in water level, the dug wells were deepened in many parts of the district and deepening of the wells were resorted to increase the yield of the dug wells. The lifting devices of water are centrifugal pump and jet pump 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.

5.0 GROUND WATER MANAGEMENT STRATEGY

5.1. Groundwater Development

The district is blessed with abundant groundwater resources in phreatic, semi-confined and confined conditions. Groundwater is mainly used for drinking and industrial purposes. The phreatic aquifer is tapped by dug wells and filter point wells generally fitted with 1.0 to 1.5 HP motors. The deeper confined Warkali and Vaikom aquifers are extensively developed through submersible or vertical turbine pumps for drinking water supply.

The ground water in the district is mostly developed through dug wells for domestic and agricultural purposes and to a limited extent for industrial and irrigation purposes. Recently the bore well culture has gained momentum. Ground water development should be coupled with management of rain water harvesting and surface water. There should be proper water budgeting in the district. The existing water resources and dug wells, ponds, tanks etc should be cleaned, protected and conserved. Artificial recharge schemes should be practiced in large scale along with rain water harvesting. Rainwater in situ collection can be practiced along the coastal region and artificial recharge to groundwater can be practiced in the midland regions.

Mass awareness programmes should be carried out in panchayat level to make awareness among the people about the importance of conservation and protection of groundwater.

5.2 Water Conservation and Artificial Recharge

CGWB has implemented one artificial recharge scheme at Sadanandapuram at the valley in the Agricultural University campus. A subsurface dyke was constructed during the year 1998.

The structure constructed was a plastered brick wall over massive basement and it was kept 1.0 m below ground level to avoid water logging in the upstream side of the dyke. Three sets of piezometers were constructed on either side of the dyke for water level measurement.

Impact assessment study revealed that during the month of May immediately after the construction of the structure there was a rise of 0.22 to 0.88 m in water levels between the upstream and the downstream side. The reservoir area of the dyke got fully recharged by the first few showers and the same trend continued till the end of December.

Due to highly undulating nature of the topography and steep slopes, ground water discharge from the phreatic aquifer is quite high, during and after the monsoon. In order to retain the groundwater storage for utilization during the non monsoon months, the subsurface runoff should be checked. This can be achieved by construction of subsurface dykes in the upland regions and in the laterite valleys. The subsurface dyke constructed in the project at Sadanandapuram. Recharge structures like percolation tanks, check dams, contour bunding, trenching, pitting and terrace cultivation can be practiced in the upland regions. In coastal areas Artificial Recharge structures are not feasible since the water levels in these areas are in the range of 0.50 to 5.9 m which does not fulfil the condition for artificial recharge. Moreover during the monsoons the excess water is in the form of rejected recharge in alluvial aquifers. Hence the most feasible option for the solution of safe drinking water is rain water harvesting structures.

Anchal, Yeroor, Adayaman, Idamulakal, Karavaloor, Thenmala, Ariankavu, Chithara, Kilikollur Panchayaths are facing acute water scarcity during summer. The below mentioned remedial measures can be adopted to solve the water scarcity of the area

- Maintenance and desilting of the ponds
- Construction of check dams
- Conservation of Panchayath wells, ponds etc
- Encourage drip irrigation
- Implementation of rainwater harvesting and artificial recharge schemes

It will be ideal if the water management of the area may be done on watershed basis, (terrain management) which will include construction of groundwater conservation structures to induce more recharge. Bore wells may be constructed along the potential fractures for irrigation and drinking water supply. Artificial recharge schemes to be implemented in the blocks on priority basis. The proposed Artificial Recharge scheme is given in Table 5 and is shown in Figure 8.

Table 5: Artificial Recharge Schemes proposed

Sl No.	Name of block	Artificial Recharge Schemes				
		Percolation tank	Check dams	SSD*	Contour bunding / Terracing	Rooftop rain water harvesting
1	Anchalamoodu	3	2	3	-	
2	Vettikavala	3	3	2	1	
3	Pathanapuram	5	2	3	3	
4	Mukhathala	2	3	1	-	

5	Sasthamkotta	3	2	4	-	
6	Ithikara	-	-	-	-	4
7	Karunagapally	-	-	-	-	2
8	Oachira	-	-	-	-	3
9	Kottarakkara	2	-	3	-	4
10	Kollam	-	-	-	-	3
11	Chavara	-	-	-	-	3
12	Chittumala	3	-	1	-	-
13	Chadayamangalam	2	1	-	-	-

*SSD: Subsurface dyke

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

The estimation of groundwater resources in different blocks of the district for the year 2004 has indicated that groundwater development in the district is around 45.82%. However four blocks in the district are in semicritical category. A considerable amount of groundwater is being developed from the midland area of the district from a number of wells for water supply and irrigation purposes. Saline water ingress is observed in the shallow alluvial aquifer in the western part of the district which is in hydraulic connection with the backwater. Water logging is generally seen in a limited area along the western border of the district bordering the backwater lagoons during rainy season. The foothill regions of the Western Ghats falling in Pathanapuram and Anchal blocks are facing acute water scarcity during summer months.

Groundwater pollution is reported from two areas of the district. One is reported from Chavara, and the other from Pozhikara. Chavara area has been polluted due to the effluents from the factory M/s Kerala Metals and Minerals Ltd. The groundwater in the nearby area shows low pH value 1.3 to 3.3 which is highly acidic and certain trace elements like Zn, Mn, Fe are also reported above the permissible limit.

The tidal regulator at Pozhikara has created some environmental problems. The paddy fields in the Ithikara area have been affected, the nearly Paravoor Kayal has become more saline and the fresh water laterite aquifer became saline due to sea water ingress.

Tsunami that occurred during 2004 had affected the coastal areas of Alappad Panchayath. The groundwater of the area had become saline. The present study (Reappraisal 2007-08) has shown that the wells affected quality wise during Tsunami have improved and the change was only a temporal phenomenon since the hydraulic gradient of the aquifer remained unaffected by the killer waves of Tsunami.

