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CONSERVE WATER – SAVE LIFE

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

GROUND WATER INFORMATION BOOKLET OF PATHANAMTHITTA DISTRICT KERALA STATE

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GROUND WATER RESOURCES AND DEVELOPMENT POTENTIAL OF PATHANAMTHITTA DISTRICT KERALA STATE

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DISTRICT AT A GLANCE

Sl No.	ITEMS	STATISTICS
1.	**GENERAL INFORMATION**	
	i) Geographical area (Sq km)	2731
	ii) Administrative Divisions (As on 31-03-2007) Number of Tehsil/Block Number of Panchayat/Villages	Taluks : 5 Blocks : 9 Municipalities : 3 Panchayats : 54
2.	**GEOMORPHOLOGY**	
	Major physiographic units	Coastal Plain, Midland and Hill ranges
	Major Drainages	Pamba and Kallada Rivers
3.	**LAND USE (Sq km)**	
	a) Forest area :	1552
	b) Net area sown :	833
4.	**MAJOR SOIL TYPES**	Forest loams, Lateritic soil, Brown hydromorphic, Riverine Alluvium, Greyish Onattukara
5.	**AREA UNDER PRINCIPAL CROPS**	Rubber : 34794 ha Paddy : 13537 ha Tapioca : 12776 ha Banana : 7173 ha Coconut : 21467 ha
6.	**IRRIGATION BY DIFFERENT SOURCES (Areas)**	
	Wells(Dug wells &Tube wells / Bore wells)	1891 hectares
	Tanks / Ponds	109 hectares
	Canals	1649 hectares
	Other Sources	2470 hectares
	Net Irrigated area	6119 hectares
7.	**NUMBER OF GROUNDWATER MONITORING WELLS OF CGWB (AS ON 31-3-2007)** No. of Dug wells No. of Piezometers	 32 10

8	**PREDOMINANT GEOLOGICAL FORMATIONS**	Archaean Crystalline formation (Gneiss, Charnockite, etc), Tertiary sedimentary formation, Sub-Recent laterite and Recent Alluvium.
9.	**HYDROGEOLOGY** Major Water bearing formation Depth to water level in mbgl (Pre-monsoon, April 2006) Depth to water level in mbgl (Post-monsoon, August 2006) Long term water level trend in 10 years(1997-2006) in m/yr	 Weathered, fractured crystalline formations; semi consolidated Tertiary formations, laterites and Recent alluvium. 1.40 to 11.43 0.32 to 9.54 29% wells show falling trend in the range of 0.006 to 0.13 m/year. 71% wells show rising trend in the range of 0.004 to 0.21 m/yr
10.	**GROUND WATER EXPLORATION BY CGWB (As on 31-03-2007)**	
	No. of wells drilled (EW, OW, PZ, SH, Total)	EW – 33, PZ –10, SH – Nil. Total – 43
	Depth Range (m)	30- 250
	Discharge (litres per second)	upto 14.51
	Transmissivity (m^2/day)	1.1 to 11.3
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limits(e.g. EC, F, As, Fe)	Quality is good. Major chemical constituents lie within the permissible limits. Fe > 1mg/l is seen in Ranni & Konni blocks
12.	**DYNAMIC GROUNDWATER RESOURCES (2004) – in MCM**	
	Annual Replenishable Ground Water Resources	316.56
	Net Annual Groundwater Draft	100.50
	Projected demand for Domestic and Industrial Uses upto 2025	47.49
	Stage of Ground Water Development	31.75%

13.	**AWARENESS AND TRAINING ACTIVITY** Water Management Training Programmes organized Date Place No. of Participants	 1 October 2003 Pathanamthitta 200
14.	**GROUND WATER CONTROL AND REGULATION**	
	Number of Over Exploited blocks	Nil
	Number of Critical blocks	Nil
	Number of blocks notified	Nil
15.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Decline in water level, Water scarcity during summer months.

GROUND WATER INFORMATION BOOKLET OF PATHANAMTHITTA DISTRICT, KERALA STATE

1.0 INTRODUCTION

Pathanamthitta is an inland district of Kerala State covering an area of 2731 sq.km. It is bordered by Kollam district in the south and Alappuzha in the west, Kottayam and Idukki districts in the north and Tamil Nadu state in the east. It lies between North latitude $9^0$5' and $9^0$28' and East longitudes $76^0$30' and $77^0$17' falling in the Survey of India degree sheet No.58C and G. The district has 5 taluks comprising 9 blocks with 3 municipalities. Ranni is the biggest block with an area of 1004.6 sq.km followed by Konni block constituting an area of 841.26 sq.km. The rest of the blocks have areas ranging from 82 to 205 sqkm (Figure 1).

The total population of the district is 1186561 with a density of population of 434 per sq.km as per the 2001 census. The blockwise population figure indicates that Pulikeezh block has got a maximum density of population of 1311 per sq.km. The blocks in the mid land area have a density of population ranging from 700 to 1000 per sq.km., whereas the hilly blocks of Konni and Ranni have a density of population of only 160 and 161 per sq.km respectively. There are no major industries in the district and only less number of small scale industries exist. Agriculture based industries dominate in the district. The industrial development is more or less restricted to the coastal block of Pulikeezh.

The district is drained mainly by two rivers viz. Pamba and Kallada. The major tributaries of the Pamba river are Achenkovil, Manimala, Kakki, Arudai, Kakkad and the Kallar that drains through major part of the district. The Kallada river flows through the southern portion of the district. Both the Pamba and Kallada rivers are perennial with a drainage density of 0.30 km/sq.km and both are fifth order streams. These rivers with their tributaries exhibit a trellis pattern of drainage in the eastern portion of the hills, sub-trellis pattern in the middle and dendritic pattern in the western part of the district.

