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CONSERVE WATER – SAVE LIFE

भारत सरकार

GOVERNMENT OF INDIA

जल संसाधन मंत्रालय

MINISTRY OF WATER RESOURCES

केंद्रीय भूजल बोर्ड

CENTRAL GROUND WATER BOARD

केरल क्षेत्र

KERALA REGION

भूजल सूचना पुस्तिका,कासरगोड जिल्ला, केरल राज्य

GROUND WATER INFORMATION BOOKLET OF KASARGOD DISTRICT, KERALA STATE

तिरुवनंतपुरम

Thiruvananthapuram

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GOVERNMENT OF INDIA
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द्वारा

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GROUND WATER INFORMATION BOOKLET OF KASARGOD DISTRICT KERALA STATE

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	No. of wells drilled (EW, OW, PZ, SH, Total)	EW - 29, OW - 7, Pz - 25
	Depth Range (m)	50.5 to 200.0
	Discharge (litres per second)	Up to 11.00
	Storativity(S)	
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	Water Management Training Programmes organized 2003 Date Place No. of Participants	1. Kasargod 01.02.2003, 125 people 2. Kasargod 16.01.2007 & 17.01.2007, 100 people
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	Projects under technical guidance of CGWB (Numbers)	Nil
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	Number of blocks notified	Nil
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GROUND WATER INFORMATION BOOKLET OF KASARGOD DISTRICT KERALA STATE

1.0 INTRODUCTION

The name, Kasargod, is said to be derived from the word 'Kusirakood' meaning Nux vomica forests (Kanjirakuttom). Kasargod is the northernmost district of Kerala, bordering Karnataka State. The population is mainly agrarian and the major crops raised are coconut, arecanut, cashew, rubber, paddy, pepper etc. Kasargod district is having cash crops as its main stay compared to food crops. Coconut is the single largest crop in the district. Recently there is considerable change in the land use and cropping pattern. The paddy cultivation has reduced from 5512 hectares in 1994-95 to 2464 hectares in 2009-10 because of the low returns from the crops compared to the investment and huge requirement of water to raise the crop. Traditionally arecanut is being cultivated in the valley portion of the district. Arecanuts are being irrigated by the springs and seepages or shallow dug wells in the valley areas or the water collected from the tunnel wells. Recently the irrigation of coconut and arecanut on the valleys and slopes are increased by pumping of borewells. The bore well culture is prevalent in Kasargod district way back from the sixties and seventies much before this was common in other parts of the state. During and after eighties the growth rate of borewell increased steadily at an alarming rate. Because of the increase of borewells in the slopes and laterite terraces, the water availability in the valley portions and tunnel wells reduced considerably. Hence farmers could not irrigate arecanut in summer which has badly affected the crops. About 75% of the area of the district is covered by laterites. 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. Further the delay in monsoon and deficit summer showers badly affect the crops and drinking water availability. Earlier days the development of groundwater for irrigation and drinking purposes were mostly through dug wells. Recently the farmers started growing bananas, vegetables etc. in paddy fields and slopes which necessitated accelerated irrigation. This forced the farmers to deepen the existing dug wells and also for construction of deeper borewells in an indiscriminate manner. In the crystalline formations especially in valleys the fracture zone starts from shallow depths. In many places the pumping of borewells badly affect the water level of the phreatic zone. Moreover, the farmers are constructing the bore wells and dug wells without much technical knowledge, which leads to faulty construction

and failure of borewells. The failure of agriculture coupled with the low price of crops, resulted in dues of loans availed by farmers for various purposes.

1.1 Administration

Kasargod district is divided into two taluks (Kasargod and Hosdurg) and 75 villages. The district has one revenue division, 6 Block Panchayaths (Manjeshwar, Kasargod, Kanhangad, Nileshwar, Karadka and Parappa) and 38 Grama Panchayaths and three Municipalities (Kasargod, Kanhangad and Nileshwar).