7.0 AWARENESS AND TRAINING ACTIVITY

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

One Mass awareness programme was conducted during March 2008 at Kollam. Around 220 people participated in the Awareness Programme.

One WMTP programme was conducted at Anchal during 2002. About 100 participants attended the Training Programme.

8.0 AREAS NOTIFIED BY CGWA/SGWA

No block in Kollam district is notified by CGWA or SGWA.

9.0 RECOMMENDATIONS

1. The groundwater potential in the alluvial terrain can be developed through various groundwater structures viz. dug wells, filter points and shallow tube wells. Dug wells ranging in depth from 4.0 to 7.0 m with diameter of 1.50 to 2.0 m is recommended. Filter point wells are feasible in areas around Chavara, Karunagapalli and Oachira blocks wherever the saturated sand thickness exceeds 5 m.

2. Laterite aquifer in the northeastern parts of the district can be developed through open dug wells ranging in depth from 10 to 12 m with a diameter of 1.5 to 3.5 m. There is a big gap between dynamic phreatic groundwater resource available and utilised in the district. Accelerated groundwater development in the district would bring more area under irrigation since there is a lot of resource untapped.

3. The deeper Tertiary sediments can be developed through tube wells. There is scope for additional 55 tube wells in the district in the depth range of 100-150 m tapping the Warkali aquifer with a minimum granular thickness of 15 m.

4. The deeper Vaikom aquifer in the Tertiary formation can be developed through tube wells and an additional 10 tube wells in the depth range of 150-300 m can be constructed.

5. Development of groundwater will go a long way in providing assured irrigation and drinking water even to remote areas. Development of water resources needs a scientific management system co-ordinating the efforts of all concerned State and Central agencies for a speedy development of the district in the agricultural sector.

6. The Panchayats suitable for constructing borewells are Anchal, Erur, Alayaman, Idamulakkal, Thenmala, Ariyankavu, Chithara, Kadakkal, Nilamel, Veliyam, Vettikavala, Pooyapalli. Proper site

selection is needed to locate the base wells in lineaments to the better results can be obtained. Immediate attention is needed in the following panchayats for water supply schemes viz. Anchal, Erur, Alayaman, Ilamukal, Thenmala, Ariyankavu, Chithara, Kadakkal, Nilamel, Veliyam, Vettikavala and Kilikollur.

7. The existing water resources like ponds, backwaters, rivers and panchayat wells should be cleaned and protected. The only fresh water kayal, Sasthamkotta kayal should be protected. All the wet lands of Kollam district shall be protected and conserved.

8. Suitable artificial recharge schemes should be implemented for conserving surface runoff from rainfall. Rainwater harvesting schemes should be practiced in the coastal areas and artificial recharge schemes like sub-surface dyke, percolation tank, contour bunding etc can be practiced in the mid land and high land regions of the district.

9. In the quality affected at Chavara and Pozhikara area rainwater harvesting shall be practiced.

10. The groundwater in Kollam district is the most precious resource and the recharge area has to be demarcated precisely and protected properly from pollution. If necessary the recharge area is to be notified as protective area where pollution prone industries are to be warned to maintain the quality of effluents as prescribed by the Pollution Control Board.

11. Any development projects along or near the coast should be technically scrutinized and environmental impact assessment study shall be made a pre requisite to assess the feasibility of the project.

12. Farmers may be encouraged to adopt modern irrigation techniques like drip irrigation to have optimal use of the available resources and community irrigation schemes have to be encouraged.

13. Necessary measures for regulating the exploitation of groundwater may be implemented in the semi critical blocks of Anchalamoodu, Mukhathala, Pathanapuram and Vettikavala.

14. Mass awareness programmes and rainwater harvesting training should be conducted at Panchayath level to create awareness among people about the importance of this precious resource of groundwater.