Almost 57% of the district area is occupied by forest and only about 31% is the net area sown. Important crops are Coconut, Rubber, Paddy, Banana and Pepper. Though the total cropped area in the district is 1151 sqkm, area sown more than once is restricted to 317 sqkm. The irrigation facilities are confined to valleys in the midland area. Only 2.2% of the district area has irrigation facilities i.e. 6119 hectares and groundwater irrigation is restricted to 1891 hectares only. A small part (600 hectares) of the command area of major irrigation project of Pamba falls in the district. The project uses the tail end water from the Sabirigiri hydroelectric project located in the upstream of Pamba river. Under minor irrigation schemes, surface water through lift irrigation and tanks and ground water through wells are utilised.

Geological mapping was carried out in the district by various officers of the Geological Survey of India. Systematic Hydrogeological Surveys were carried out by Shri. Lakshminarayanan. P of CGWB during 1975-76 & 1982-83. The

SIDA Assisted Coastal Kerala Ground Water Project carried out detailed hydrogeological studies with exploration in the district during the period 1983 – 88. Shri. D.D. Sharma carried out reappraisal hydrogeological surveys during 1989-90. During the years 2001-03, 23 exploratory bore wells were drilled under the ground water exploration programme.

2.0 RAINFALL & CLIMATE

Wet type of climatic condition prevails in the district. The district receives an average rainfall of 3133.9 mm annually. The major rainfall contribution is from south-west monsoon season during June to September. Based on 1901-99 data, rainfall during south-west monsoon contributes nearly 56.8% to the annual rainfall. Followed by this season, the north-east monsoon season from October to December contributes about 21.7% and the balance 21.5% is received from the rainfall during January to May months (summer showers).

The eastern part of the district receives maximum rainfall in comparison with the western part. The area around Konni receives the highest rainfall and the area around Adoor receives the lowest. The month wise rainfall distribution of some of the rain gauge stations in the district is presented in Table 2.1.

Table 2.1 Normal monthly rainfall distribution (1901-99) in mm

	Thiruvalla	**Konni**	**Pathanamthitta**	**Adoor**	**Average**
January	30.3	31	28.4	21.4	27.8
February	27	56.6	46.7	36.4	41.7
March	62.1	132.3	107.3	92.4	98.5
April	145.5	243.2	233.2	186.8	202.2
May	314.2	334.2	312	264.6	306.3
June	639.8	586	565.2	548.9	585
July	588.8	573.8	538.1	499.3	550
August	374.1	408.7	367.4	338.2	372.1
September	284.7	282	275.2	244.8	271.7
October	347	404.8	403.5	338.8	373.5
November	214.9	257.5	263.2	235.1	242.7
December	61.7	57.8	68.9	61.3	62.4
Total	3090.1	3367.9	3209.1	2868	3133.9

The humidity is higher (about 87%) during the monsoon period i.e. from June to September. Generally March and April months are the hottest and December and January are the coldest. The maximum temperature ranges from 28.5^{o} to 32.7^{o}C whereas the minimum temperature ranges from 22.6^{o} to 25.5^{o}C.

3.0 GEOMORPHOLOGY AND SOIL TYPES

3.1 Geomorphology

Physiographically the district can be divided into three units viz. the coastal plain in the west, the mid land region in the center and the hill ranges in the east. (Table 3.1) The elevation of the land varies from <5 to 1500 m amsl. The coastal plain in the western part of the area is restricted to Pulikeezh block of the district with an area of 82 sqkm. The mid land region in the western part of the district is of undulating terrain of low and broad valleys with some valleys becoming narrow close to the foothills. The major part of the area in this region is characterized by thick laterite cover. The foothills of Western Ghats form the hill ranges in the eastern part of the district. The area is characterised by steep hills, narrow gorges and precipitous escarpments and is thickly forested. The elevation rises steadily from 80 to 300 m.amsl beyond which it abruptly increases. Thambimalai with a highest elevation of 1520 m amsl forms a prominent hill in the area.

Table 3.1 Physiographic units in Pathanamthitta District

Sl.No.	Physiographic units	Arial extent (km^2)	Elevation (mamsl)
1	Coastal plain	82	< 5
2	Mid land	700	5 - 80
3	Hill ranges	1950	80-1500

3.2 Soil Types

Based on the morphology, physical and chemical properties, the soils of the district are classified as

(a) Forest Loam,
(b) Lateritic,
(c) Brown hydromorphic,
(d) Riverine alluvium and
(e) Greyish Onattukara.

The diversity of the parental rock, the climatic conditions and differential weathering has lead to the formation of these different soil types. Forest loam is the product of weathering of the country rock under forest cover. Forest loamy soil is encountered in the eastern parts of the district falling in major parts of Ranni and Konni blocks. Lateritic soil is the most widely occurring soil type in the district. This soil is the product of lateritisation of the crystallines and sedimentaries under humid tropical conditions. Brown hydromorphic soil occurs mostly in valley portions in the midland area of the district. The soil is formed as a result of transportation and deposition of material from the adjoining hill slopes under impeded drainage conditions. Riverine alluvium occurs mostly along the banks of rivers and their tributaries. Greyish Onattukara soil is having very limited occurrence in the district and is restricted to the western parts of Pulikeezh block.

4.0 GROUND WATER SCENARIO

Pathanamthitta district is underlain by geological formations ranging in age from Archaean to Recent. About 96% of the area of the district is underlain by crystalline rocks of Archaean age, which have under gone weathering and lateritisation. The Archaean group of rocks comprises charnockites and gneisses along with minor occurrence of pyroxene granulites and are traversed by pegmatite and quartz veins. There are several basic dykes of doleritic and gabbroic composition cutting across the crystalline rocks. The crystalline rocks have undergone several phases of deformation and have suffered intensive fracturing and dislocations. The regional strike of foliation in charnockites and gneisses is generally NW – SE with variation from NNW – SSE to WNW – ESE with steep southerly dips ranging between 60^{o} and 80^{o}. There is one major shear zone – the Achenkovil Shear trending in NW – SE direction along which the Achenkovil river flows. The rest of the area in the north-western parts of the district is underlain by Tertiary sediments equivalent to the Cuddalore and Rajamundry sandstones of east coast with a capping of Recent Alluvium. Lithologically these rocks are composed of carbonaceous clay with lignite, sandstone and grit with alternate lenses and beds of variegated clays.

