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CONSERVE WATER – SAVE LIFE

MINISTRY OF WATER RESOURCES

CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET OF KOZHIKODE DISTRICT, KERALA STATE

By

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GROUND WATER INFORMATION BOOKLET OF KOZHIKODE DISTRICT KERALA

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DISTRICT AT A GLANCE

Sl. No.	ITEMS	STATISTICS
1.	**GENERAL INFORMATION**	
	i) Geographical area, km^2	2344
	ii) Administrative Divisions (As on 31-03-2007) Number of Tehsil / Block Number of Panchayat/Villages	 3 / 12 77 / 117
2.	**GEOMORPHOLOGY**	
	Major physiographic units	Lowland, Midland and Highland
	Major Drainages	Chaliyar, Kuttiadi, Mahe, Kadalundi, Kallayi and Korapuzha
3.	**LAND USE (ha)**	
	a) Forest area	41386
	b) Net area sown	232307
4.	**MAJOR SOIL TYPES**	Alluvial soil**,** laterite soil and forest loam.
5.	**AREA UNDER PRINCIPAL CROPS, ha**	210905
6.	**IRRIGATION BY DIFFERENT SOURCES (Areas (ha) and Number of Structures)**	
	Wells (Dug wells &Tube wells / Bore wells)	2561
	Tanks / Ponds	419
	Canals	2237
	Other Sources	780
	Net Irrigated area	5997
	Gross Irrigated area	-
7.	**NUMBER OF GROUNDWATER MONITORING WELLS OF CGWB (AS ON 31-3-2007)** No. of dug wells No. of piezometers	55 32 23
8	**PRE-DOMINANT GEOLOGICAL FORMATIONS**	Archaean Crystalline formation (Gneiss, Charnockite), Tertiary sedimentary formation, Sub-Recent laterite and Recent coastal Alluvium.

9.	**HYDROGEOLOGY** Major Water bearing formation Depth to water level (Premonsoon, April 2006), mbgl Depth to water level (Post monsoon, Nov. 2006),mbgl Long term water level trend in 10 years (1997-2006), m/yr	 Weathered fractured crystalline formations; semi consolidated Tertiary formations, laterites and Recent alluvium. 2.00 to 16.05 0.38 to 9 Rise – 0.0037 -0.3387 Fall – 0.0008 -0.1681
10.	**GROUND WATER EXPLORATION BY CGWB (As on 31-03-2007)**	
	No. of wells drilled (EW, OW, PZ, SH, Total)	EW – 17, PZ –23, SH – Nil. Total – 40.
	Depth range, m	93 to 200
	Discharge, lpm	10- 540
	Transmissivity, m^2/day	9.8 to 104.00
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limits	Quality is good. Major chemical constituents lie within the permissible limits.
12.	**DYNAMIC GROUNDWATER RESOURCES (2004) – in MCM**	
	Annual Replenishable Ground Water Resources	344.81
	Net Annual Groundwater draft	213.38
	Projected demand for Domestic and Industrial uses up to 2025	111.45
	Stage of Ground Water Development, %	61.88
13.	**AWARENESS AND TRAINING ACTIVITY** Mass Awareness Programmes organized Date Place No. of Participants	Nil
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14.	**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**	
	Projects completed by CGWB (No & Amount spent)	Nil
	Projects under technical guidance of CGWB (Numbers)	Nil

15.	**GROUND WATER CONTROL AND REGULATION**	
	Number of Over Exploited blocks	1
	Number of Critical blocks	2
	Number of blocks notified	1
16.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Decline in water level, water scarcity, and salinity ingress in coastal aquifers.

1.0 INTRODUCTION

The district of Kozhikode is one of the coastal districts of Kerala. Kozhikode district is bounded on the north by Kannur district, on the east by Wayanad district, on the south by Malapuram district and on the west by Lakshadweep sea. It lies between North latitudes 11º 08' and 11º 50' and East longitudes 75 º 30' and 76 º 8'. It is falling in parts of Survey of India Toposheets 58 A and 49 M.

The district has an area extent of 2344 sq.km and is accessible by road, rail and air. The national highway (NH -17) connecting Cochin with Mangalore passes through the district. The district headquarters – Kozhikode is well connected by road with the rest of the state. Apart from the above, a number of roads viz. tar roads, metalled roads, unmetalled roads and panchayat roads connect all villages and panchayats of the district. The total length of roads in the district is around 9800 km. The Trivandrum-Mangalore-Mumbai railway is passing through the district. The Kozhikode airport, which operates several international flights to Gulf countries, is situated at Karipur in Malappuram district, which is very close to Kozhikode city. The political history of Kozhikode is a story of treacherous and ill-conceived conspiracies hatched by the Western powers. Vasco Da Gama landed at Kappad (16 km north of Kozhikode) in May 1498, as the leader of a trade mission from Portugal and was received by the Zamorian himself. The district is divided into 3 taluks and 12 developmental blocks and 77 panchayats for administrative purposes. The district has one corporation (Kozhikode) and two municipalities namely Quilandy and Badagara. It has a total of 117 revenue villages (Figure 1).

The district is drained by six rivers of which one is of medium nature and all others are minor ones namely Chaliyar, Kuttiyadi, Mahe, Kadalundi, Kallayi and Korapuzha. The Chaliyar River is a medium river and originates at a height of 2066 m amsl in Ilambalari hills of Western Ghats of Gudallur district, Tamil Nadu. The Chaliyar drains in to Beypore estuary. It is a sixth order stream with a length of 169 km. At its upper reaches it is formed by Punnurpuzha, Pandiyur, Karimpuzha,

Cherupuzha, Kanhirampuzha, Kurumbanpuzha, Vathatpurampuzha & Iruvantipuzha. At its lower reaches near Cheruvannur, it is flowing as a broad river developing inlets.

The Kuttiadi river originates at a height of 1334 m amsl on the western slopes of Wayanad plateau. The river is also known by the name of Murat river. It has a length of 75 km and flows through Badakara and Quilandy taluks. It flows in northerly direction at first then bends and takes southwesterly direction of flow. At Turaiyur it is joined by the Agalapuzha. Further it takes a “U” turn and flow northwesterly direction as the Murat River developing lagoons and joins the sea at Kottakkal near Badagara. The river is dammed at Kakkayam for the hydroelectric project and the tailrace waters of the project are stored at Peruvannamamuzhi, for irrigation.

The Mahe river originates at a height of 910 m amsl at Vanchimagate hills of Wayanad in Western Ghats and flows in the northeastern corner of the district. The course is forming northern boundary of the district. Near its lower reaches it also bends and turns at Kariyad and flow in northwesterly direction and join the sea at Mahe.

The Kadalundi river formed by the union of Olipuzha and Veliyarpuzha and has a length of 130 km. It enters the district at near its mouth of flow with only 14 km length in the district.

The Kallayi river has a length of 22 km. It originates at Cherukulathur, which is at a height of 45 m amsl and drains the district, joining the sea near Kozhikode. It is connected by man-made Buckingham Canal with the river Chaliyar.

The Korapuzha is a small river with a length of 40 km formed by the union of Agalapuzha and Punnurpuzha. It drains into the Arabian Sea at Elathur

The drainage characteristics of the important rivers are shown in Table 1.

Table 1: Drainage Characteristics of rivers

Sl.No	Drainage characteristics	Chaliyar	Kuttiadi	Mahe
1	Catchments area, km^2	2923	583	394
2	Basin length, km	169	75	54
3	Stream order	Sixth	Sixth	Fifth
4	Drainage pattern	Dendritic	Dendritic	Trellis

There is only one major irrigation project in the district namely the Kuttiyadi irrigation project across the Kuttiyadi river. The Kuttiyadi irrigation project (KIP) partially completed in 1972 comprises a main dam 35.5m high across Kuttiyadi at Peruvannamuzhi form a reservoir of storage capacity 113.28 MCM for regulating the yield from the catchment below the Kuttiyadi hydel dam and the tail waters of Kuttiyadi power station and the salient features of Kuttiyadi irrigation project is given in Table 2.

Table 2: Salient features of Kuttiyadi irrigation project

Place	Peruvannamuzhi
District	Kozhikode
River	Kuttiyadi
Latitude	11 º 36’ 45”N
Longitude	75 º 49’ 27” E
Catchment area	10950Ha
Gross storage	121.2 MCM
Live storage	113.9 MCM
Water spread area	1052 Ha
Type of dam	Masonry, gravity
Gross ayacut	31020 Ha
Net ayacut	14550 Ha

Besides the major irrigation schemes, the district is irrigated by number of minor irrigation schemes, lift irrigation schemes, community irrigation schemes, wells and tanks.