1.2 Drainage, Irrigation practices

The district is drained by nine rivers, all minor in nature except *Chandragiri* and *Karingote* which are originating from the eastern highland and flowing towards the west to join the Lakshadweep Sea. Most of the rivers have an east to west trend.

Even though the district is drained by 9 rivers which discharges about 4257 MCM of water to the ocean every year as surface run off, there is not a single major irrigation scheme to arrest this water for effective utilization for irrigation. At present out of the total cropped area of 1381.65 sq.km., only 401.30 sq.km. is being irrigated by different sources leaving major cropping as rain fed. Coconut is the principal crop irrigated which covers 60% of the total irrigated area followed by arecanut which accounts for 23%. Paddy cultivation in the district is now reduced to 6% of the total irrigated area.

Among source of irrigation, ground water is the principal source of irrigation accounting for about 64% of the area under irrigation and the rest by lift and other methods of irrigation. The index map showing location of block headquarters, boundary, drainage, location of EW, PZ are shown in **Figure 1.**

1.3 Works carried out by CGWB

The report on ground water resources of Kasargod district was compiled by Dr. K.Md. Najeeb (1987). Reappraisal survey was carried out by Sh. V. Dhingaran (1989-90), Shri V. Kunhambu and Sh. N.C. Nayak (1996-97) and Sh. K. Balakrishnan (2000-2004, 2007-08) Micro level survey was carried out in Kasargod block by Shri K. Balakrishnan (2002-03). Ground water exploration was carried out in Kasargod Taluk during 1983-85 upto the depth of 100 m. Groundwater exploration to the depth of 200 m was continued during the year 2002-03 and 2004-05 using DTH rig of 200 m capacity. Under hydrology project,

piezometers were constructed in 1999 and again piezometers were constructed in over-exploited and semi-critical blocks in 2004-05. Mass awareness programmes were conducted at Kasargod (2000) Kanhangad (2004) and Manjeswar (2007) and water management training at Kasargod during 2003 and 2007. Pamphlets depicting ground water scenario of the district were distributed to the public during each functions.

2.0 RAINFALL & CLIMATE

The district receives an average of about 3500 mm rainfall annually. The major source of rainfall is southwest monsoon from June to September which contributes nearly 85.3% of the total rainfall of the year. The northeast monsoon contributes nearly 8.9% and balance of 5.8% is received during the month of January to May as pre monsoon showers. Out of the 106 rainy days in a year, 87 rainy days occur during south west monsoon season. The normal monthly rainfall in mm at Kasargod for the period 1901-1999 is given below.

Jan	Feb	Mar	April	May	Jun	July	Aug	Sept.	Oct.	Nov.	Dec.	Total
4.4	2.4	12.1	51.7	216.6	996.2	1067.4	612.2	272.6	210.2	91.7	23.4	3560.9

The monthly rainfall data of the district for the period 2006 - 2011 is given in the **Table 1**

Table1: Rainfall (mm), Kasargod District

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
2006	0.0	0.0	0.0	1.0	659.0	869.0	624.1	428.0	533.5	220.2	109.8	0.0	3444.6
2007	0.0	0.0	0.0	11.8	199.3	1268.0	735.5	787.2	631.4	169.0	53.5	0.0	3855.7
2008	0.0	2.6	295.0	133.4	63.2	1004.7	672.9	528.3	403.5	158.4	49.0	8.9	3319.9
2009	0.0	0.0	16.0	16.4	152.0	560.6	1238.2	446.0	330.9	76.7	294.2	9.8	3140.8
2010	7.3	0.0	0.1	35.2	78.5	1034.0	1276.2	681.1	357.1	283.6	241.6	17.3	4012.0
2011	0.0	0.0	0.0	166.0	87.0	867.0	1106.0	697.0	558.0	204.0	172.0	0.0	3857.0

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 29.2 to 33.4^{0}C and minimum temperature ranges from 19.7 to 25^{0}C.

Relative Humidity

Relative humidity is more during morning hours and is less during evening hours. During the morning hours it ranges from 87.1 to 98.7% and during evening hours it ranges from 54.4 to 86.5%.