Ground water in Pathanamthitta district occurs under phreatic condition in the alluvium, laterites and weathered crystallines. It occurs under semi-confined to confined conditions in Tertiary sediments and deep seated fractured aquifers in crystalline rocks.

The important aquifer systems in the district are:

1. The weathered,fissured and fractured crystalline formations,
2. The semi-consolidated Tertiary formations,
3. The laterites and
4. Alluvial formation.

The hydrogeological map of Pathanamthitta district is shown in Figure 5. The description of various hydrogeological units, their aquifer and hydraulic parameters are discussed below;

Crystalline formation

Weathered mantle, partly weathered and fractured zones in the crystallines form potential phreatic shallow aquifer supporting a large no. of dugwells. Charnockite is the dominant rock type in the district except in the southern part where gneisses occur. The thickness of weathered zone in the district ranges less than 1 to more than 10m. The depth of the wells in crystalline rock areas ranges from 2 to 12 mbgl with general depth to water levels in the range of 1.55 to 9.35 mbgl. The yield of open wells in hard rock ranges from 5 to 10 m^3/day.

The SIDA assisted Coastal Kerala Groundwater Project of CGWB explored the potentialities of the deep fractured rocks in the district. During the project 9 exploratory bore wells were drilled. Subsequently 23 bore wells were drilled by CGWB in the ensuing Field Season Programs during the years 2001-

03. The yield of these wells widely ranged from 0.5 to 990 lpm with transmissivity ranging from 1.1 to 11.3 m^2/day. But barring a few wells, yield of borewell was mostly less than 180 lpm. The only borewell along the NNW- SSE lineament had the highest yield of 990 lpm. Boreholes located along NW lineament yielded little water. The depth of borehole drilled ranged from 44 to 257.97 mbgl and depth to weathering varied from 2.50 to 16.50 mbgl. The Static Water Level of these wells ranged
from 1.1 to 3.84 mbgl. The summarized details of the exploratory borewells drilled in Pathanamthitta district is presented in Appendix I.

Semi-consolidated Tertiary formation

The Tertiary sediments belonging to Vaikom bed occur below the alluvium at a depth between 13.7 and 85.7 mbgl with a thickness of 72 m as revealed from the only tube well constructed under SIDA Project, CGWB at Pulikeezh. Groundwater occurs under semi-confined to confined conditions. The static water level is 4.50 m bgl with a high discharge of 16.76 lps. The quality of water from the tube well is brackish.

Laterite formation

The ground water occurs under phreatic condition and is developed by dug wells used for domestic use. The depth of wells in laterite ranges from 5.0 to 13.0 m bgl and depth to water level varies from 3.40 to 11.40 mbgl during pre-monsoon. The wells in laterites have specific capacity ranging from 1.728 to 15.55 m^3/d/m and yield in the range of 5 to 30 m^3/d depending on the size and location of the well.

Unconsolidated Alluvial formation

The alluvial deposits occur along the northwestern portion of the district in Pulikeezh block. This is one of the most potential shallow aquifers and is extensively developed by dug wells for domestic needs. The groundwater occurs in phreatic condition in this formation. The thickness of alluvium is about 13.7 m bgl as indicated by the data of borehole at Pulikeezh. The depth of dug well range from 2 to 5 m bgl. The depth to water level during pre-monsoon period is between 1.40 to 3.35 m bgl. The yield of these wells ranges between 10 to 30 m^3/day.

Fluctuation in Water levels

Ground water level is being monitored through a network of Ground Water Monitoring wells (GWMW) established since 1969. Water level is measured four times a year in the months of January, April, August and November. As on 31.03.2007 the total number of monitoring wells in the district were 42 which include 32 dug wells and 10 piezometers(bore wells). The data from these monitoring wells are analysed and discussed below.

During April 2006, the depth to water levels in monitoring wells in the district ranged from 1.40 to 11.43 mbgl. Shallow water level of less than 2 mbgl is observed in 4.17% of wells and depth to water level in the range of 2 to 5 m bgl in about 41.67% of the wells analysed, whereas it was between 5.0 to 10.00 in 50% of wells. The shallowest water levels in the district were recorded in Pulikeezh block. Water levels in the range of 2.0 -5.0 m bgl were observed in this block. Majority of observation wells in Koipuram, Elanthoor, Kulanada and Konni blocks had water levels in the range of 5-10.0 m bgl. Water levels in the range of 10.0 to 12.0 m bgl were observed in certain parts of Mallappally block. Map depicting the depth to water level during April 2006 is shown in Figure 2.

During post monsoon period (November 2006) the depth to water levels in observation wells in the district ranged from 0.32 to 9.54 mbgl. Shallow water level of less than 2 mbgl is observed in 34.62% of wells and depth to water level in the range of 2 to 5 m bgl in about 42.31% of the wells analysed, whereas it was between 5.0 to 10.00 in 23.08% of wells. No wells had water levels deeper than 10.0 m bgl. The shallowest water levels during the period were observed predominantly in Kulanada, Elanthoor and Pulikeezh blocks. Water levels in the depth range of 5-10 m bgl were observed predominantly in Konni, Ranni and Mallappally blocks. The block-wise minimum and maximum depth to water level during April 2006 and November 2006 is presented in the Table 4.1. Depth to water level during November 2006 is shown in Figure 3.

The difference in groundwater levels during November 2006 compared with the water levels during April 2006 indicate the extent of replenishment of shallow aquifers due to the southwest and northeast monsoon rainfall. The analysis indicates that the water levels have risen during post monsoon period in comparison to pre monsoon in major part of the district. Rise in water levels during the period is in the range of 0.0 to 2.0 in about 50% of wells, between 2.0 to 4.0m in about 37.50% and more than 4m in about 8.33% of the wells.