Figure 2a

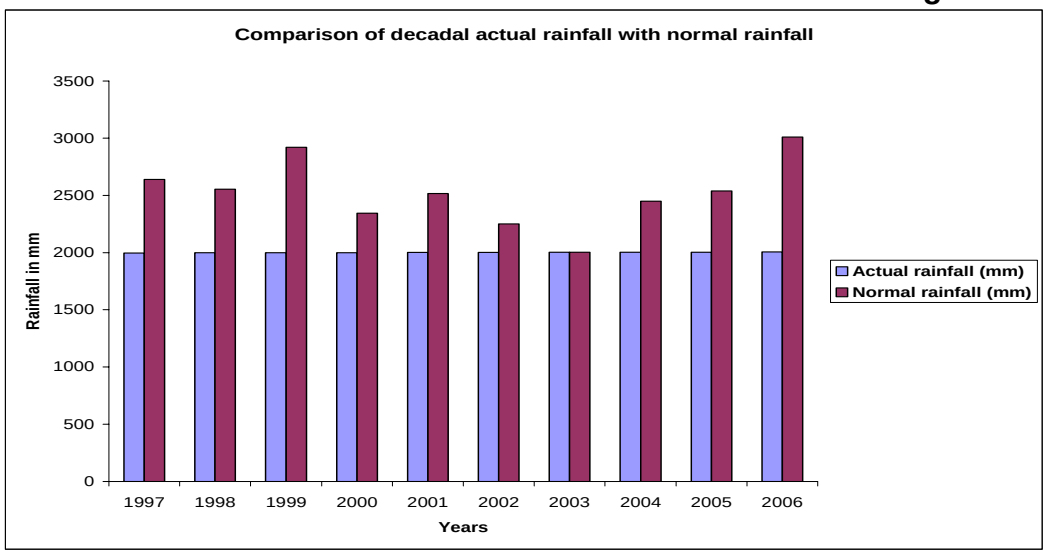


Figure 2b

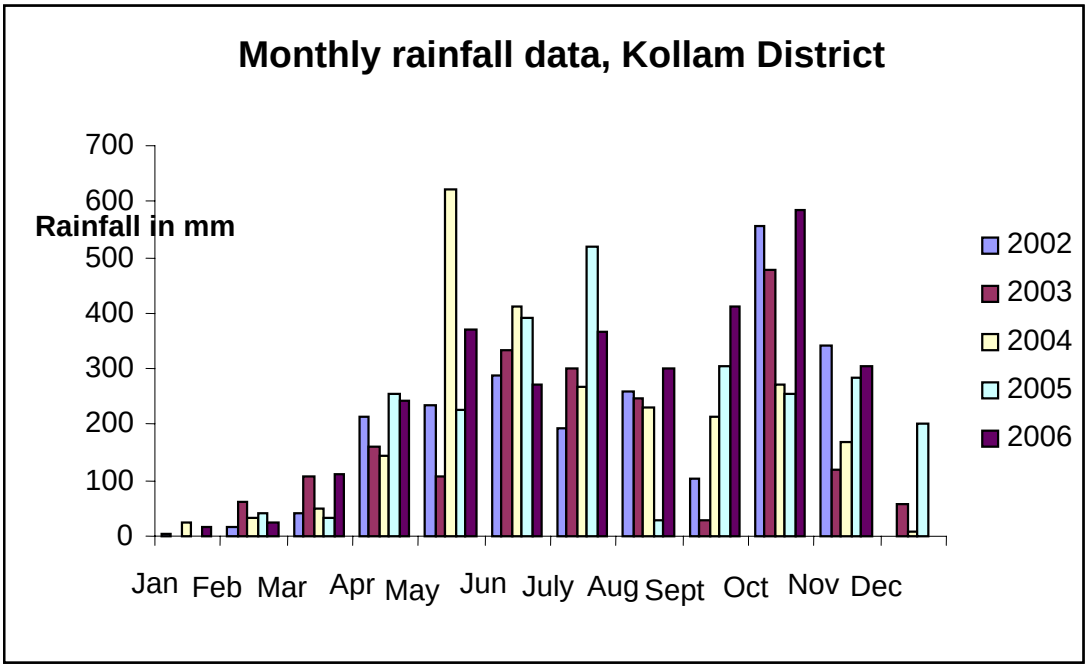
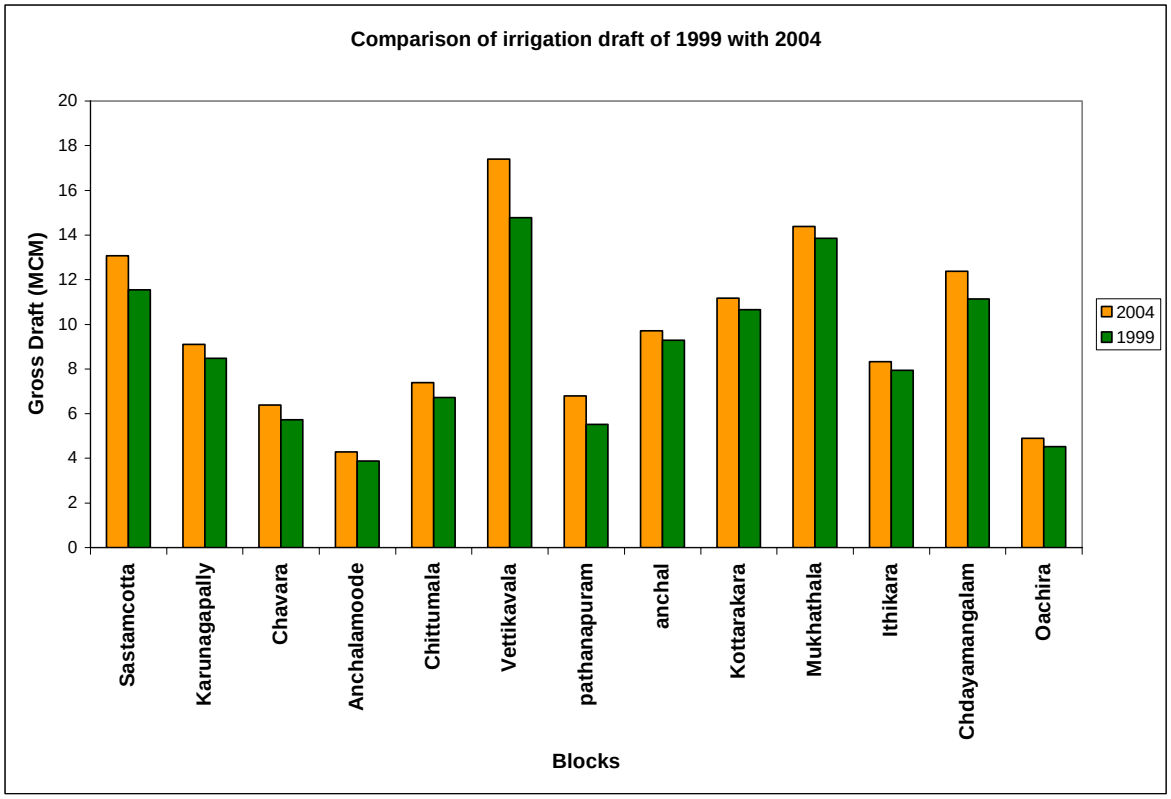


Figure 6


Comparison of irrigation draft of 1999 with 2004
Gross Draft (MCM)
20
18
16
14
12
10
8
6
4
2
0
2004
1999
Sastamcotta
Karunagapally
Chavara
Anchalamoode
Chittumala
Vettikavala
pathanapuram
anchal
Kottarakara
Mukhathala
Ithikara
Chdayamangalam
Oachira
Blocks