Evaporation

Evaporation is more during summer months of March to May. In general it ranges from 2.2 to 6.3 mm/day. During south west monsoon season it ranges from 2.2 to 3.7 mm/day.

Sunshine Hours

Sunshine ranges from 3.2 to 10.2 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 2.1 to 3.3 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 177.0mm.

3.0 GEOMORPHOLOGY AND SOIL TYPES

Physiographically the district can be divided into three district units viz. the coastal plains, the midlands and the eastern highland regions. The coastal plains with an elevation of less than 10m 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 10 to 300 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. The midland and hill ranges of the district present a rugged and rolling topography with hills and valleys. Along the midlands the hills are mostly laterite and the valley are covered by valley fill deposits. The valley fill deposits are composed of colluvium and alluvium.

There are four major soil types encountered in the district. They are Lateritic Soil, Brown Hydromorphic Soil, Alluvial Soil 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 plain is characterised by secondary soils which are sandy and sterile with poor water holding capacity. The width of the zone increases towards the southern part of the district. Forest loamy soil is found in the eastern hilly areas of the district and are characterised by a surface layer rich in organic matter.

4.0 GROUND WATER SCENARIO

Groundwater occurs under water table conditions in alluvium, laterites and weathered mantle of the crystallines, where as in the deeper fractured crystallines the groundwater occurs under semi confined to confined conditions. The physiographic set up and geological formations are same for Manjeshwar, Kasargod, Kanhangad and Nileshwar blocks, (the block area starts from

the coast and ends on midland areas. The block area of Karadka and Parappa starts from midland on west and ends as hilly area on the east. Alluvium occurs as narrow strips parallel to the coast and the width increases from the northern part of Kanhangad block to southern part of Nileshwar block and around Trikaripur of Nileshwar block. In Kasargod and Manjeshwar blocks alluvium occur as isolated patches close to the coast and have limited thickness. The crystalline formations having phreatic aquifer is found mostly in Karadka and Parappa blocks.

4.1 Hydrogeology

Four hydrogeological units encountered are Alluvium (including valley fills) laterites weathered crystallines and fractured crystallines. Coastal Alluvium occurs as narrow strips parallel to the coast south of Kasargod. The width of alluvium increases to the south and attains about 5 km. around Trikaripur. North of Kasargod (in Kasargod and Manjeshwar blocks), the alluvium occurs as isolated patches close to the coast and have limited thickness. In the Kanhangad and Nileshwar blocks even though the width of alluvium is more, potential zones are seen in the top portion only followed by Tertiary sediments at deeper levels which does not contain potential granular zones. Valley fills occur in between laterite hills which are composed of colluvium and alluvium. The water level ranges from 2.93 m to 5.63 m bgl in pre-monsoon period and 1.20 to 3.20 m bgl in post monsoon period. The water level fluctuation is in the range of 0.98 to 2.68 m.

Laterite is the most wide spread and extensively developed aquifer in the district. They widely vary in their physico-chemical characteristics. The laterite is generally underlain by thick lithomargic clay which is the preliminary lateritisation front. The thickness of lithomargic clay varies from about 0.5 m to 5.0 m at places. Laterite is more ferruginous, porous and hard in northern parts of the district compared to those in the southern parts of the district. Due to its porous nature the dug wells tapping laterite get recharged fast and also the water escapes as sub-surface flow and water level falls quite fast especially in wells located on topographic highs and hill slopes.