The Central Ground Water Board carried out systematic and reappraisal hydrogeological surveys in the district by Shri P. Lakshminarayanan, Shri V. Dhinagaran (1988-89 & 1990-91), Shri K. Balakrishnan (1998-99) and Dr. V S Joji

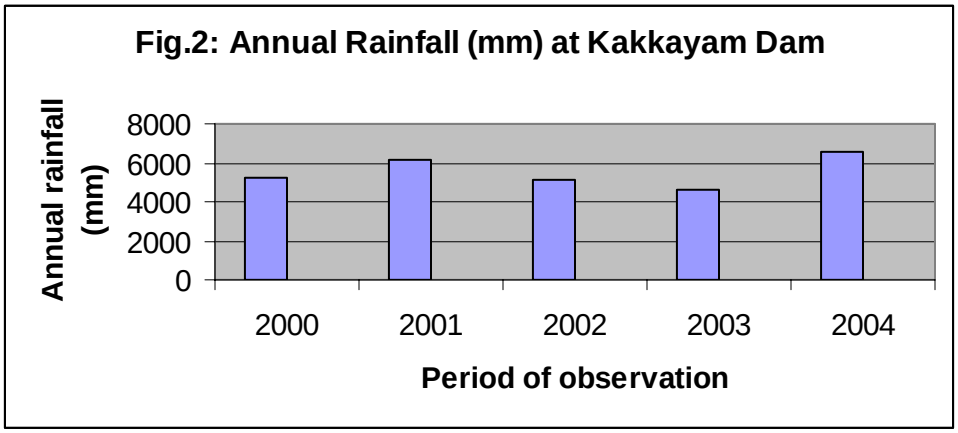
(2004-05). Under the Exploratory drilling programme the Central Ground Water Board carried out drilling in hard rock areas and sedimentary areas of the district during 1994 to 1999. 15 exploratory wells were drilled in hard rock area with depth ranging from 114 to 200 m and in sedimentary areas at Badagara and Melady. Periodical water level and water quality monitoring is being carried out in the district by CGWB and State Groundwater Department.

2.0 RAINFALL AND CLIMATE

Kozhikode district experienced annual rainfall of 3698 mm in the year 2006. The high rainfall areas in the district are Kakkayam dam site and Kakkayam Power House. Kakkayam dam site has been experiencing more than 4500 mm of annual rainfall since 2000. It has been noticed that rainfall displays an increasing trend towards northeastern areas of the district. The climate of the area is divided in to four seasons – summer, South West tropical monsoon period, North East tropical monsoon period and winter. The SW and NE monsoons mainly contribute rainfall in the area with 82.77 % of the rainfall. In 2006 during winter (January to March), Summer (April and May), SW tropical monsoonal (June to October) and NE tropical monsoonal seasons Kozhikode district received 0.49%, 16.74%, 72.15% and 10.63% rainfall respectively. The month of June experiences maximum rainfall. The months of July, August and October also receive heavy rainfall. The annual rainfall received at Kakkayam Dam during the period from 2000 to 2004 years is compiled in Table 3 and depicted in Figure 2.

Table 3: Annual rainfall (mm) received at Kakkayam Dam

Year	2000	2001	2002	2003	2004
Rainfall, mm	5247.7	6177	5078	4656	6515

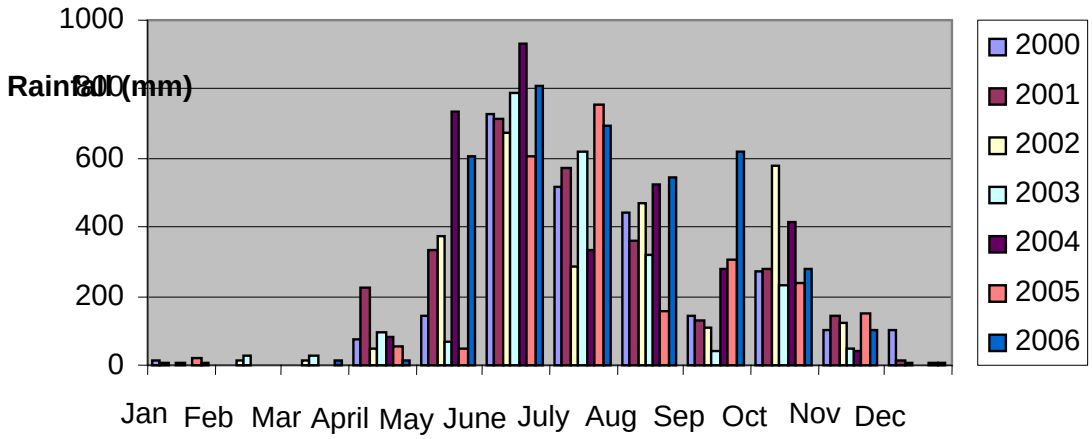


The monthly rainfall of the district for the last 7 years is given below (Table 4). The change in rainfall distribution during the last seven years is depicted in Figure 2a. The agricultural activity of the district depends on the onset of SW tropical monsoon.

Table 4: Rainfall variation in Kozhikode district (2000-2006)

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
2000	11	0	0	76	145	729	514	439	141	270	99	105	2529
2001	9	1	0	225	331	712	573	359	131	281	141	15	2778
2002	0	17	12	51	373	671	288	472	107	575	123	5	2694
2003	5	27	27	95	69	789	617	323	44	231	47	1	2275
2004	1	0	1	85	733	935	333	522	279	418	41	0	3348
2005	22	0	0	57	48	606	754	159	308	236	147	10	2347
2006	6	0	12	13	606	811	694	547	616	279	105	9	3698

Fig.2a: Change in rainfall distribution (mm) in Kozhikode district



2.3.1 Other meteorological parameters

The various meteorological parameters other than rainfall are discussed in brief.

2.3(a) Temperature

The minimum temperature ranges between 22 and 25.8ºC and the maximum between 28.2 and 32.9ºC. The temperature reaches its peak in the month of April and attains minimum in January.

2.3(b) Relative Humidity

The relative humidity ranges from 74 to 92 % during morning hours and from 64 to 89% in evening hours. The monsoon months record high humidity.

2.3(c) Wind speed

The wind speed ranges from 8.1 to 12.6 km/h. The maximum wind speed is during April and minimum in November.

2.3(d) Potential Evapotranspiration

The annual Potential Evapotranspiration (PET) is 1505.7 mm. The monthly PET ranges from 92.9 to 170.2 mm. The PET is less than the rainfall during May to November and hence the possibility of recharge to ground water regime is more during these months.

3.0. GEOMORPHOLOGY AND SOIL TYPES

The physiographic divisions of Kozhikode district are low land (<7.6 m amsl), mid land (7.6 to 76 m amsl) and high land (above 76 m amsl). The highest elevation of the district is 1935 m amsl at Nilamala in northeastern corner of the district.

The low land extends as a narrow stretch of land lying along the coast from south Kadalundi to North Mahe. The height of the plain is less than 7.6 m amsl. The plain is interrupted by steep laterites cliffs and rock outcrops. The low land forms 6.7% of the total area of the district.

The midland area lies at a height between 7.6 and 76 m amsl. It may be further classified into low rolling terrain and moderately undulating terrain. The low rolling terrain has a slope of less than 15%. It consists of rolling laterite hills surrounded by valleys. The valleys are flood plain alluvium and red loamy soil. The moderately undulating terrain covering large area of the district has a slope between 15 and 25%. In addition to the agricultural crops of paddy and coconut, cash crops like rubber and arecanut are cultivated.

Area with elevation above 76 m amsl is called the highland. It is in the eastern part of the district. The area is prone to landslides and land slips and comprises of steep slopes and barren rocks.

The landform units identified in Kozhikode are alluvial plain, flood plain, valley fill, linear ridge, hillcrest, sloping terrain, rocky slope (scarp face) and hilly terrain. The flood plain and valley fill are the major fluvial landforms whereas moderately

sloping terrain (S2), highly sloping terrain (S3), rocky slope (scarp face), linear ridge and hillcrest are major denudational landform units. The fluvial and gently sloping terrains are promising zones of groundwater. Denudational landforms are unproductive zones.

The soils of the district are alluvial soil, lateritic soil and forest loam.