Annexure 1a

Exploratory wells drilled in Hard rock area of Kollam District

Sl No	Location	Coordinates	lithology	Depth	Zones encountered	SWL	Dis lps	DD m	T (m2/day)
1	Karamkode	8^0 51' 20'' 76^0 43' 20''	Khondalite	200.5	-	18.24	-	-	-
2	Karukone	8^0 54' 15'' 76^0 56' 05''	Khondalite	200.53	35.00 75.00	9.10	0.31	-	0.43
3	Kampamkode	8^0 54' 50'' 76^0 51' 20''	Granite biotite gneiss	200.53	50.47 70.0 141.6	7.29	5.5	-	11
4	Nellikunnam	8^0 57' 30'' 76^0 46' 30''	Granite biotite gneiss	200.0	45.0 80.0	2.86	0.61		1.17
5	Tadikad	8^0 57' 05'' 76^0 52' 55''	Khondalite	175.67	50.47 80.61 118.71	12.05	4.5		4.5
6	Kottarakara	8^0 59' 50'' 76^0 46' 15''	Granite biotite gneiss	114.71	12.37 23.61	65.37	23		51
7	Kundara	8^0 58' 0'' 76^0 41' 20''	Garnet biotite gneiss	206.15	-	-	-	-	-
8	Ariankavu	8^0 58' 15'' 77^0 09' 00''	Granite biotite gneiss	129.95	58.0 80.0 90.0	2.05	20	-	80.6
9	Punaloor	9^0 01' 35'' 76^0 55' 30''	Granite biotite gneiss	200.53	-	-	-	-	
10	Mailom	9^0 01' 45'' 76^0 47' 10''	Granite biotite gneiss	300.06	111.0 210	4.28	0.9	-	-
11	Puvattur Padinjaru	9^0 03' 10'' 76^0 47' 10''	Granite biotite gneiss	200.53	-	-	-	-	-
12	Ambalattumbhagam	9^0 04' 20'' 76^0 4' 50''	Granite biotite gneiss	301.89	-	-	-	-	-
13	Kadakkamam	9^0 04' 10'' 76^0 53' 50''	Calc granulite	168.05	35.5 85	12.35	15.1	-	17

14	Idakkattu	9^0 05’ 40’’ 76^0 39’ 50’’	Granite biotite gneiss	200.53	45 90 142	1.30	2.5		3.0
15	Kulathupuzha	8^0 54’ 15’’ 77^0 04’ 30’’	Khondalite (Granite biotite gneiss)	115	37.80-40.80 56.10-59.10 65.20-71.30 95.70-98.80 111-115.0	1.05	11.04	9.10	52.835
16	Thottathara	8^0 53’ 42’’ 76^0 51’ 40’’	Khondalite (Granite biotite gneiss and quartzo feldspathic gneiss)	200	16.40-19.50 25.60-28.00 98.80-104.90 141.50-144.50	5.0	2.90	22.12	7.403
17	Kadakkal	8^0 48’ 54’’ 76^0 55’ 10’’	Khondalite (Granite biotite gneiss)	200	19.50-22.50 120.10-123.20 187.20-190.30	2.32	2.0	29.50	1.083
18	Kottukal	8^0 53’ 38’’ 76^0 84’ 41’’	Khondalite (Granite biotite gneiss)	200	28.60-31.70 62.20-65.20 150.60-153.70	21.06	1.50	15.70	2.26
19	Nellikunnam	8^0 57’ 58’’ 76^0 46’ 38’’	Granite biotite gneiss	166	7.0-9.0 46.90-50.0 83.50-86.60	0.20	1.30	36.0	0.83
20	Ezhukone	8^0 58’ 15’’ 76^0 43’ 32’’	Khondalite (Granite biotite gneiss)	123	13.40-16.40 19.50-22.50 43.90-46.90	3.0	0.85	10.54	0.644
21	Pattazhy	9^0 49’ 15’’ 76^0 48’ 20’’	Granite biotite gneiss with charnockites patches	200	19.5-22.50 25.6-28.60 53.0-56.10	4.52	1.20	22.93	1.16

22	Vazhathopu	9^0 04’ 20’’ 76 ^{0}39’ 40’’	Charnockites	200		4.52			
23	Karavur	9^0 03’ 30’’ 76^0 56’ 45’’	Charnockites	200	19.5-22.50 25.6-28.60 53.0-56.10	1.21	4.0	22.93	1.16
24	Valiyakavu	9^0 03’ 45’’ 76^0 59’ 00’’	Granite biotite gneiss with charnockites patches	123	19.50-22.50 86.60-89.60 101.80-104.9	9.03	16.66	7.19	45.16
25	Mullumala, Kottarakara		Khondalite	200	10.50-13.50 132.30-135.50	6.16	4	22.15	-
26	JNV, Kottarakara		Khondalite	200	31-32	17.17	1	10	-
27	Tazhethukulakada		Khondalite	200	-	-	-	-	-
28	Chadayamangalam		Khondalite	200	-	-	-	-	-
29	Pathanapuram		Fractured Khondalite	200	22.50	8.10	1.0	12.0	-

Annexure 1b

Details of wells drilled in Sedimentary area , Kollam District, Kerala

Sl No.	Year of construction	Location	Coordinates & Toposheet No.	Depth drilled (m bgl)	Depth constructed m bgl	Static Water Level m bgl	Aquifer tapped	Discharge lps
1	1972	Poodakulam	$08^0$47'30", $76^0$42'30", 58D/9.	129.54	Nil	Nil	Slim Hole	
2	1985	Kalaikode	$08^0$47'40", $76^0$41'05", 58 D/9.	159.11	152.45	12.63	Quilon+ Vaikom	13.86
3	1958	Mayyanad	$08^0$50'00", $76^0$39'00", 58 D/9.	137.6	Nil	Nil	Vaikom	Abandoned well
4	1986	Ittikara	$08^0$51'45", $76^0$41'45", 58 D/9.	76	53	15.73	Vaikom	-
5	1972	Pannimasseri	$08^0$52'05", $76^0$39'15", 58D/9.	107.9	100.58	3.71	Vaikom	11.67
6	1986	Kollurvilla	$08^0$52'20", $76^0$36'58", 58 D/9.	250	190	7.15	Vaikom	Not tested
7	1972	Kannanallore	$08^0$53'35", $76^0$41'05", 58 D/9.	67.21	Nil	Slim Hole	Slim Hole	NA
8	1986	Tirumullavaram	$08^0$53'32", $76^0$38'18", 58 D/9.	Pz -1 - 328.7 Pz-II - 40.7	Pz - 1- 300m, Pz - 2- 36.0m.	11.46 4.45	Warkali+ Vaikom	7.88 3.3