The depth to water level in pre-monsoon period ranges from 5.33m to 24.32 m bgl **(Figure 2)** and in post-monsoon period 4.15 m to 22.60 m bgl **(Figure 3)**. The DTW is shallower in the valley portions and gentle slopes and deeper in laterite hillocks and lateritic ridges. The DTW is comparatively deeper in eastern part of Chengala (Kasargod block), Karadka and Delampady panchayaths (Karadka Block). The DTW is found to be more than 20 m in parts of Chengala and Karadka panchayaths only. Similarly deeper water level in laterite is seen in western part of Parappa block. Water level in laterite formation is found shallow in western part of Nileshwar block where the Laterite is formed from the Tertiary formations. The water table fluctuation ranges from 0.30 m to 4.35 metres. Maximum fluctuation is observed in wells located in topographic highs and slopes. In the northern part of the district, in midland areas a very common ground water abstraction structure are the Tunnel wells (locally known as 'SURANGAMS'), which is a horizontal well (Adit) with a width of 50 cm to 75 cm and height of around 2 m. The length of Tunnel well varies from few metres to 100 metres. Generally the tunnel well starts at the foot hills and cut across the slope horizontally to have the maximum yield. The yield of tunnel wells varies from 1 m^3/day to upto 50 m^3/day in summer. In peak summer, the yield of tunnel wells is generally less.

In the eastern part of the district (Karadka and Parappa blocks) the thickness of lateritisation is comparatively low and weathered crystallines are encountered underlying the laterites in dug wells. The weathered crystallines form the aquifer of limited potential sustaining domestic dug wells. The depth to water level ranges from 3.11 m to 11.55 m bgl in pre-monsoon period and 1.95 m to 10.97 m bgl in post-monsoon period. The water level fluctuation ranges form 0.63 m to 2.73 meters.

In the fractured crystalline aquifer ground water occurs under semi-confined to confined conditions. They are tapped through borewells for domestic, irrigation and industrial

purposes. Majority of the medium waters supply schemes in the districts are by bore wells. The yield of borewell in the district ranges from 500 to 72,000 lph. The data collected during reappraisal survey in the year 2007-08 pertaining to the depth to water level in pre-monsoon period, post monsoon period are given in **Tables 2(a) & 2 (b).** The hydrogeological map of the district is shown in **Figure 4**

Table 2 (a) DTW Range- Pre monsoon (April)

Formations	DTW range			
	<5 m	5 to 10 m	10 to 20 m	>20 m
Alluvium (24 wells)	20 83%	4 17%	-	-
Laterites (144 wells)	2 1.5%	49 34%	91 63%	2 1.5%
Crystallines (17 wells)	1 6%	14 82%	2 12%	-

Table 2 (b) DTW Range – Post monsoon (November)

Formations	DTW range			
	<5m	5 to 10m	10 to 20 m	>20m
Alluvium (24 wells)	24 100%	-	-	-
Laterites (144 wells)	17 12%	88 61%	37 25.5%	2 1.5%
Crystallines (17 wells)	4 23.5%	12 70.5%	1 6%	-

Long term trend of pre-monsoon and post-monsoon water level of groundwater monitoring wells (NHS) between 2002 and 2011 are analysed. Declining water level in the range of 0.015 to 0.206 m/year in pre-monsoon period is observed in some part in the central and western part of Kasargod, Manjeshwar and Kanhangad blocks. However in majority of the area the water level shows a rising trend in the range of 0.013 to 0.294 in pre-monsoon period and 0.11 to 0.185 in the post monsoon period. In the post-monsoon period the water level showed a decline in a few wells only in the range of 0.010 to 0.059 m/year.

4.2 Ground Water Resources

The ground water assessment was done block wise as per GEC-1997 methodology as on March 2009.

Table 3: Salient Details of Assessment of Dynamic Ground Water Resources of Kasargod District as in 2009.