Alluvial soil seen mostly along the coastal plain and valley. They are coastal alluvial soil and river alluvial soils. They are excessively drained to moderately drained and are of sandy to clayey textures. Majority of the area under riverine alluvium was once occupied by paddy cultivation. But those areas are now utilised for the cultivation of various crops especially plantain. The riverine alluvium contains moderate organic matter, nitrogen, phosphorous and potash.

Lateritic soil is derived from the laterite under tropical climate with alternate wet and dry conditions. It is reddish in colour and well drained gravelly to clayey. They are found mostly along the midland portion of the district. The organic matter in the soil is very less with moderate nitrogen, phosphorous and potash. The pH of soil ranges between 5.5 and 6.5 and texture is clayey loam to silty loam with 5 to 20% coarse fragments. Laterites on high grounds are more compact when compared to the low-lying areas.

Forest loam is deep or very deep and well drained loamy to clayey textures. They are rich in organic matter, nitrogen and humus. Forest loam is dark reddish brown in colour formed by weathering under forest cover with loamy to silty loam texture. The pH of the soil ranges between 5.3 and 6.3 and is slightly acidic in nature.

4.0 GROUNDWATER SCENARIO

Groundwater occurs in the weathered and fractured portions of crystalline formations and alluvial formations in the district. Phreatic conditions exist in weathered formation and are mostly developed by dug wells for domestic and

irrigation purposes. Semi-confined to confined conditions exist in deep fractures where storage and movement of groundwater is mainly controlled by the fracture system. Deep bore wells with high yield are located along fractures / lineaments.

4.1 Hydrogeology

The district is mainly underlain by crystalline rocks. The Weathered, Fissured and Fractured crystalline rocks, laterite and alluvium are the major hydrogeological formations occurring in the district.

4.1.1 Crystalline Formation

Groundwater occurs under phreatic condition in weathered crystallines and under confined to semi-confined conditions in deeper crystalline formations. Dug wells are the suitable abstraction structures in this area. The depth to water level varies from 2.00 (Thiruvalloor) to 16.05 m bgl (Kozhikode) during pre monsoon (April, 06) and from 0.55 to 11.40 m gbl during post monsoon (November, 06). The yield of dug wells in phreatic formations ranges between 5 and 10 m^3/day with pumping duration ranging from less than 1 to 4 hours in a day. The open dug wells are used for domestic purposes and their yield reduces during drought periods.

The deep fractures, in crystalline rocks form potential aquifers and ground water is abstracted through bore wells. Semi confined to confined condition exists in the case of water occurring in deep fractures. The fractured deeper aquifers were explored down to a depth of 200 m by CGWB. The depth of casing ranges from 7.00 to 30.5 m bgl. The potential fractures occur between 10.60 and 169.2 m bgl. In the bore wells, fracture zones are found to vary between 50.20 and 169.2 m bgl. The details of EW drilled in the district by the Central Ground Water Board is given in Appendix I. The quality of water in hard rock aquifer is good. The general hydrogeological condition is depicted in hydrogeological map (Figure 3).

In deeper crystalline aquifers fractures are feasible locations for bore wells. High yielding wells can be located along fracture zones identified by proper hydrogeological and geophysical studies. The depth of bore wells drilled by the

CGWB in the district varies from 114 to 200 m bgl with yield in the range of 10 to 1020 LPM. The yield of bore wells in hornblende biotite gneiss varies between 10 and 402 LPM and that in biotite gneiss varies between 150 and 410 LPM. The highly fractured potential aquifer among the crystalline rocks is hornblende-biotite gneiss. The yield of bore wells in Charnockite varies between 82 and 286 LPM. Exploration drilling by CGWB has revealed occurrence of deep potential fractures between 70 and 151 m bgl along lineaments. The maximum discharge observed from these wells is around 1020 LPM (Appendix I). Drilling in the fractured hard rocks indicate that the NE-SW fractures in the biotite gneisses are the most potential fractures in the district. They are followed by the NS fractures.

The over burden thickness is maximum in hornblende biotite gneiss and is generally in the range of 10.5 to 30.0 m and for biotite gneiss from 14.50 to 19.50 m and for charnockites 8.00 – 20.90 m.

4.1.2 Laterite

The midland terrain of the Kozhikode is generally covered by very porous laterite and forms potential phreatic aquifers along topographic lows and valleys. The depth to water level ranges around 2.11 to 16.86 m bgl in pre-monsoon and around 0.33 to 11.84 m bgl in post-monsoon and are developed by open dug wells. The depth of wells ranges between 7.06 and 18.06 m bgl. The yield of the dug wells ranges between 5 and 10m^3 / day.

4.1.3 Alluvium

The alluvium consists of sand, silt and clay, its thickness varies between 2 and 8 m and the ground water occurs under phreatic condition. There are two types of alluvium - riverine and coastal. Coastal alluvium occurs in the western part of district and the riverine alluvium occur along river courses. The abstraction structures in alluvium are dug wells and filter point wells wherever the saturated sand

thickness is 4 m or more. The depth of wells ranges between 3.14 and 9.12 m bgl. The depth to water level ranges from around 2.00 to 6.63 m bgl in pre-monsoon period and from 0.99 to 4.03 m bgl in post-monsoon period. The yield of wells ranges between 30 and 80 m^3/day.

4.1.4 The Tertiary

The Teritiaris occurring in the district are the Vaikom bed and these are occurring below the alluvium and have been encountered at shallow depths in the narrow coastal strip of the district. The thickness and extend of Tertiary beds is very limited with poor ground water potential.

4.2 Water levels

Seasonal fluctuation of the water table is due to variation in the rainfall, evapotranspiration, withdrawals for irrigation and other purposes, base flow, seepage from surface water bodies etc. Pre monsoon (April 2006) depth to water level and post monsoon (November 2006) depth to water level maps are shown in Figures 4 and 5. The annual water level fluctuation is in the range of 0.45 to 4.65 m.

The hydrographs of selected stations for the period from 1996-2005 are shown in Figure 6. Both rise and fall in water level trends can be seen at various locations but any significant change in trend for concern is not observed.

4.3 Groundwater Resources

The ground water resources assessment is based on Groundwater Resource Estimation Methodology 1997 (GEC-'97). Groundwater recharge from rainfall in different blocks during monsoon ranges between 8.53 and 44.45 MCM and that of non-monsoon 3.2 and 11.33 MCM respectively. Existing gross groundwater draft for irrigation ranges between 4.99 and 15.02 for different blocks. The groundwater draft for domestic and industrial use ranges between 3.93 and 12.45 MCM for different blocks. Kozhikode block comes under over–exploited category, Balusserri and Tooneri critical, Chevayoor semi- critical and the remaining blocks are safe (Figure 7).

The gross draft for all uses in 2004 (in MCM)

Sl. No	Block	Net Annual GW Availability	Existing Gross GW Draft for irrigation	Existing Gross GW Draft for domestic and industrial water supply	Existing Gross GW Draft for all uses
1	Badagara	19.16	4.99	4.65	9.64
2	Balusseri	22.50	19.16	8.71	27.87
3	Kozhikode	18.90	7.04	12.45	19.49
4	Chevayoor	20.58	10.03	7.83	17.86
5	Koduvally	42.42	15.02	9.84	24.86
6	Kunnummel	22.32	7.67	7.13	14.80
7	Kunnamangalam	36.60	13.06	11.58	24.64
8	Meladi	42.42	9.56	4.74	14.30
9	Panthalayani	49.52	9.17	3.93	13.10
10	Perambra	26.49	13.57	5.99	19.56
11	Thodannur	30.10	8.11	4.82	12.93
12	Tooneri	13.80	9.25	5.08	14.33
Total		344.81	126.63	86.75	213.38

4.4 Groundwater Quality

The quality of water from shallow and deep aquifers in the district is good for domestic and irrigation purposes. The electrical conductivity (EC) is a measure of mineralisation in water and it depends on degree of weathering and mineralisation. The EC of water samples collected from shallow aquifer of GWMW ranges between 50 (Punnasserri) and 661 (Kozhikode) micromhos/cm at 25^{o}C. The pH value of water ranges from 6.29 to 8.29 indicating neutral to alkaline and occasionally acidic nature. Total hardness of water samples ranges between 12 and 155 mg/l as Ca CO_3 shows soft nature of the water.

The qualitative studies indicate that the cations and anions are within the permissible limit. The water from the shallow aquifers is good and potable. As per the drinking water standards of Bureau of Indian Standards (BIS) all the major chemical constituents including fluoride in the groundwater of Kozhikode district is within the permissible limit and is suitable for all purposes. The chemical quality data of water samples of the area is compiled (Appendix II).