Table 4.1 Block-wise depth to water level range

Name of Block	No. of wells analysed	DTW in mbgl (April 06)		DTW in mbgl (November 06)	
		Min	Max	Min	Max
Elanthoor	2	3.40	6.25	0.32	3.40
Koipuram	1	8.10	8.10	6.13	6.13
Konni	2	5.07	6.15	1.72	5.54
Kulanada	1	6.90	6.90	2.90	2.90
Mallappally	2	4.25	11.43	2.86	7.60
Parakkode	1	9.60	9.60	2.39	2.39
Pandalam	2	1.40	5.03	0.34	1.95
Pulikeezhu	3	2.35	3.95	0.54	1.29
Ranni	12	1.55	9.85	0.65	9.54

Long term Water level Fluctuations

The long-term water level fluctuations in the district have been analysed using the historical water level data of observation wells in the district. Two methods have been used for the analysis viz. a) Comparison of water levels recorded during April 2006 with the mean April water levels of the previous decade and b) trend of pre monsoon water levels for the last decade.

The analysis of comparison of April 2006 water level with that of decadal mean value of the April water levels of the period 1996-2005 indicate that the water levels have rise in about 87% of the wells throughout the district. The rise in water levels is in the range of 0.05 to 1.85m. Fall in groundwater levels have been observed in about 13% of wells monitored ranging from 0.14 to 1.07m especially in Parakkode block.

The trend of groundwater levels was computed using Simple Linear Regression for pre-monsoon periods for the last decade (1997-2006). The trend analysis for the pre monsoon period indicates that the water levels are showing a rising trend in about 71% of wells analysed. The annual rise in ground water levels in the district ranges from 0.004 to 0.21 m/yr. Declining trends of water levels ranging from 0.006 to 0.13 m/yr have been observed in about 29% of wells.

4.2 Groundwater Resources

Pathanamthitta district receives a normal rainfall of 3133 mm, which forms the most important source of recharge. Recharge also takes place partly by irrigation and seepage from canals. Other sources of recharge includes surface water bodies. The groundwater assessment was done block wise using GEC 1997 methodology and is computed as on March 2004 and these figures are used in this report.

Computation of Recharge

The total annual groundwater recharge of the district has been computed block wise using the data of average water level fluctuations in GWMW and specific yield of the aquifers in the district. The monsoon (after providing for natural discharge) recharge in the district is worked out as 151.41 MCM/Year. The non-monsoon recharge is 145.69 MCM/year and return flow from irrigating fields and other possible sources for recharge was computed separately and it is around 48.09 MCM giving a net annual resource to 316.56 MCM/year. The resources available vary considerably from block to block depending on the geographical area of the block and ranges from 20.68 MCM in Kulanada block to 64.01 MCM in Ranni block. The block wise details are given below in Table 4.2(a).

Table 4.2(a) Block wise groundwater resources in Pathanamthitta District as on 31st March 2004.

Sl. No.	Block	Net Annual Groundwater Availability	Existing Gross Groundwater Draft for all uses	Allocation for domestic and industrial requirement supply up to next 25 years	Net Groundwater Availability for future irrigation development
1	Pulikeezh	26.23	8.07	3.94	17.61
2	Mallappally	22.63	10.04	5.07	11.96
3	Koipuram	22.38	9.91	5.28	11.82
4	Ranni	64.01	12.22	7.56	50.60
5	Elanthur	25.79	9.57	4.55	15.68
6	Konni	57.61	12.83	6.35	43.97
7	Parakode	54.75	17.89	8.85	35.74
8	Pandalam	22.48	12.14	2.89	9.93
9	Kulanada	20.68	7.84	3.00	12.41
	Total	316.56	100.50	47.49	209.71

Groundwater Draft

Groundwater withdrawal is taking place for irrigation, domestic and industrial purposes. The domestic and industrial requirements were computed as per the norms considering the population of 2001 and also based on the projected population for the year 2025. The irrigation draft was calculated based on the number of groundwater abstraction structures and the number of hours the well is in use per day and average number of days of irrigation in a year. The ground water draft is showing an increasing trend during the recent years. In the Pandalam block there is a significant rise in the draft since 1999. Groundwater draft for 9 blocks based on 1999 and 2004 year's data is given in Table 4.2(b).

Based on the stage of groundwater development, the blocks of the country are categorised as safe, semi-critical, critical and over-exploited (Figure 4). The stage of development in Pathanamthitta district is 31.75%. Maximum development is seen in Pandalam block (54%) and minimum in Ranni block (19.09%). All the blocks are under safe category in the district.

Table 4.2(b) Stage of Groundwater Development in Pathanamthitta district

Sl. No.	Name of blocks	Net Groundwater available in (MCM)	Total gross draft (MCM)		Stage of Groundwater development (%)		Categorization of block	
			1999	2004	1999	2004	1999	2004
1	Pulikeezh	26.23	7.95	8.07	30.31	30.77	Safe	Safe
2	Mallappally	22.63	10.03	10.04	44.32	44.37	Safe	Safe
3	Koipuram	22.38	9.98	9.91	44.59	44.28	Safe	Safe
4	Ranni	64.01	12.56	12.22	19.62	19.09	Safe	Safe
5	Elanthur	25.79	9.61	9.57	37.26	37.09	Safe	Safe
6	Konni	57.60	12.98	12.83	22.53	22.26	Safe	Safe
7	Parakode	54.75	17.60	17.89	32.15	32.68	Safe	Safe
8	Pandalam	22.48	3.36	12.14	14.95	54.00	Safe	Safe
9	Kulanada	20.68	7.62	7.84	36.85	37.92	Safe	Safe

4.3 Ground Water Quality

The range of chemical parameters in the ground water samples taken from GWMW during April 2005 is given in Table 4.3(a) and the result of analysis is given in Appendix II.