Sl. No.	Assessment Unit/ Block	Total Annual Ground Water Recharge	Provision for Natural Discharges during non monsoon season	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for All uses	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development (%)	Categorisation
1	Kanhangad	9085.59	908.56	8177.03	5434.05	2427.11	66.46	Safe
2	Kasargod	8004.09	800.41	7203.68	6509.75	371.01	90.37	Critical
3	Manjeswar	11271.00	1127.10	10143.90	7306.02	2552.50	72.02	Semicritical
4	Nileswaram	7999.65	799.97	7199.69	4083.67	2870.87	56.72	Safe
	TOTAL (ha.m)	**36360.34**	**3636.03**	**32724.30**	**23333.49**	**8221.48**	**71.30**	
	TOTAL (MCM)	**363.60**	**36.36**	**327.24**	**233.33**	**82.21**	**71.30**	

As per the categorization of blocks based on 2004 data, Kasargod block was under over exploited category. Manjeshwar and Kanhangad under semicritical and Nileshwar block was safe. As per 2009 data computations, Kasargod block became critical, Manjeshwar under semi critical and other two under safe category **(Figure 5)**. The reason for change in categorisation is mainly due to the difference in draft calculations and also due to improved position due to good rainfall.

4.3 Ground Water Quality

The chemical quality of groundwater is generally good in both phreatic as well as deeper fractured rock aquifers. About 45% of NHS samples showed EC less than 100 μs/cm at 25^0C and almost all the water samples showed EC less than 250 μs/cm at 25^0C **(Annexure II).** Only in areas very near to the coast and tidal zones, the water samples had EC around 1000 μs/cm at 25^0C. All the water samples had fluoride within the permissible limit. The maximum value shown was 0.18 ppm. In laterite formations, the quality of water is generally excellent, but in some instances higher concentration of iron was reported.

In the bore wells, 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.

In general the qualities of water in phreatic and deeper fracture zones are suitable for domestic, industrial and irrigation purposes.

4.4 Status of Ground Water Development

Though there are 6 community development blocks in the district since 01.11.2010, the status of ground water development is described as per earlier classification of blocks.

The hydrogeological conditions in all the four blocks of the district are same. The aquifers are Alluvium, Laterites, weathered crystallines and deep fractured crystallines.

The yield of wells including filter point wells in alluvium ranges from 10 to 50 m^3/day. The dug wells have depth ranging from 3.59 m to 6.74 mbgl. The diameters of wells are 1.5 m to 2.5 m. Filter point wells with a depth of about 6 metres are constructed along the coastal areas especially along Kasargod, Kanhangad and Padannakkad areas.

The yield of wells in laterite ranges from 5 to 60 m^3/day in winter period and it reduces to the range of 2 to 20 m^3/day in summer. The depth ranges of wells are from 4.84 m to 24.76 mbgl. The diameters of wells are 2.0 to 4.0m. Generally large diameter wells are constructed in laterite terrain.

In the weathered crystallines, the yield of wells ranges from 1 to 10 m^3/day in summer period. The depth ranges of wells are 4.35 to 16.46 mbgl and the diameter of wells are 1.5 to 3.0m. The depth ranges of wells in different formations are given in **Table 4(a).**

In the fractured crystalline rocks, the bore wells constructed to the depth ranges from 40 m to around 120 metres. The potential zones are generally encountered between 40 to 75 metres. Below 100m depth only in limited areas high yielding zones encountered. 200 m deep wells were drilled by CGWB under groundwater exploration programme. The yield of borewell ranges from less than 500 to 72,000 lph. The data from exploratory drilling carried out by CGWB and borewell data from State Departments were analysed. The NE-SW lineaments, followed by N-S and E-W lineaments are found to be potential in the district. The borewells in the central and northern parts of the district yields comparatively higher discharges **(Annexure 1).**

In Manjeshwar block about 57% of the borewells are in the depth range of 70 to 90 mbgl and in Kasargod block it is about 45%. In Kanhangad and Nileshwar blocks, more than 50% of the wells are in the depth range of less than 70 m. Generally in the western part of the blocks, the depth of borewells is shallower. In Manjeshwar block the depth of bore wells is comparatively deeper. Maximum shallow borewells are seen in Kumbla, Mangalapady, Manjeshwar panchayaths of Manjeshwar blocks, Chengala, Chemnad, Kuttikole, Mogral-

puthur panchayaths of Kasargod block, Udma, Ajanur, Pallikkere and Pullur-Periye panchayaths of Kanhangad block, Nileshwar, East Eleri, Kayyur-Chimeni panchayaths of Nileshwar blocks. The borewells are generally shallower in valley areas, lineaments and shear zones and deeper in the hillocks and slopes and ridges. The depths of borewells are generally deeper in the eastern parts of the blocks. The depth range of borewells is given in **Table 4(b).**