The quality of water from deep aquifers also indicates that the water is suitable for drinking water purposes and various parameters are within the permissible limits prescribed by Bureau of Indian Standards.

4.5 Status of groundwater development

The stage of groundwater development in the district of Kozhikode during 2004 is 61.88 %, leaving scope for further development. At present about 126.63 MCM of groundwater is used for irrigation out of the net annual groundwater availability of 344.81 MCM. A balance of about 120.53 MCM is left for future irrigation developments. This shows the vast scope for irrigation using groundwater. The block wise stage of groundwater development and resource available for future development is given below.

S.No	Block	Net annual GW availability, MCM	Net GW availability for future irrigation development, MCM	Stage of GW Development, %	Categorization of Block
1	Badagara	19.16	8.23	50.31	Safe
2	Balusseri	22.50	0.0	123.87	Critical
3	Kozhikode	18.90	0.0	103.12	Over exploited
4	Chevayoor	20.58	0.55	86.78	Semi critical
5	Koduvally	42.42	14.63	58.60	Safe
6	Kunnummel	22.32	5.51	66.31	Safe
7	Kunnamangalam	36.60	8.87	67.32	Safe
8	Meladi	42.42	26.74	33.71	Safe
9	Panthalayani	49.52	35.10	26.45	Safe
10	Perambra	26.49	5.09	73.84	Safe
11	Thodannur	30.10	15.81	42.96	Safe
12	Tooneri	13.80	0.0	103.80	Critical
Total		344.81	120.53	61.88	

The groundwater is mostly used to irrigate the standing paddy crops during fag end of the season and some cash crops and vegetables after the monsoon. During the SW and NE monsoon period from June to November, no irrigation is required. The main ground water abstraction structures used for irrigation are dug and bore wells. The yield of dug wells located along the valleys and in alluvium is higher than that in weathered crystallines. The yield of dug wells varies from less than 500 to 10,000 LPH and can sustain pumping for a period of less than an hour to 3 hours. Mostly centrifugal pumps of 1 to 3 HP are installed in shallow irrigation wells. The cost of construction of dug wells in alluvium and valley fills comes to around Rs. 25,000/- including the cost of pump set. In weathered crystalline it may go up to Rs. 30,000/-.

The tube wells, dug wells, tanks/ponds and public taps are employed for urban and rural water supply in the district of Kozhikode. The public taps are the main means of water supply followed by dug wells, tanks/ponds and tube wells. The Drinking water facility in Kozhikode district in different blocks is compiled.

Drinking water facility in Kozhikode District

Block	Public tube wells	Public wells	Public tanks/ponds	Public taps
	Nos	Nos	Nos	Nos
Vadakara	26	69	8	533
Tooneri	25	55	12	394
Kunnummal	42	119	22	383
Thodannur	14	27	5	373
Melady	17	60	8	355
Perambra	53	84	19	680
Balussery	38	87	25	405
Panthalayani	24	89	6	360
Chelannur	23	94	23	231
Koduvally	30	105	12	668
Kunnamangalm	52	238	18	581
Kozhikkode	19	77	25	608

5.0 GROUNDWATER MANAGEMENT STRATEGY

Kozhikode district with the three physiographic units of low, mid and high lands needs different water management strategies to suit its physiography. Implementation of water management strategies and recharge structures are to be designed and promoted with people's active participation at grass root level to make it a grand success.

The high lands have high run off rate and also more sensitive to vagaries in climatic conditions, hence need more attention in the implementation of water conservation and recharge structures. There are numerous soil conservation structures like contour bunding, terrace cultivation, gully plugging etc, which act as water recharge structures in high lands. The wide network of drainage developed by the rivers in the district has numerous ideal locations for check dams, which may act as water conservation and recharge structures.

The artificial recharge structures suitable for Kozhikode district are percolation tanks, gully plug, check dams, sub-surface dykes and roof top rainwater harvesting. Rainwater harvesting for groundwater recharge as well as for storage in tanks for

drinking water purpose can be promoted by popularizing the techniques on water harvesting especially in the northeastern areas of the district.

Percolation tanks are suitable for areas with valley fill, colluvium and highly weathered rocks. Check dams can be constructed across small streams with gentle slope with permeable beds and such sites are available in all the blocks except the Kozhikode, Badakara and Meladi.

Sub-surface dyke along gently slopping wide valleys with narrow out let are effective groundwater conservation structures at different areas of Balusserri, Kunnummal, Tooneri, Koduvalli and Kunnamangalam blocks.

A large number of springs (46 numbers) in the district can be developed for drinking water supply. The springs in Kozhikode district are not effectively utilised for drinking water supply. Desiltation of tanks / ponds may augment the groundwater recharge. The rainwater harvesting and other water conservation and recharge structures can be popularised through mass awareness programmes and training programmes.

Dug well recharge can be practiced in Badakara, Meladi, Panthalayani, Chelavoor and Kozhikode blocks. In areas with high degree of urbanisation with less land holdings, people can practice rainwater harvesting using storage tanks.

Gully plugs are suitable for all high land areas with local break in slope especially in the high land terrains of Koduvally, Perambra, Tooneri, Kunnummal and Balusserri blocks.

5.1 Groundwater Development

On the basis of groundwater development the blocks are categorised into over exploited, critical, semi-critical and safe. Stage of groundwater development in different blocks of the district ranges between 26.45 and 123.87 %.

The common abstraction structures in all the blocks of Kozhikode district are open dug wells and bore wells fitted with hand pumps. The groundwater development reported maximum in Balusserri (123.87%) and minimum in Pathalayani (26.45%) among the 12 revenue blocks. The ground water draft is mainly used for drinking and irrigation purposes in all the blocks. A spurt in the construction of bore wells in the district has been reported in recent years. Bore wells are mainly used for irrigation purpose. A groundwater prospect map shown in Figure 3.

5.2 Water Conservation and Artificial Recharge

As Kozhikode is covered by a good drainage net work formed by Chaliyar, Kuttiadi, Mahe, Kadalundi, Kallayi and Korapuzha and their tributaries, the district is suitable for the implementation of various Minor Irrigation (MI) schemes such as lift irrigation, diversion weirs, vented cross bars (VCB), check dams, irrigation tanks/ ponds. The minor irrigation schemes are utilized for integrated paddy field development, Western Ghat Development, vegetable cultivation and drought mitigation.

The artificial recharge schemes proposed by CGWB are gully plug, desilting and renovation of ponds and tanks, subsurface dyke and check dam and roof top rainwater harvesting etc. The artificial recharge schemes viable in the Blocks are depicted in Figure 8.

S.No	Name of Block	Artificial Recharge Schemes				
		Gully plug	Desiltation & deepening of pond/tank	Subsurface Dyke	Check dam	Roof top rainwater harvesting
1	Vadakara	-	2	-	-	4
2	Tooneri	5	2	1	2	2
3	Kunnummal	2	3	1	2	4
4	Thodannur	3	4	-	-	5
5	Meladi	5	4	-	-	-
6	Perambra	4	4	1	3	5

7	Balussery	4	4	1	3	3
8	Panthalayani	3	4	-	-	5
9	Chelannur	3	4	-	-	5
10	Koduvally	4	3	1	2	5
11	Kunnamangalm	4	3	1	2	5
12	Kozhikkode		5	-	-	6
Total		37	40	6	14	45

6.0 GROUNDWATER RELATED ISSUES AND PROBLEMS

The major problems noticed in the district are water scarcity, decline in water level and localised pollution etc.

Water scarcity is a severe problem during the drought period in many blocks especially those bordering Wayanad district namely Tooneri, Kunnummal, Perambra, Balusserri, Koduvalli and Kunnamangalam. The people of the high land areas are walking far distances for fetching drinking water. Decline in water level is observed at many places in the district.

Rainwater-harvesting structures have been constructed in a number of places. Most of these are storage tanks for collection of rainwater falling on rooftops. They are doing only storage rather than recharge to groundwater system. Now most of the structures require renovation for the proper storage. Most of the tanks and ponds in the district are filled with silts and waste materials. The ponds in the district are not recharging water into ground water system due to siltation.

Direct pumping of water from rivers is very common in the district especially by those people residing on the banks of rivers. The river water is exploited by constructing infiltration galleries to large wells and the galleries are open to the river channel.

Localised pollution is reported from many areas in the district, especially from effluent and sewage discharges from factories and hotels.