Table 4.3(a) Range of chemical constituents in shallow aquifer

Sl.No.	Constituent	Range	
		Minimum	Maximum
1	pH	5.05	8.06
2	EC µs/cm at 25^0C	50	454
3	Total hardness, mg/l	8	114
4	Calcium, mg/l	2.4	19
5	Magnesium, mg/l	0.5	7.8
6	Na, mg/l	2.1	16
7	Potassium, mg/l	0.5	7.6
8	Carbonate, mg/l	0	0
9	Bicarbonate, mg/l	0	151
10	Sulphate, mg/l	0.08	34
11	Chloride, mg/l	4.3	67
12	Fluoride, mg/l	0.01	0.47
13	Nitrate, mg/l	0.8	52

The above data indicates that the groundwater in this area is of excellent quality. The electrical conductivity values are less than 500µs/cm at 25^0C. The higher electrical conductivity values are recorded in the well tapping alluvium (Pulikeezh) and this could be due to proximity of these wells to backwaters. The minimum and maximum values of electrical conductivity suggest that the groundwater in most of the area is very fresh. The fluoride content is <0.1. The pH of groundwater varies from 5.05 to 8.06 indicating that the water are slightly acidic to nutral and are occasionally alkaline. The groundwater is of bicarbonate type falling within the range of nil to 151 mg/l. The iron content more than permissible limit of 1 mg/l is seen in Ranni and Konni blocks. The chloride content is between 4.3 to 67 mg/l.

Water quality of Deeper Aquifers

i) Fractured Aquifer

The chemical quality data of water samples collected from exploratory bore wells indicate that the pH ranges between 6.4 and 6.98 indicating that at places it is slightly acidic and at other places it varies between 7.1 and 8.2 indicating the water is alkaline. EC values range between 60 and 670 micro siemens per cm at 25^0C. All other parameters analysed fall under the permissible

limit. Thus water from all the bore wells tapping fractured aquifer in the hard rocks of the district is suitable for domestic and agricultural purposes.

ii) Vaikom aquifer of Tertiary formation

One tube well was drilled tapping the deeper zones of Vaikom aquifer. The chemical analysis of water samples from this tube well at Pulikeezh is summarized in Table 4.3(b)

Table 4.3(b) Quality of water from Pulikeezh tube well

Constituent	Value
pH	5.89
TH	1040
Calcium mg/l	184
Mg ,,	141
CO_3 ,,	0
HCO_3 ,,	29
Cl ,,	2244
F ,,	0.21
Na ,,	960
K ,,	31
EC µs/cm at 25^0C	6300

The data indicates that the Vaikom aquifer is brackish with the electrical conductivity value is of 6300 µs/cm at 25^0C. Thus the water is unfit for domestic and irrigation purposes.

4.4 Status of Groundwater Development

Groundwater in the district is mostly developed through dug wells and bore wells for domestic, agricultural and industrial purposes. Apart from this the Kerala Water Authority is developing the resources for the principal water supply in the rural area and for supplementing the urban water supply schemes (Table 4.4). A good percentage of the house holds in the district have their own drinking water wells. The groundwater development in the district as elsewhere in Kerala is mostly through dug wells. Recently the bore well culture has picked up and gained momentum in the district. In the crystalline terrain the groundwater is developed through dug wells, dug cum bore wells and bore wells. Along the valley fills and laterite terrain the groundwater is developed through dug wells.

Table 4.4 Drinking water supply schemes in Pathanamthitta district

Sl No.	Name of the block	Public tube wells	Public wells	Public tanks/ pond	Public taps
1	Elanthur	26	16	4	415
2	Koipuram	33	82	10	822
3	Konni	187	112	27	185
4	Kulanada		52	6	44
5	Mallapally	61	65	15	464
6	Pandalam	26	51	60	266
7	Parakode	54	130	107	472
8	Pulikeezh	264	150	19	1271
9	Ranni	147	73	29	678
	Total	797	731	277	4616

5.0 GROUNDWATER MANAGEMENT STRATEGY

The groundwater development in the district is feasible through different abstraction structures tapping the shallow phreatic aquifers in the hard rocks, laterite, alluvium and deep fractured crystalline rocks. Depending upon the hydrogeological set up and requirement, the development can be planned with suitable structures.

5.1 Groundwater development

It can be seen that the stage of groundwater development in the district is only 31.75% leaving a vast scope for future development. The government may give more incentives to farmers for developing well irrigation apart from providing the requisite infrastructure.

Based on the GEC norms for unit draft per structure it is computed that 40,900 structures can be constructed by developing 70% of the balance resource available for irrigation and about 52,000 structures can be constructed by 90% development. Since all the blocks fall under safe category abstraction structures can be constructed keeping in view of the groundwater sustainability of the region.

In the western part of the district i.e. in Pulikeezh block dug well with a depth of 6 to 8 m and a diameter of 3 m can be constructed for irrigation purpose. These wells require protection with concrete rings with weep holes allowing inflow of ground water. The gap between the rings should not be cemented. Centrifugal pumps of around 3 HP will be ideal for these wells. The total cost of construction and energisation will be about Rs.20,000/-

In the mid land areas the dug wells with a diameter of 4 - 5 m and depth to 8 -12 m may be required and the same can be energized with 3-5 HP centrifugal pump positioned 2 - 4 m below ground level depending upon the pre-monsoon and post monsoon water levels. Alternatively jet pumps and compressor pumps can be used in areas of deep water table even though the efficiency is comparatively less. For submersible pump, the investment is quite high. The cost of dug well and the pump set in the mid land area is around Rs.30, 000 to Rs.40,000 depending upon the options used and the depth and diameter of dug well.

In the mid lands and high lands bore wells can be constructed after proper scientific site selection procedures. The bore wells can be of 6" (152) mm diameter for agricultural purpose, so that submersible pumps can be lowered. Alternatively air compressor pump/jet pump can be used in a well of 100 mm diameter, which will work out cheaper but have low efficiency. The cost of structure will be highly variable depending on depth of bore hole, diameter of bore hole and the pump used. It generally varies from Rs.25,000 to Rs.60,000 per structure.

Sustainable development of Groundwater in hard rock area

Groundwater potential maps on a micro water shed basis should be generated for effective and functioning of managing groundwater resources. Such maps should contain all the available information on groundwater availability, present abstraction practices, surface irrigation details, water budget, including groundwater balance, socio-economic details, cropping pattern etc.