The yields of bore wells are generally up to 5000 lph. In Manjeshwar block about 70% of the bore wells show discharge up to 5000 lph, and in other blocks it is around 58%. In Kasargod block, about 20% of the bore wells are yielding more than 10,000 lph and out of this about 4.5% yields more than 20,000 lph. Most of these high yielding wells are utilizing for regional water supply. The higher yielding wells are constructed in Bedadka, Chemnad and Mogral-puthur panchayaths of Kasargod block, Kumbla, Badiadka, Manjeshwar panchayaths of Manjeshwar block, Pullur-Periye, Pallikkere panchayaths of Kanhangad block. The failure percentage of borewells is generally less than 10%. The discharge range of bore wells block wise is given in **Table-5.** .

Table 4 (a) Depth Range of Wells (Formation wise)

Formation	Depth Range			
	<5m	**5-10m**	**10-20m**	**>20m**
Alluvium (24 wells)	18 75%	6 25%	-	-
Laterite (144 wells)	2 1.5%	27 18.5%	111 77%	4 3%
Crystallines (17 wells)	1 6%	14 82%	2 12%	-

Table 4 (b) Depth Range of Borewells (Block wise)

Name of Block	No. of Borewells	Depth Range			
		<50m	**50-70m**	**70-90m**	**>90m**
Manjeshwar	575	59 10.3%	109 19%	329 57.2%	78 13.5%
Kasargod	494	94 19%	132 26.7%	223 45.2%	45 9.1%
Kanhangad	371	86 23.2%	113 30.5%	131 35.3%	41 11%
Nileshwar	109	27 24.8%	33 30.3%	42 38.5%	7 6.4%
Total	1549	266 17.2%	387 25%	725 46.8%	171 11%

Table 5 Discharge Range of Bore wells (Block wise)

Name of Block	No. of Borewells	Discharge Range				
		<1000 lph	1000-5000 lph	5000-10000 lph	10000-20000 lph	>20,000 lph
Manjeshwar	575	65 11.3%	342 59.5%	105 18.2%	47 8.2%	16 2.8%
Kasargod	494	55 11.1%	230 46.6%	106 21.4%	81 16.4%	22 4.5%
Kanhangad	371	37 10%	179 48.2%	97 26.2%	45 12.1%	13 3.5%
Nileshwar	109	12 11%	52 47.7%	25 22.9%	19 17.4%	1 1%
Total	1549	169 11%	803 52%	333 21.5%	191 12%	52 3.5%

In the recent years, due to the fall in water level, the dug wells were deepened in laterites and the crystalline areas. The wells are deepened by 1 to 3 metres. Horizontal bores were constructed in crystalline areas to increase the yield. The lifting devices of water are through centrifugal pumps, jet pumps for dug wells and submersible pumps and compressor for borewells. Water is also being lifted by bucket and rope from dug wells for domestic purposes. The stage of groundwater development in the district as on 2009 was 71.30% leaving some scope for future development. Out of the four blocks in the district, one is critical, one semi critical and two are safe. Future development can be possible in Nileshwar block and Kanhangad blocks (safe) and limited developments in Manjeshwar block (semi critical) and Kasargod block (critical).

For drinking water needs in the district, Kerala Water Authority and Grama Panchayats are empowered with supply of protected water for domestic use. Open wells, borewells and rivers are the principal sources of water supply. The Kerala Water Authority has 496 borewells, 731 dug wells, 135 ponds/tanks for water supply. Kasargod town is provided with piped water supply from Chandragiri River. The water supply to Kanhangad town is from infiltration galleries made at Kaniyachira Checkweir in Kikankote Chal (stream). In addition to this, most of the houses have their own wells to meet the domestic requirements. Recently under sector reforms and swajaldhara-2 schemes of district panchayat, drinking water facilities were provided in 17 grama panchayaths. From the 431 rural water supply schemes of these projects, a total of 133275 persons were benefited. The Jalanidhi schemes for drinking water supply is further extended to 5 grama panchayats.