7.0 AWARENESS AND TRAINING PROGRAMME

The central Ground Water Board, Kerala Region conducted Water Management Training programmes at Kozhikode to impart training on rainwater harvesting. The training programmes have been found very useful by the participants as was evident by the number of queries and discussions that followed the lectures. The training programmes witnessed gathering of 85 to 95 delegates from all walks of like viz. $NGO_{S,}$ farmers, housewives, students, officers and staff of State Government departments.

8.0 AREAS NOTIFIED BY CGWA/SGWA

Kozhikode block of the district is notified by CGWA/SGWA as the block is over exploited. The further development of the ground water should be restricted.

9.0 RECOMMENDATIONS

1. The stage of groundwater development in Kozhikode district during 2004 is 61.88 % leaving wide scope for future development except in Kozhikode, Balusserri, Tooneri and Chevayoor.
2. The groundwater development in the blocks of Kozhikode, Balusserri, Tooneri and Chevayoor are more compared with other blocks. The Kozhikode, Balusserri, Tooneri and Chevayoor blocks come under over exploited, critical, critical and semi-critical categories respectively. Hence, future development may be restricted in these blocks.
3. In Kozhikode district there are 46 numbers of springs, which are the perennial sources for drinking water. These have not been developed so far effectively. Attention may be given for the proper rejuvenation of springs as the spring water is usually free from pollutants, perennial and can be supplied to the down streams by gravity flow.

4. The existing dug-wells, ponds, tanks and streams should be cleaned, protected and conserved.
5. In order to have a proper assessment of the groundwater resources at micro level, studies may be undertaken particularly in the over-exploited and critical blocks.
6. Groundwater development should be limited with conjunctive use of rainwater and surface water. More stress should be given for watershed development for better water management. The existing water sources viz. dug wells, ponds & tanks should be protected and conserved.
7. Proper water budgeting in the district should be carried out. There are number of minor irrigation and water supply schemes in the district, which require periodic maintenance and attention.
8. A technical database has to be created at CGWB Regional Office, incorporating data from GWD and other agencies. This may be disseminated to the public through local bodies and NGOs.
9. Mass awareness programmes may be organised in Panchayath level to make awareness among people about the importance of conservation of water resources. Stress should be given for integrated watershed management and conjunctive use of water resources in the district.
10. The agriculture as well as inhabitation is concentrated along valleys and in certain pockets. Groundwater draft is restricted to such areas. Whereas, the groundwater resources are computed for the entire district. Due to this peculiar situation, the recharge computed is comparatively high in the district. Hence, the resource assessment made on watershed/ micro-water shed basis will be more useful and reliable.