9	1972	Kottangara	$08^0$56'50", $76^0$40'00", 58 D/9.	35.05	Nil	Slim Hole		NA
10	1972	Thrikkaruva	$08^0$56'50", $76^0$36'50", 58 D/9.	189.89	184.29	8.60	Vaikom	42.96
11	1992	Chavara	$08^0$58'00", $76^0$32'05", 58 D/9.	**I** 189.53, **II** 160.0, **III**101.45	185.0, 143.0, 48.0.	12.91 9.18 2.89	Warkali+ Quilon+ Vaikom	30 1.83 0.67
12	1972	Mainagappalli	$09^0$02'15", $76^0$34'30", 58 C/12.	196.59	175	3.08	Vaikom	56.9
13	1993	Sasthamkotta	$09^0$02'49", $76^0$37'10", 58 C/12.	178.92	Nil	Slim Hole	NA	NA
14	1990	Maradurkulangara	$09^0$02'35", $76^0$30'37", 58 C/12.	l-416.00, ll-164.50	323.0, 150.0	5.1	Vaikom	26 25
15	1957	Karunagapalli	$09^0$03'25", $76^0$31'40", 58 C/12	304	271	2.25	Warkali + Vaikom	NA
16	1987	Poruvazhi	$09^0$06'00", $76^0$39'00", 58 C/12	47	32	7.62	Vaikom	0.75
17	1972	Sooranadu	$09^0$06'15", $76^0$35'35", 58 C/12.	99.97	92.8	1.63	Vaikom	36.86
18	1987	Vayyankara	$09^0$08'15", $76^0$37'45", 58 C/12	62.6	51.5	19.22	Vaikom	4.83
19	1988	Pallickal	09 08' 42" 76 39' 05" 58 C/12	30.1	28.5	8.12	Vaikom	NA

Annexure 2

Chemical Analysis data of GWMW samples collected from Kollam district during April 2006

Sl. No.	Location	EC in us/cm at 25^0C	Total Hardness as $CaCO_3$	Ca	Mg	Cl	F
			<----------in mg/l---------->				
1	Ummannur	172	24	7.2	1.5	31	0.12
2	Quilon	244	62	21	2.4	36	0
3	Pozhikkara	350	76	17	8.3	61	0.09
4	Anchalummodu	436	38	9.6	3.4	108	0.04
5	Ezhukone	170	34	8	3.4	23	0.1
6	Kumbalam	59	14	4.8	0.5	9.9	0.02
7	Kulathupuzha	233	24	6.4	1.9	43	0
8	Thenmala	52	8	2.4	0.5	9.9	0
9	Madathara	114	12	4	0.5	23	0
10	Akkal	126	16	4	1.5	17	0
11	Kadakkal	295	50	14	3.9	43	0.39
12	Iravipuram	491	108	35	4.9	60	0.02
13	Karunagapalli	325	110	35	5.4	31	0
14	Perinadu	150	18	6.4	0.5	31	0
15	Chadayamangalam	170	18	6.4	0.5	34	0.15
16	Kulakada	109	24	9.6	0	13	0
17	Yeroor	348	66	18	5.4	30	0.04
18	Edamon	54	6	1.6	0.5	7.1	0.25
19	Punnala	88	14	3.2	1.5	13	0.2
20	Pathanapuram	486	74	23	3.9	97	0.36
21	Paripally	86	14	4.8	0.5	16	0.13
22	Ariyankavu	140	38	6.4	5.4	13	0.18
23	Chenkulam	89	10	2.4	1	14	0.12
24	Vadakunthala	419	78	23	4.9	75	0.16
25	Tadicaud	117	14	4.8	0.5	24	0.1
26	Sasthamkotta	172	38	15	0	26	0.15
27	Punalur-II	121	30	7.2	2.9	17	0.12
28	Chavara	1370	465	162	15	298	0.26

Sl. No.	Location	EC in us/cm at 25^0C	Total Hardness as $CaCO_3$	Ca	Mg	Cl	F
			<----------in mg/l---------->				
29	Thevalakkara	109	24	8.8	0.5	14	0.25
30	Punalur I	85	18	4	1.9	13	0.16
31	Ayur	69	16	5.6	0.5	5.7	0.38
32	Ailara	72	10	3.2	0.5	14	0.1
33	Vallikavu	191	62	21	2.4	18	0.14
34	Kottakayam	43	8	3.2	0	5.7	0.11
35	Pavithreswaram	78	6	1.6	0.5	18	0.1
36	Oyur	65	10	2.4	1	11	0.1
37	Achenkovil	296	64	15	6.30	34.00	0.24
38	Nallila	120	24	8	1.00	17.00	0.12
39	Kottarakara	177	18	4	1.90	31.00	0.15
40	Kutavettur	87	18	4.8	1.50	9.90	0.12
41	Neendakara	847	320	100	17.00	132.00	0.33
42	Channapetta	715	265	102	2.40	46.00	0.36
43	Avaneswaram	76	16	4.8	1.00	5.70	0.00