5.0 GROUND WATER MANAGEMENT STRATEGY

Groundwater in the district is mostly developed through dug wells, dug cum borewells, filter point wells, borewells and tunnel wells mostly for domestic and irrigation. Most of the households have their own wells to meet the domestic requirements. Along the coastal areas groundwater development for irrigation is through filter point wells and dug wells. In the valley fill areas and laterites, groundwater is developed mostly through dug wells. Recently for irrigation and domestic needs in most of the areas in midlands and in eastern uplands groundwater is developed through borewells.

Ground water development studies should be coupled with management of rain water harvesting and surface water. The existing water resources and dug wells, ponds, tanks etc should be cleaned and protected. Artificial recharge schemes should be practiced in large scale along with rain water harvesting. The springs seen in the eastern part of the district can be developed.

There should be proper water budgeting in the district. 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.

5.1 Ground Water Development

Only two blocks out of four blocks in Kasargod district is in safe category, further groundwater development is limited. The groundwater abstraction structures feasible in the blocks are dug wells in alluvium with depth of 3 to 5 metres and diameter of 1.5 to 2.25 metres. Filter point wells are feasible along the coast where thickness of alluvium is more than 6 metres. In the valley fill areas the dug wells are feasible with depth range of 4 to 8 metres with a diameter of 2 to 3.0 metres. In the laterite terrain, dug wells are feasible in the valley portion with a depth range of 4 to 10 metres and diameter of 2.0 to 3.5 metres and on hillocks and ridges with a depth range of 10.0 to 23.0 metres and diameter of 2.0 to 3.5 metres. In the crystalline formations dug wells are feasible with a depth range of 5.0 to 15.0 metres with a diameter of 2.0 to 2.5 metres. Borewells are feasible in favourable locations in crystallines (includes crystallines covered by laterite). The bore wells are generally feasible at a depth of about 40 metres to 75 metres bgl. The site has to be selected along lineaments, fractures, shear zones etc. For proper site selection for groundwater abstraction structures especially borewells farmers may make use of the technical knowhow of CGWB, GWD etc.

There should be a mode for disseminating the technical knowledge through panchayaths. Farmers should also take support of GWD and reliable NGOs for Geophysical surveys for locating borewell sites.

Additional groundwater abstraction structures can be recommended in the district with a feasibility study only except Kanhangad and Nileshwar blocks. Since the data on actual number of groundwater abstraction structures are not available, the actual draft could not be calculated precisely. Indiscriminate construction of borewells in private sector is common in the district for the last ten years. The census data on the number of groundwater abstraction structures is a must for computation of actual draft.

5.2 Water Conservation and Artificial Recharge

CGWB has implemented artificial recharge and rain water harvesting schemes in Kasargod. They are given in **Table 6**.

Table 6: Artificial Recharge and Rain Water Harvesting Schemes

S.No.	Location	Type of Structure	Year
1	Kadappallam	Percolation tank	2001
2	Bangalamkulam	Recharge pond	2001
3	Collectorate Kasargod	Roof top rain water harvesting and recharge to groundwater	2002
4	Aninjha	Check dam	2003
5	Govinda Pai Memorial Govt. College, Manjeshwar	Artificial recharge to ground water (Checkdams, Gabion structure, Recharge tank, Contour bunds, Contour trenches etc.	2010
6	Govt. UP School, Kolathur II	Recharge pond, Ferro cement tank	2010
7	Pallippara	Desiltation of pond	2010