Figure 1: Index Map of Kozhikode District

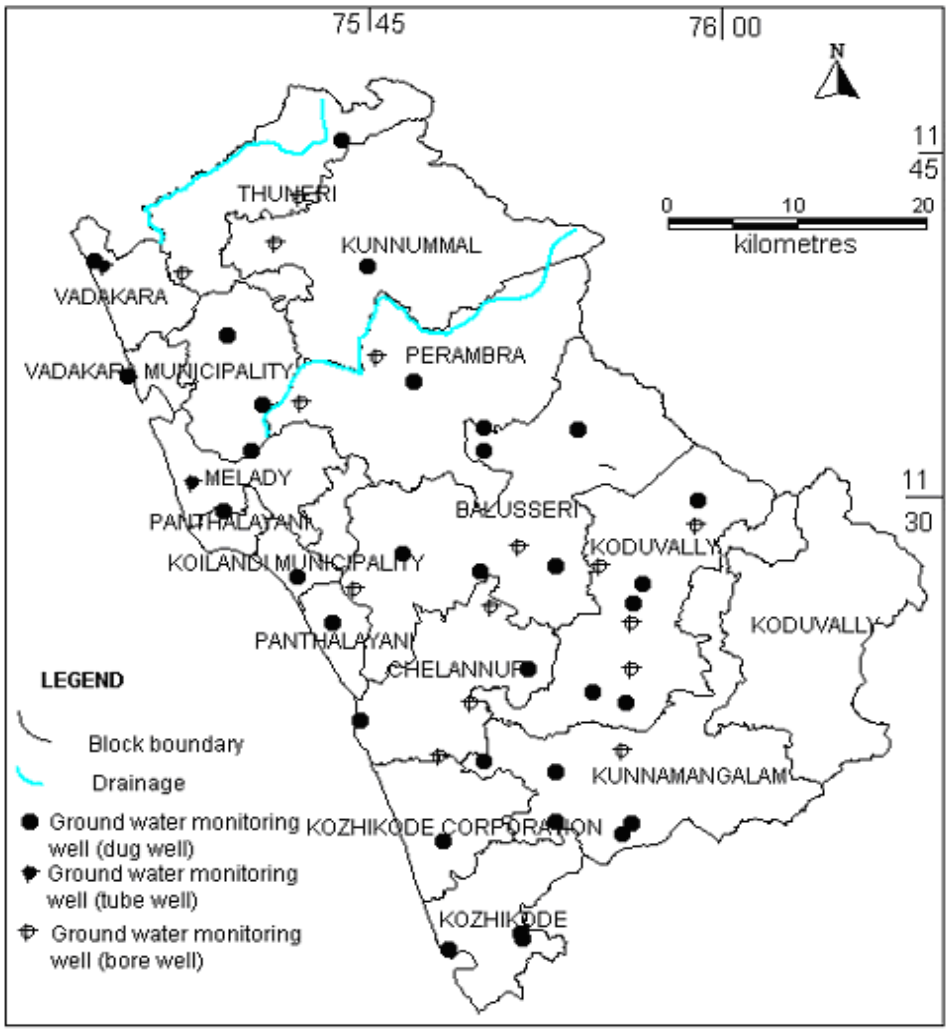


Figure 3: Hydrogeological Map of Kozhikode district

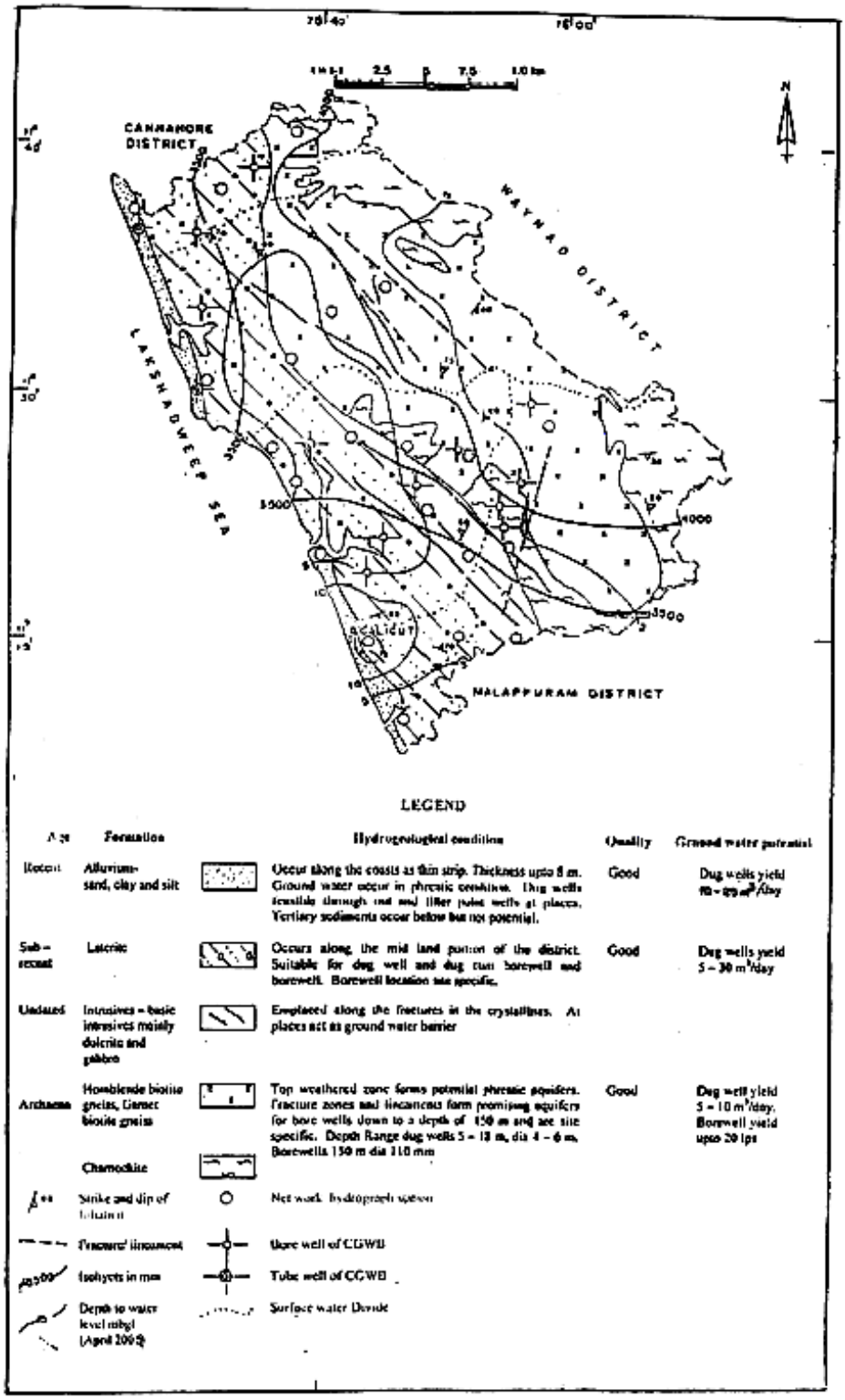


Figure 4: Pre monsoon depth to the water level in Kozhikode district (2006 April)

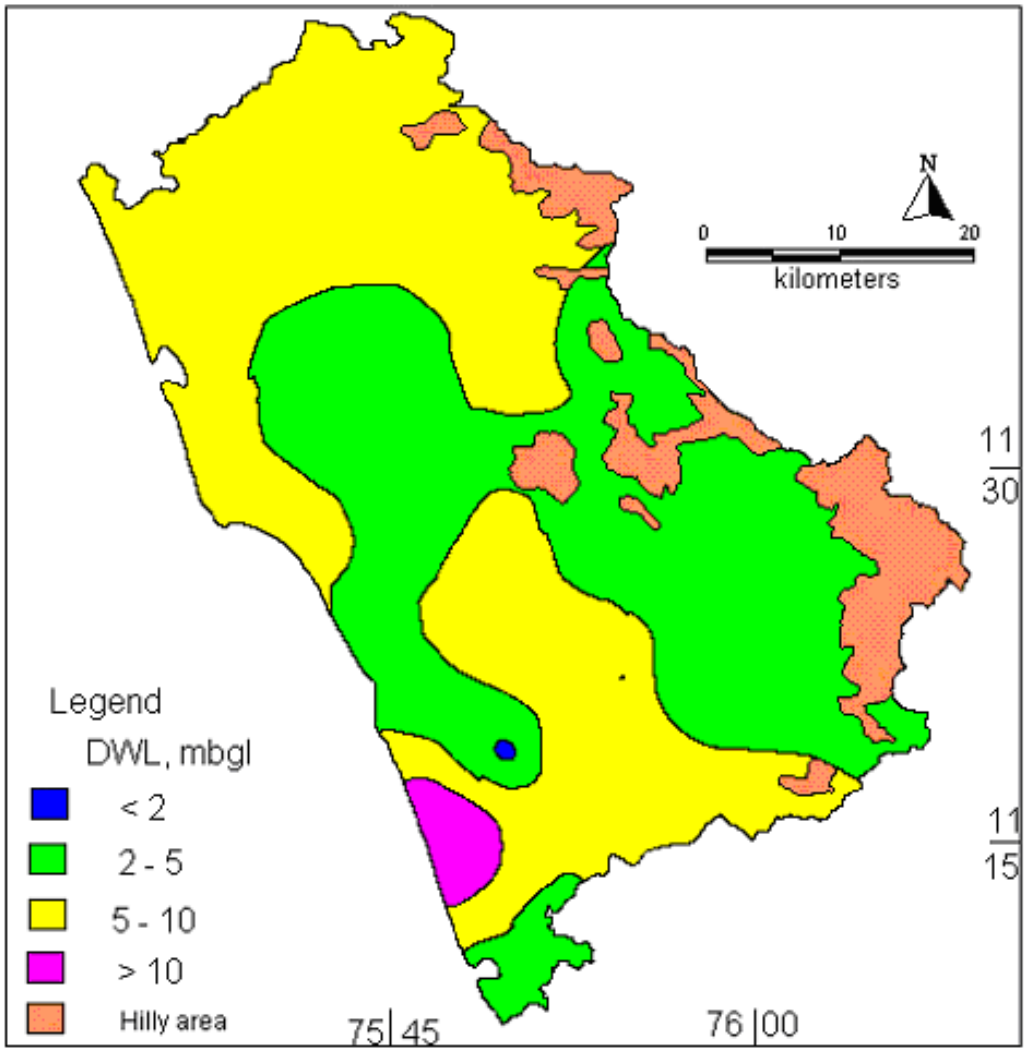


Figure 5: Post monsoon depth to the water level in Kozhikode district (2006 November)

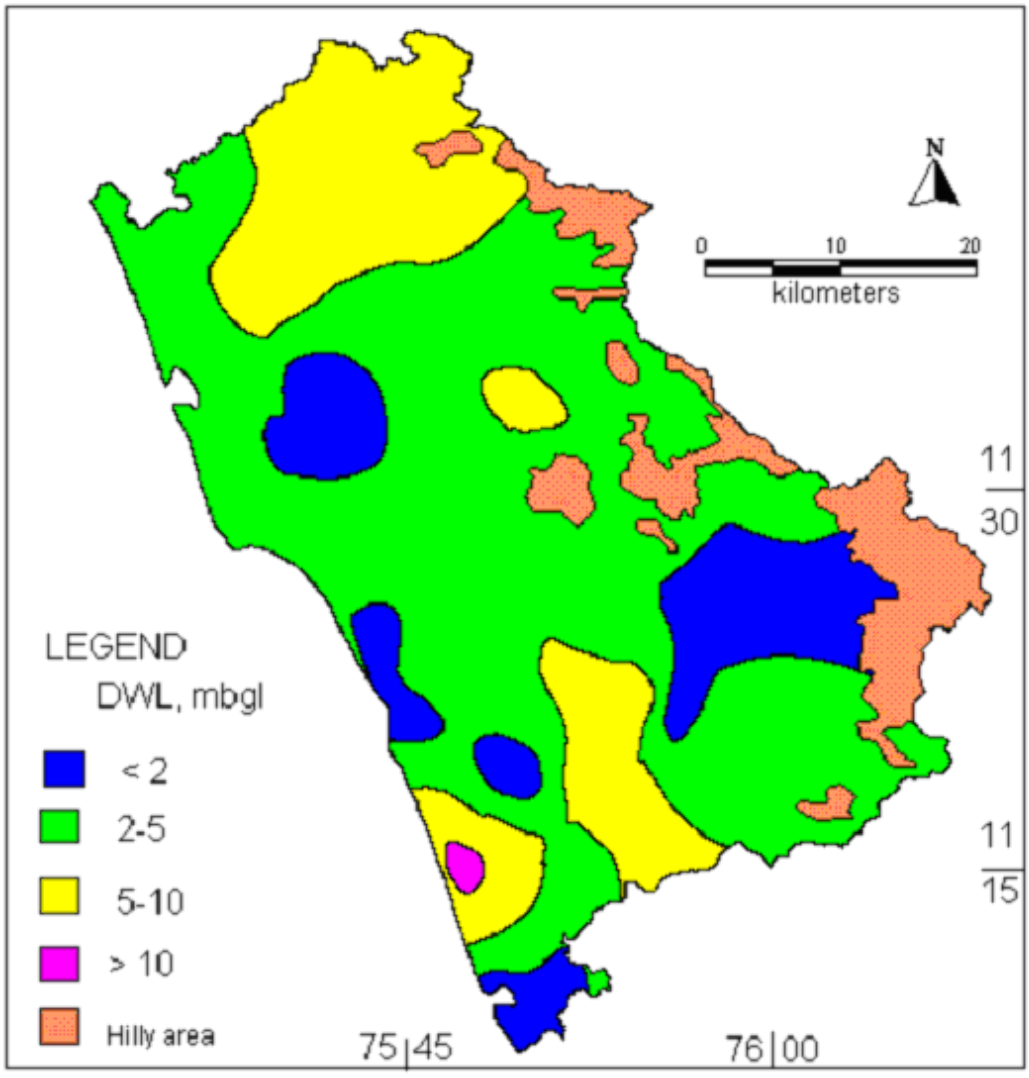
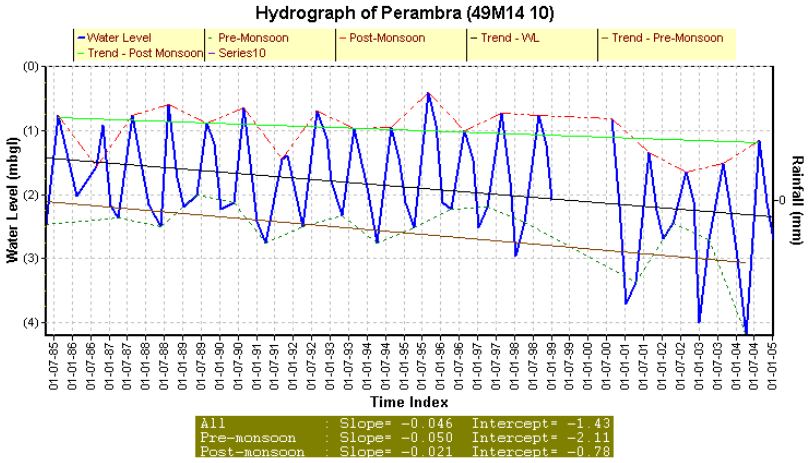
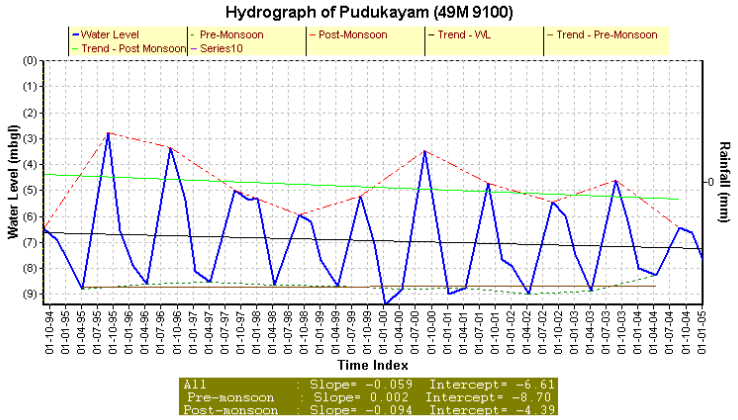