Groundwater legislation should be enacted and the abstraction monitored properly and strictly.Artificial recharge structures wherever needed should be constructed only after a detailed study on the availability of excess run off in each micro watershed.

5.2 Water conservation and Artificial Recharge

The major problem in the district is the non availability of ground water in the dug wells located along the hill slopes of the mid land area. It is not due to over development but due to the natural discharge on the sloping bedrock topography. Even though the rainfall is widely distributed through out the year except a dry spell for 3-4 months in the summer, the topography is not suitable to retain the ground water. Major parts of the rain escapes as surface run off with in hours of rainfall. The other part, which infiltrates into ground water escapes as sub surface run off.

In these areas the solution will be to check/retard the subsurface out flow of ground water by construction of sub surface dams wherever feasible which will arrest the sub surface flow and create a build up in the up stream side.

In addition to the conservation measures like sub surface dam, artificial recharge measures like contour bunding, trenching, gully plugging, terracing, check dams etc will help in impounding part of the rainfall and allow slow percolation into the ground water. This will also help to tide over the water scarcity for 2-3 months. Check dams across small streams help in arresting surface runoff as well as rising of water table in the adjoining area. Recommended artificial recharge structures in Pathanamthitta district is shown in Figure 6.

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

Vulnerable area

Even though the rainfall is quite high and is spread over the year, acute water scarcity is felt in the mid land and high areas of the district during the five months of January to May. The limited thickness of weathered / lateritised mantle gives limited thickness of saturated zones. The sloping nature of the ground accelerates the fast subsurface out flow of the ground water. This is the case in most of the hill slopes in the district where dug wells dry up in extreme summer. Then water will be available only in the valley portion. As the district is dissected by innumerable hills and valleys of different magnitude, the

problems and the vulnerable area are also scattered and alternates with potential zones.

The problems of water logging are not present in the district due to its topography. Since the district is industrially backward, there are no pollution problems in the district. The problems of water scarcity during summer months are not due to over development. As seen in earlier chapters though the ground water development is on a low key still water scarcity is experienced in certain areas of the district in mid land, because of its geomorphology.

7.0 AWARENESS & TRAINING ACTIVITY

A Water Management Training Programme was organized by Central Ground Water Board at Pathanamthitta on 22.10.2003 to raise the awareness on need for conservation and recharge of groundwater. The programme was inaugurated by Shri. Mathew Kulathinkal, President, District Panchayath, Pathanamthitta. The programme attained wide publicity and was attended by about 200 participants.

8.0 AREAS NOTIFIED BY CGWA&SGWA

As all the blocks of Pathanamthitta district are falling in safe category, no area has been notified by CGWA or SGWA.

9.0 RECOMMENDATIONS

The net available groundwater recharge in the district is about 316.55 MCM of which the present draft is about 100.51 MCM and the stage of groundwater development is about 31.75 %.

For development of groundwater 3 m diameter dug wells with cement rings can be constructed down to 6-8m in Pulikeezh block. In mid land large diameter dug wells down to 8-12 m can be constructed. Bore wells of 100 to 152mm diameter) down to 200 m can be constructed along potential lineaments.

The alternating hills and valleys present ideal sites for construction of subsurface dams for conservation of groundwater, which will mitigate the water scarcity of the upstream side. Several such structures can be constructed.

Artificial recharge measures like check dams, contour bunding, trenching, gully plugging, terracing etc should be encouraged in the mid land area which will improve groundwater availability in summer.

For isolated habitation in the eastern hilly parts of the district roof water harvesting can be the assured source of drinking water.

Community irrigation schemes using groundwater resources have to be given a thrust backed up by scientific investigations.

Appendix I

Details of exploratory wells drilled in hard rock areas of Pathanamthitta District

Well No	Location	Year of construction	Lineament Direction	Depth drilled (mbgl)	Discharge during drilling	SWL mbgl	T m^2/day	EC micromhos/cm at 25^0C	Cl ppm
1	Kadika	1983-87	NNE-SSW	200.53	90	1.09	1.33	380	13
2	Marur	1983-87	NW-SE	200.53	Nil	dry	-	-	-
3	Kalanjur	1983-87	N-S	221.39	180	1.10	7.30	280	8.5
4	Mudiyurkonam	1983-87	NS	244.22	240	3.90	1.11	670	78
5	Konni	1983-87	NW-SE	206.15	30	5.38	1.35	90	18
6	Vadaserikkara	1983-87	NE-SW	248.25	Nil	4.92	-	-	-
7	Theodical	1983-87	N-S	175.70	240	1.90	6.66	300	11
8	Perumpatti	1983-87	NNW-SSE	129.95	990	1.62	11.3	200	9.9
9	Valiakavu	1983-87	N-S	257.97	150	3.67	0.5	510	11
10	Chetheckal-West	2001-02	NW-SE	92.00	120	3.50	11.85	335	4.3
11	Chetheckal-East	2001-02	NW-SE	101.00	6	3.25	-	120	11
12	Pothipad	2001-02	-	101.00	6	5.28	-	91	9.9
13	Edamuri	2001-02	N-S	101.15	6	3.20	-	-	-
14	Pamba KSEB	2001-02	N-S	101.00	6	9.75	-	-	-
15	Pamba KSRTC	2001-02	N-S	101.00	60	2.14	-	-	-
16	Thriveni	2001-02	NW-SE	44.00	6	10.00	-	-	-
17	Vettur	2001-02	N-S	101.00	6	-	-	-	-
18	Kalleli	2001-02	-	101.00	6	5.20	-	-	-
19	Naduvathumoozhi	2001-02	NW-SE	101.15	30	6.85	2.16	-	-
20	Arikkakavu	2001-02	NW-SE	101.15	36	7.10	1.6	316	8.5
21	Mekkozhur	2001-02	-	100.00	36	8.00	0.84	307	-
22	Nilackal	2002-03	Nil	100.00	30	7.00	-	225	8.5
23	Angamoozhi	2002-03	N-S	101.15	40	6.10	-	363	5.7
24	Plappally	2002-03	Nil	101.15	30	17.91	-	283	5.7
25	Elakollur	2002-03	-	101.15	30	9.13	-	-	-
26	Vallikode	2002-03	-	101.00	6	-	-	-	-
27	Ranni	2002-03	NE-SW	100.00	12	-	-	-	-
28	Vechoochira	2002-03	N-S	101.00	36	7.52	-	344	21
29	Kummannur	2002-03	-	101.35	dry	-	-	-	-
30	Konni Elephant Camp	2002-03	-	64.75	120	14.51	2.88	141	5.7
31	Padam	2002-03	-	101.35	5	10.25	12.34	156	32
32	Perinad	2002-03	E-W	101.00	30	5.90	-	-	-