Figure 8

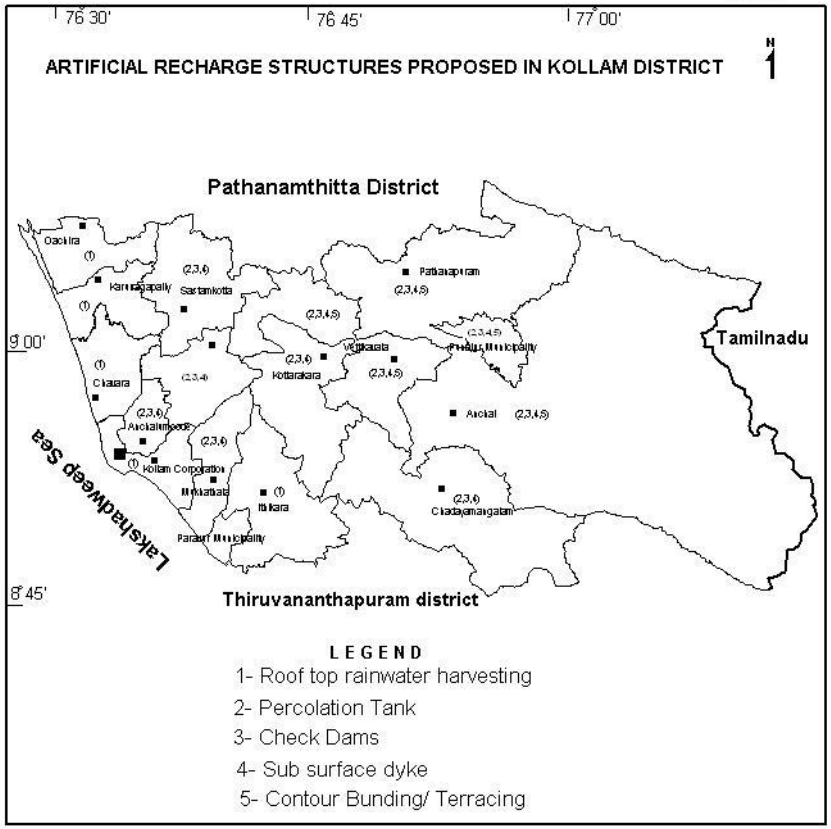

76° 30'
76° 45'
77° 00'
ARTIFICIAL RECHARGE STRUCTURES PROPOSED IN KOLLAM DISTRICT
N
Pathanamthitta District
9° 00'
8° 45'
Tamilnadu
Lakshadweep Sea
Thiruvananthapuram district
Oachira
Karunagapally
Sasthamkotta
Pathanapuram
Chavara
Kottarakara
Velikavala
Punalur Municipality
Anchal
Anchalumoodu
Kollam Corporation
Mynagappally
Ilakara
Chadayamangalam
Paravur Municipality
LEGEND
1- Roof top rainwater harvesting
2- Percolation Tank
3- Check Dams
4- Sub surface dyke
5- Contour Bunding/ Terracing

Figure 7

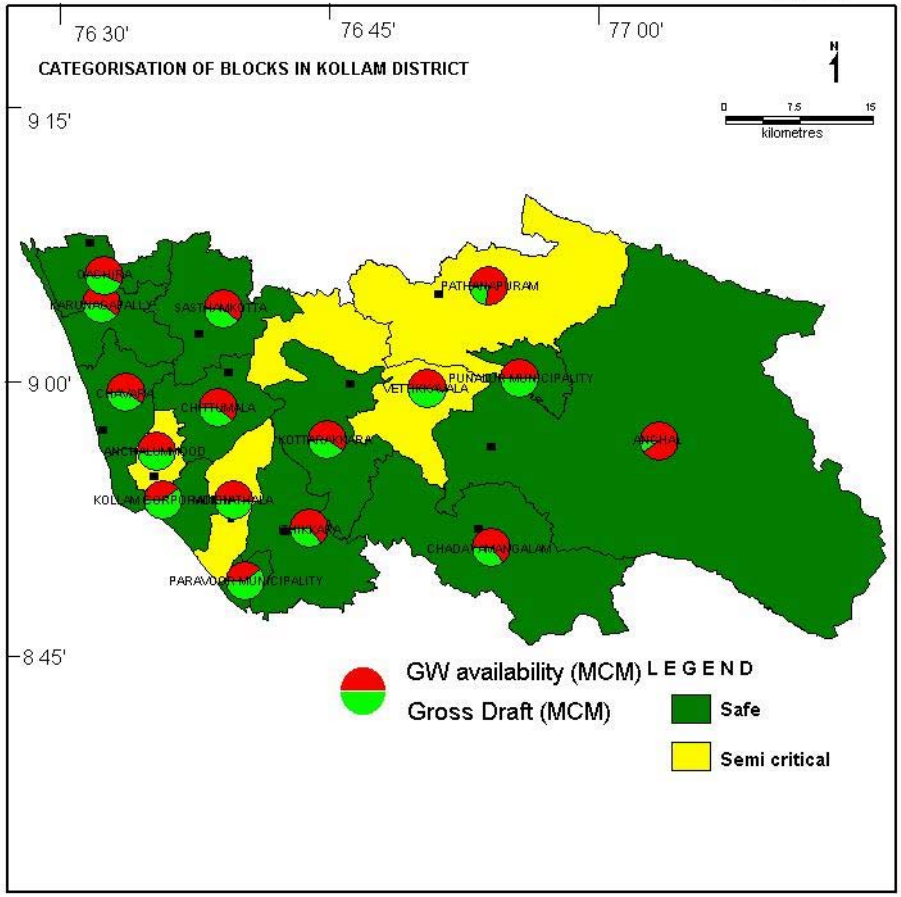

76 30'
76 45'
77 00'
CATEGORISATION OF BLOCKS IN KOLLAM DISTRICT
N
0 7.5 15
kilometres
9 15'
9 00'
8 45'
PATHANAPURAM
PUNALUR MUNICIPALITY
VETTIKKAVALA
KOTTARAKKARA
ANCHAL
CHADAYAMANGALAM
PARAVOOR MUNICIPALITY
GW availability (MCM)
Gross Draft (MCM)
LEGEND
Safe
Semi critical