Figure 6: Hydrographs of Selected Stations





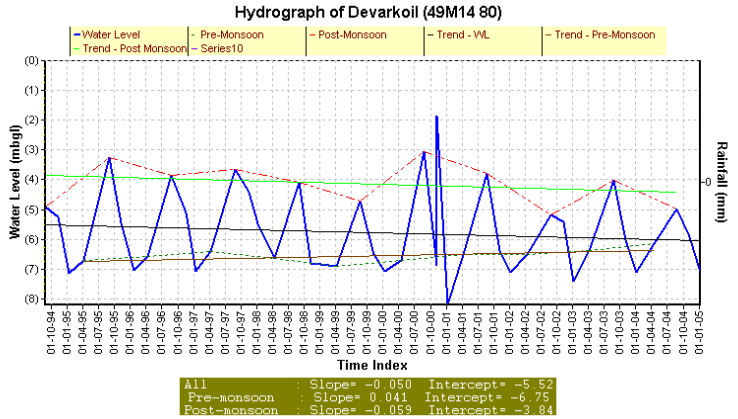


Figure 7: Categorisation of Blocks in Kozhikode District

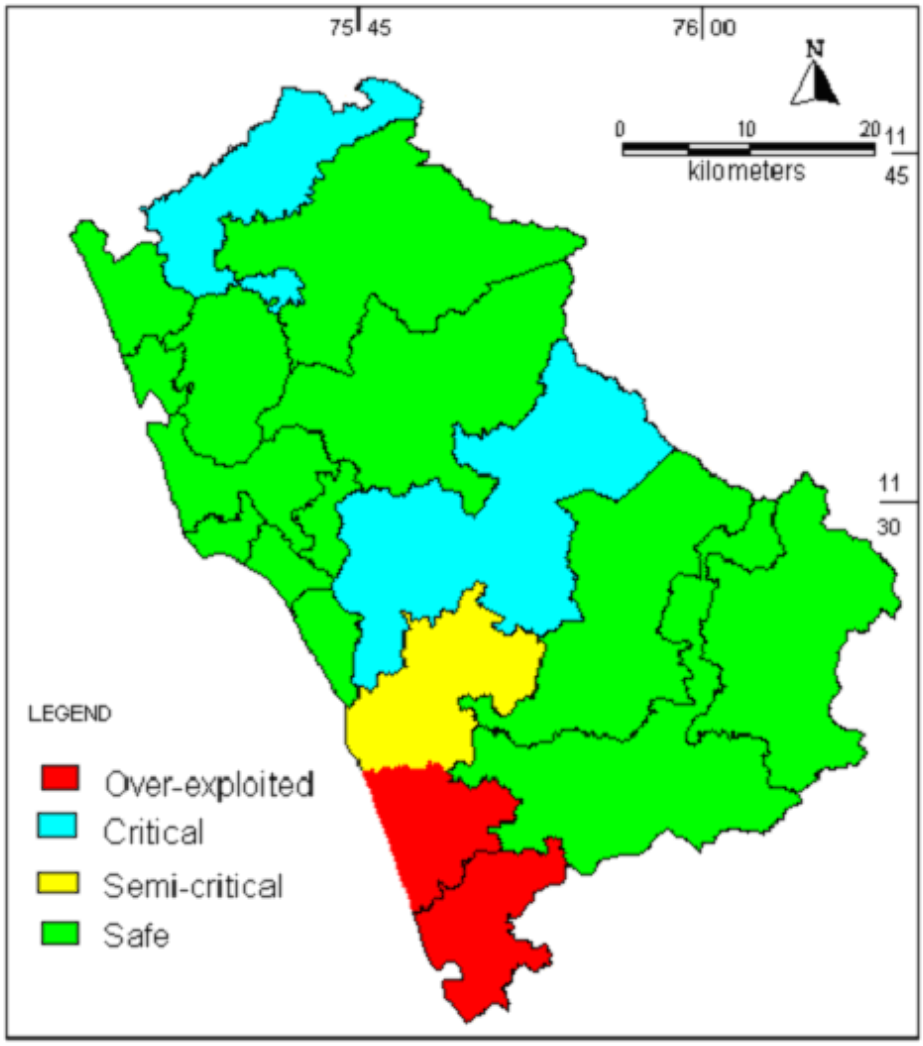
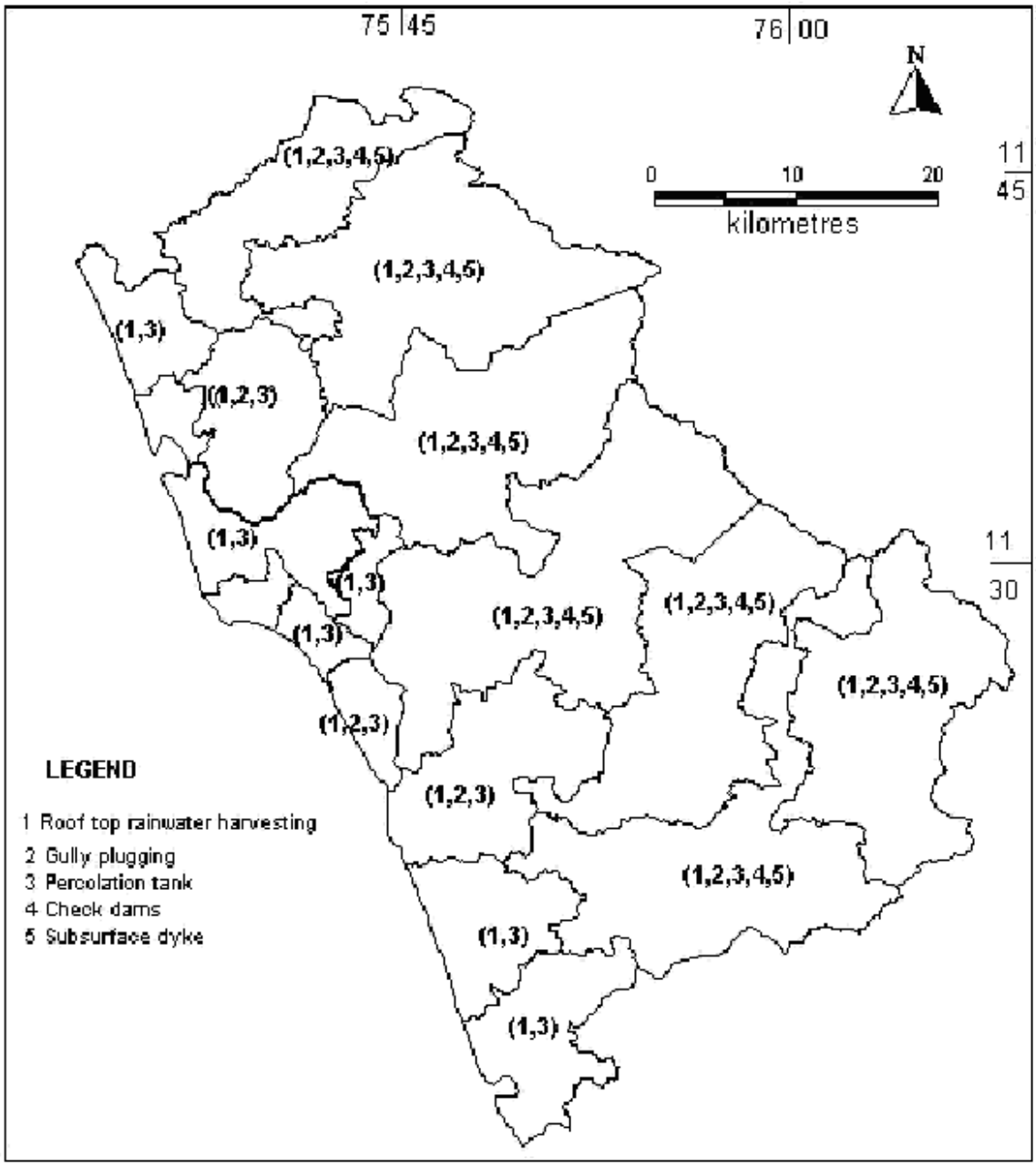