Fig. 1

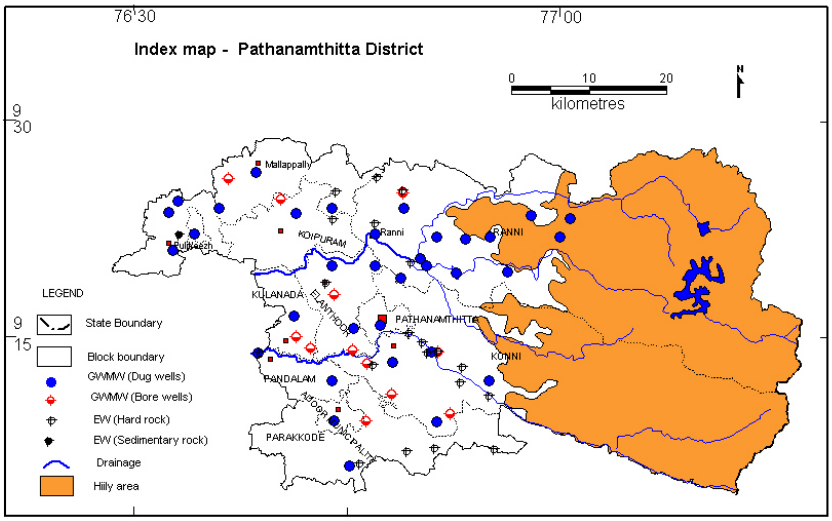

76°30
77°00
Index map - Pathanamthitta District
0
10
20
kilometres
N
9
30
9
15
LEGEND
State Boundary
Block boundary
GWMW (Dug wells)
GWMW (Bore wells)
EW (Hard rock)
EW (Sedimentary rock)
Drainage
Hilly area
Mallappally
Ranni
KOIPURAM
RANNI
KULANADA
ELANTHOOR
PATHANAMTHITTA
KONNI
PANDALAM
ADOOR
PARAKKODE
PUNALUR

Fig. 2

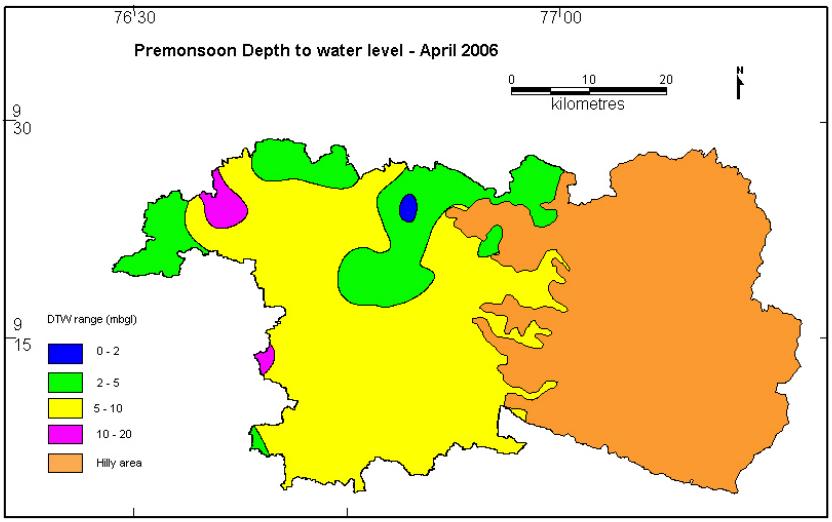

76°30
77°00
Premonsoon Depth to water level - April 2006
0
10
20
kilometres
N
9°30
9°15
DTW range (mbgl)
0 - 2
2 - 5
5 - 10
10 - 20
Hilly area

Fig. 3

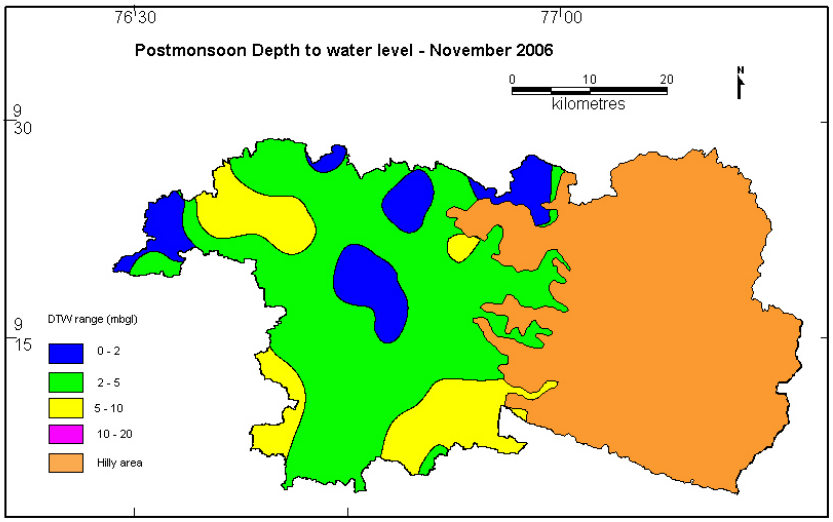

76°30
77°00
Postmonsoon Depth to water level - November 2006
0
10
20
kilometres
N
9
30
9
15
DTW range (mbgl)
0 - 2
2 - 5
5 - 10
10 - 20
Hilly area