Figure 5

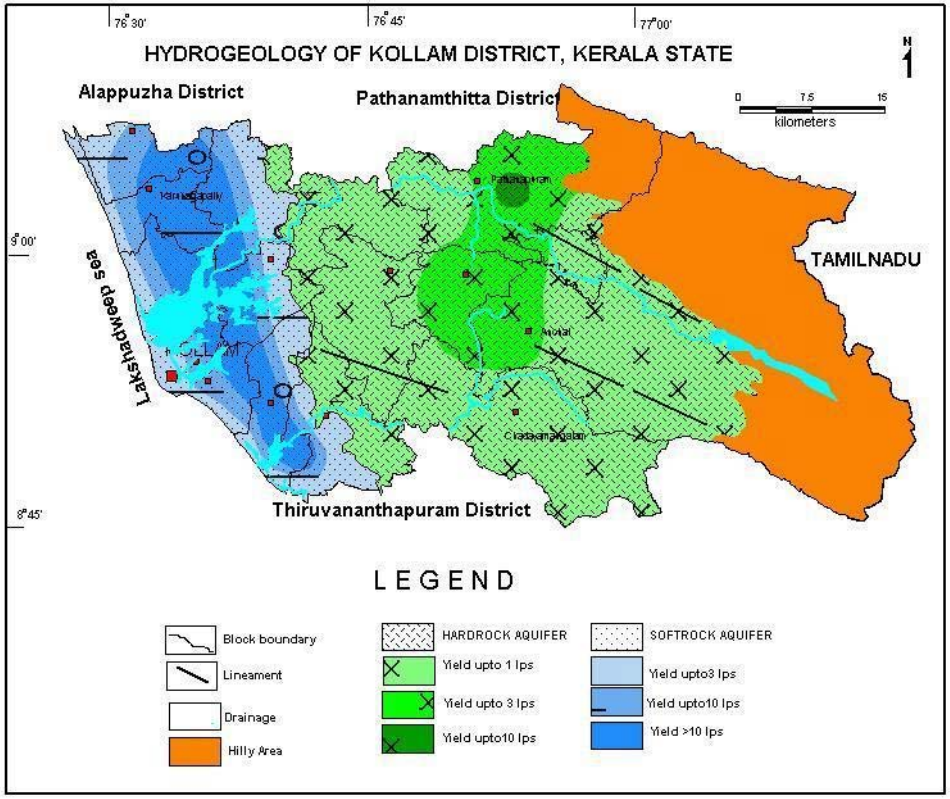

76°30'
76°45'
77°00'
HYDROGEOLOGY OF KOLLAM DISTRICT, KERALA STATE
N
Alappuzha District
Pathanamthitta District
0 7.5 15
kilometers
9°00'
8°45'
Lakshadweep sea
TAMILNADU
Thiruvananthapuram District
LEGEND
Block boundary
Lineament
Drainage
Hilly Area
HARDROCK AQUIFER
Yield upto 1 lps
Yield upto 3 lps
Yield upto10 lps
SOFTROCK AQUIFER
Yield upto3 lps
Yield upto10 lps
Yield >10 lps

Figure 1

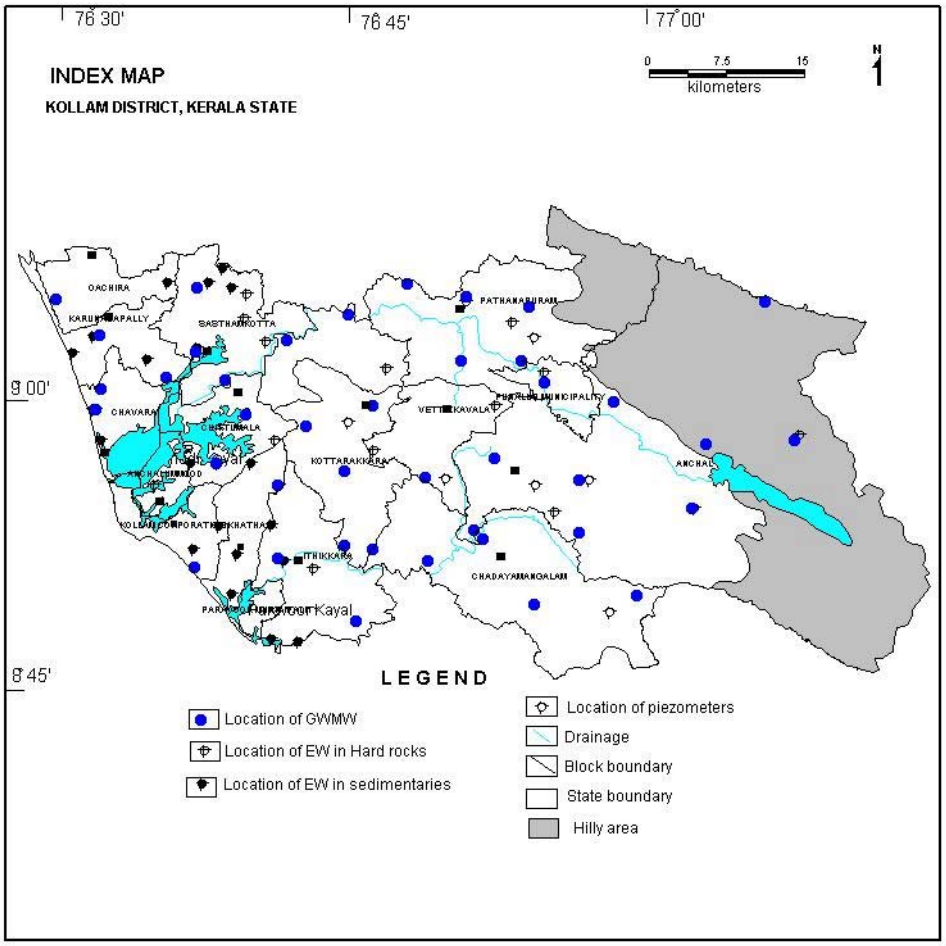

76 30'
76 45'
77 00'
INDEX MAP
KOLLAM DISTRICT, KERALA STATE
0 7.5 15
kilometers
N
9 00'
8 45'
OACHIRA
KARUNAGAPALLY
SASTHAMKOTTA
PATHANAPURAM
CHAVARA
VETTIKKAVALA
KOTTARAKKARA
ANCHAL
ITHIKKARA
CHADAYAMANGALAM
Kayal
LEGEND
Location of GWMW
Location of EW in Hard rocks
Location of EW in sedimentaries
Location of piezometers
Drainage
Block boundary
State boundary
Hilly area