Figure 8: Artificial recharge schemes proposed for Kozhikode district



Appendix I: Details of Drilling carried out by CGWB in Kozhikode district

Location, coordinates & toposheet No.	Lineament	Depth & SWL, m bgl	Casing, m bgl	Fracture zones & yield, lpm	Discharge, lpm	T, m^2/day	EC micro mhos/cm at 25^0 C	Cl, ppm	Rock type
Thamarasseri, $11^0$24'30", $75^0$56'10", 49 M/15	NS	135, 13.30	16.70		540		213	43	Charnockite
Kuttoth, $11^0$26'00", $75^0$44'20", 49 M/11	NS	160, 12.67	27.20		420		2930	831	Horneblende biotite gneiss
Edacherri, $11^0$39'40", $75^0$37'00", 49 M/5 & 10	NNW	200	7.25		Dry		-	-	Horneblende biotite gneiss
Chelakkad, $11^0$41'00", $75^0$41'00", M/10		145 5.95	20.00	28-35, 35-60, 90-99	410		300	13	Biotite gneiss
Paleri, $11^0$36'03", $75^0$45'20", 49 M/14	NE-SW	145 7.64	9.3	142-145	1020	21.57	2340	518	Biotite gneiss
Avala Kuttoth, $11^0$34'05", $75^0$42'05"		185, 4.07	15.00	11-17,148-151	150		4630	1253	Biotite gneiss
Kannadipoil, $11^0$27'50", $75^0$51'20", 49 M/15	EW	200.00, 3.30	7.00		240		286	2.1	
Puduppadi, $11^0$28'43", $75^0$58'56", 49 M/15		114.30	21.20		10				Horneblende biotite gneiss
Vanimel, $11^0$43'00", $75^0$42'00", 49 M/10		175.00, 8.90	30.5		12				Horneblende biotite gneiss
Nanminda, $11^0$25'10", $75^0$50'10"	NA	157.0, 11.77	13.7	NA/366	366	18.18	204	8.5	Horneblende-biotite gneiss
Kalaranthri, $11^0$22'30", $75^0$56'10"	NA	152.4, NA	8.5	71.6-77.7/30	30	NA	286	7.1	Charnockite
Chelapuram, $11^0$18'45", $75^0$48'00"	NA	200.0, NA	21.40	56.3-65.5/60	60	NA	82	9.9	Charnockite
Kakkur, $11^0$21'00", $75^0$49'20"	NA	190.0, 1.26	11.00	56.3-80.7 129.5-169.2 /252	252, 402	104.0	292	19.0	Horneblende biotite gneiss
Vettiozhinjathottam, $11^0$27'00", $75^0$54'50"	NA	200.0, 16.33	16.7	65.5-100.0 150.9-160.0/150	150, NA	9.8	207	5.7	Charnockite
REC Chathamangalam, $11^0$18'55", $75^0$55'48", 49 M/15	NA	200.0, 1.97	13.75	50.2-51.2 67.5-68.5/60	60, NA				Charnockite

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

Location,	RL	Depth	Depth	Zones	Disc harg	Specific	T	EC micro

Appendix II: Chemical quality of water samples of GWMSs of Kozhikode District (2004 April)

Sl. No	Location	pH	EC in µs/cm at 25^{o} C	TH as $CaCO_3$	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	F	NO_3
1	Ramanattukkara	8.16	448	114	23	14	36	5.9	0	95	44	68	0.13	0.53
2	Beypore	8.26	595	155	46	9.7	45	5.8	0	73	20	71	0.13	124
3	Kozhikode	8.21	661	155	52	6.1	44	29	0	67	60	78	0.18	99
4	Peruvayal	8.09	94	26	7.2	1.9	5.5	0.7	0	27	3.7	14	0.07	0.47
5	Mavoor- II	8.1	94	24	8.8	0.49	5.6	4	0	37	2.6	8.5	0.12	0.94
6	Malayamma	8.15	100	30	8	2.4	6.7	1	0	39	2.2	13	0	0.9
7	Thamarasseri	8.01	93	18	5.6	0.97	7.2	4.3	0	27	4.6	13	0.15	1.1
8	Unnikulam	7.66	72	12	4	0.49	8.2	1.2	0	9.8	0.84	13	0.04	9.2
9	Kakkayam	7.89	60	14	4.8	0.49	4.4	1.8	0	24	1.6	4.3	0.13	3
10	Puduppadi	7.56	58	12	4	0.49	5.1	1.2	0	9.8	1.6	11	0.04	4.2
11	Devarkoil	7.47	104	22	7.2	0.97	8.8	1	0	12	0.3	16	0.18	19
12	Pudukkayam	7.79	51	12	4.8	0	3.9	0.6	0	22	0.18	4.3	0.08	0.6
13	Nadapuram	8.16	498	98	30	5.8	47	5.7	0	76	17	94	0.2	25
14	Mukkali	6.29	155	20	6.4	0.97	15	6.2	0	2.4	7.9	21	0.15	34
15	Badagara	8.29	474	126	41	5.8	34	10	0.01	80	41	62	0.26	38
16	Viliyapalli	8.1	118	26	6.4	2.4	11	0.9	0	22	0.48	20	0.13	9.5
17	Thiruvalloor	7.95	111	24	7.2	1.5	9.6	3.9	0	27	4.6	14	0.11	5.8
18	Perambra	7.96	114	48	17	1.5	4.6	1.7	0	63	1	5.7	0.17	1.1
19	Koothali	7.62	64	14	4	0.97	3.7	3.6	0	7.3	1.4	9.9	0.15	9.7
20	Balusseri	7.98	213	44	12	3.4	26	4.1	0	29	1.3	50	0.14	22
21	Punnasseri	8.02	50	12	4	0.49	4.6	1.4	0	17	0.48	5.7	0.16	1.9
22	Koyilandy	8.42	317	84	29	2.9	20	10	2.4	56	18	36	0.12	39
23	Tikkodi	7.87	133	22	6.4	1.5	14	3.1	0	7.3	0.78	23	0.16	20
24	Chemencheri	7.81	128	34	13	0.49	9	1.7	0	20	17	11	0.09	14
25	Elattur	8.26	191	68	26	0.97	11	1.6	0	71	15	17	0.16	3.3
26	Kannankara	8.28	150	30	8.8	1.9	15	2.3	0.01	29	12	24	0.05	2.5
27	Chelavoor	8.77	150	20	7.2	0.49	20	2.4	2.4	34	3.8	20	0.04	16
28	Koduvally	8.3	108	34	8	3.4	9.2	1.3	2.4	59	1.4	4.3	0.08	0.52