Fig. 4

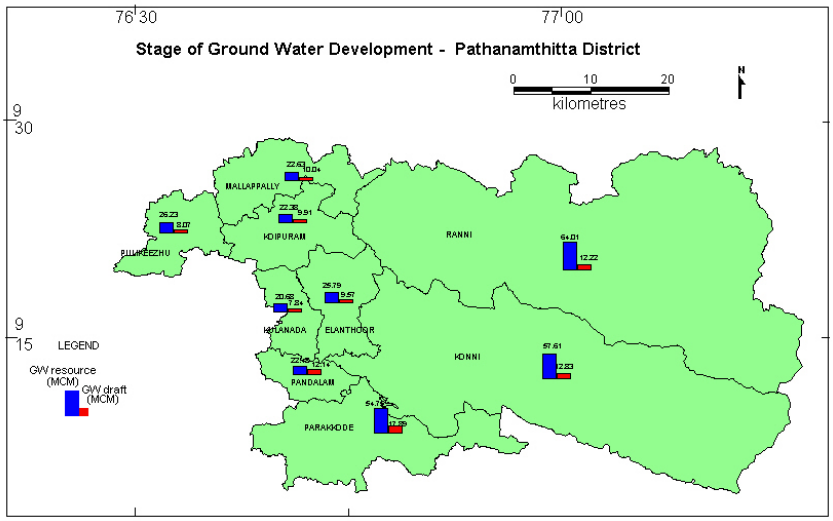

76°30
77°00
Stage of Ground Water Development - Pathanamthitta District
0
10
20
kilometres
N
9°30
9°15
LEGEND
GW resource (MCM)
GW draft (MCM)
MALLAPPALLY
KOIPURAM
PULLIKEEZHU
RANNI
KONNI
ELANTHOOR
PANDALAM
PARAKKODE

Figure 8.11

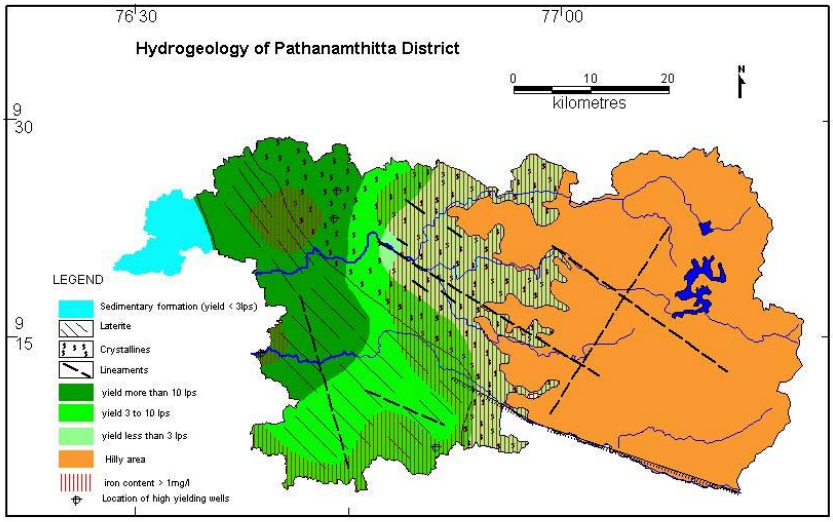
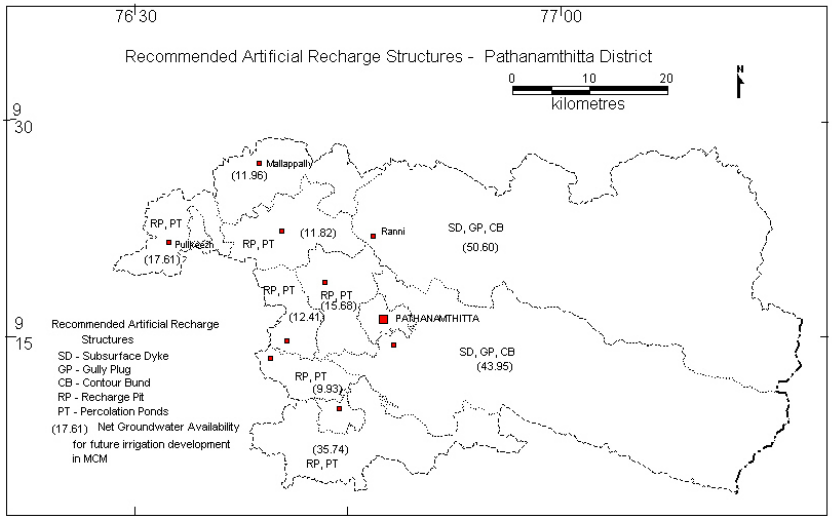

76°30
77°00
Hydrogeology of Pathanamthitta District
0
10
20
kilometres
N
9
30
9
15
LEGEND
Sedimentary formation (yield < 3lps)
Laterite
Crystallines
Lineaments
yield more than 10 lps
yield 3 to 10 lps
yield less than 3 lps
Hilly area
iron content > 1mg/l
Location of high yielding wells

Fig. 6


76°30
77°00
Recommended Artificial Recharge Structures - Pathanamthitta District
0
10
20
kilometres
N
9°30
9°15
Mallappally
(11.96)
RP, PT
Pullikeezh
(17.61)
RP, PT
(11.82)
Ranni
SD, GP, CB
(50.60)
RP, PT
RP, PT
(15.68)
(12.41)
PATHANAMTHITTA
SD, GP, CB
(43.95)
RP, PT
(9.93)
(35.74)
RP, PT
Recommended Artificial Recharge Structures
SD - Subsurface Dyke
GP - Gully Plug
CB - Contour Bund
RP - Recharge Pit
PT - Percolation Ponds
(17.61) Net Groundwater Availability for future irrigation development in MCM