Figure 4

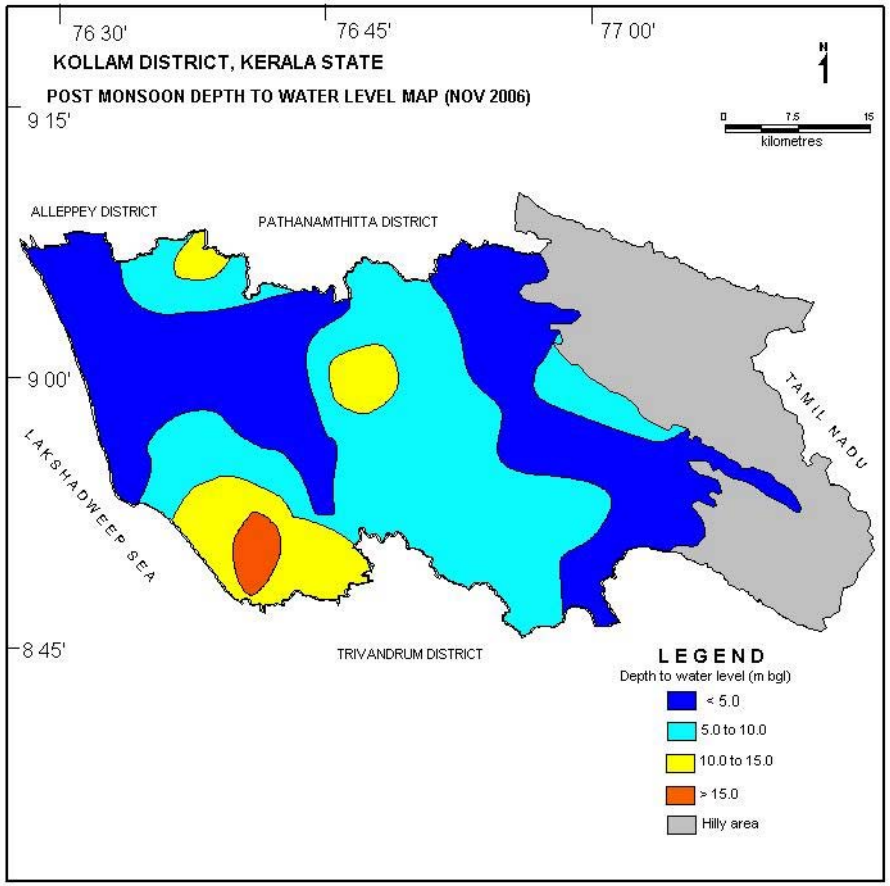
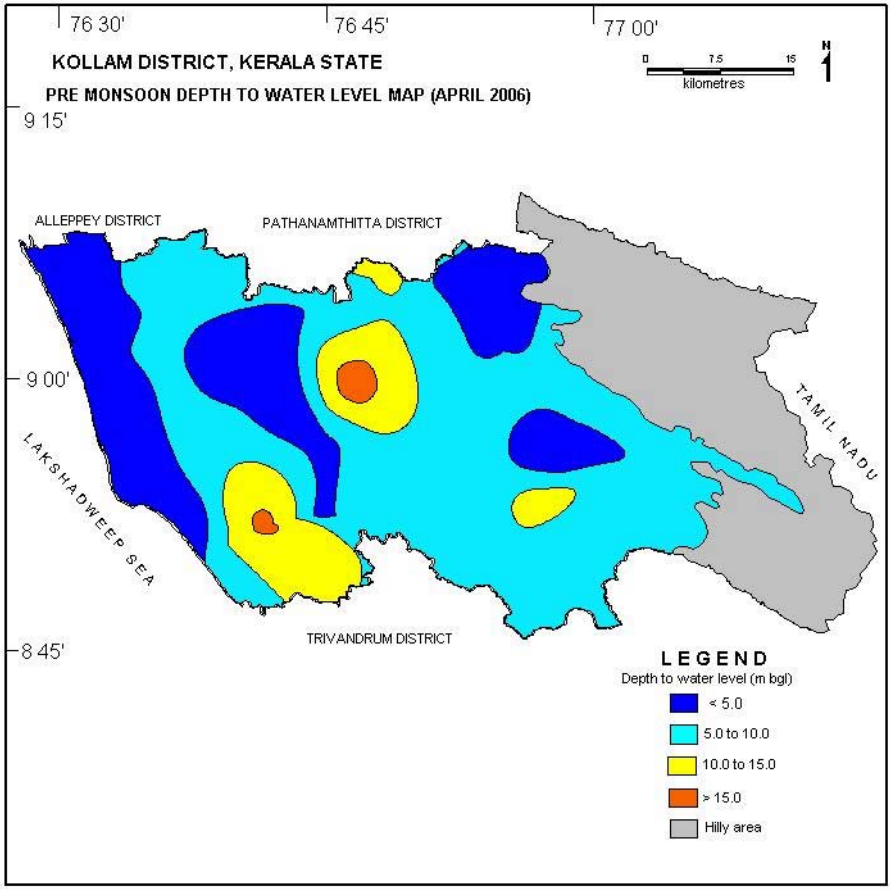

76 30'
76 45'
77 00'
KOLLAM DISTRICT, KERALA STATE
POST MONSOON DEPTH TO WATER LEVEL MAP (NOV 2006)
N
0 7.5 15
kilometres
9 15'
ALLEPPEY DISTRICT
PATHANAMTHITTA DISTRICT
9 00'
TAMIL NADU
LAKSHADWEEP SEA
8 45'
TRIVANDRUM DISTRICT
LEGEND
Depth to water level (m bgl)
< 5.0
5.0 to 10.0
10.0 to 15.0
> 15.0
Hilly area

Figure 3


76 30'
76 45'
77 00'
KOLLAM DISTRICT, KERALA STATE
PRE MONSOON DEPTH TO WATER LEVEL MAP (APRIL 2006)
0
7.5
15
kilometres
N
9 15'
9 00'
8 45'
ALLEPPEY DISTRICT
PATHANAMTHITTA DISTRICT
TAMIL NADU
LAKSHADWEEP SEA
TRIVANDRUM DISTRICT
LEGEND
Depth to water level (m bgl)
< 5.0
5.0 to 10.0
10.0 to 15.0
> 15.0
Hilly area