Kadappallam is located on laterite upland. After the development of the percolation tank it is observed that water level in the dug wells at downstream side of the structure has a rise around 0.6 metres in summer compared to previous years and earlier dry dug wells also became perennial. At Bangalamkulam also there is considerable rise observed in the water levels of dug wells down stream of the structure. At Aninjha after the construction of check dam there is considerable rise in water level of dug well on both sides of the stream and upstream side. By construction of different artificial recharge structures at Govinda Pai Memorial Govt. College, Manjeshwar, there is very much increase in yield of dug wells in downstream area and also find good changes in the flora of the surrounding areas. The

recharge pond constructed at Govt. UP School, Kolathur II of Bedadaka grama panchayat collects rain water many times in a season and the recharge of the same is very well observed in the dug wells of the surrounding areas. The desiltation of pond at Pallippara also has shown positive effect in water level. Recently water conservation and artificial recharge works had been taken by the Kasargod district panchayat. Under sector reforms and Swajaldhara-2 schemes, the district panchayat had constructed 2288 rain water harvesting structures in 17 grama panchayaths having a storage capacity of 266.92 lakhs litres. The schemes were confined in 5 panchayats subsequently. The rain water harvesting structures became a boon for coastal panchayat Valiyaparamba which is surrounded all the sides by saline water. Groundwater development could be coupled with management of rainwater and surface water. More stress should be given for water shed management. The existing water resources and dug wells, tanks/ponds and streams should be cleaned and protected. Along with rain water harvesting, artificial recharge schemes should also be practiced in large scale. The hydrogeological set up of the district very well suits for artificial recharge. Using rain water, bore wells can be recharged especially in the critical and semi critical blocks.

The artificial recharge schemes proposed for all the six blocks are

1. Percolation tank by developing the abandoned laterite quarries
2. Vented cross bar (VCB)
3. Desiltation and deepening of pond/tank
4. Recharge of borewells with recharge pit
5. Recharge pit

The type of AR structure and their intensity recommended for each blocks are given in **Table 7.**

Table 7: Artificial Recharge Schemes feasible in various blocks in Kasargod district

S.No.	Name of Block	**Artificial Recharge Schemes**				
		Percolation tank	**Vented Cross bar**	**Desiltation and deepening of pond/tank**	**Borewell recharge with recharge pit**	**Recharge pit**
1	Manjeshwar	4	3	10	5	3
2	Kasargod	4	3	10	5	5
3	Kanhangad	4	3	10	5	3
4	Nileshwar	3	2	5	-	-
5	Karadka	4	2	5	5	-
6	Parappa	3	2	5	-	-

The artificial recharge prospects of the district are shown in **Figure 6.**

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

Acute water scarcity is being faced in the hilly areas in summer period due to drying up of dug wells. Dug wells in midland region get dried up if monsoon is delayed or if there is no summer showers. The increased dependence on borewells in midland areas leads to drying up of dug wells in lateritic mounds and slopes which affects the water needs of farmers and poor people. The construction of new bore wells by individuals near the existing water supply bore wells badly affecting the yield of many water supply bore wells.

7.0 AWARENESS AND TRAINING ACTIVITY

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

Three Mass Awareness Programmes on conservation and protection of groundwater were conducted at Kasargod in 2000 and 2007 and at Kanhangad in 2004. In these programmes the hydrogeological conditions of Kasargod district, the measures for water conservation and protection were discussed and clarified the doubts of participants. About 200 persons attended in all these Programmes.

Two Water Management Training programme were conducted at Kasargod in the year 2003 and 2007. More than hundred participants attended these trainings. In the programme the methods for rainwater harvesting, artificial recharge to groundwater and the structures suitable for water conservation in different areas of the district and the general hydrogeological conditions of the district were discussed.

8.0 AREAS NOTIFIED BY CGWA/SGWA

Kasargod block (Critical area).

9.0 RECOMMENDATIONS

1. The stage of groundwater development in the district during 2009 was 71.3% leaving some scope for future development.
2. The groundwater development in the central and western parts of the district are found to be more. The water level in these areas are showing falling trend in pre monsoon period but no much change in post monsoon period. Hence large scale future development is possible in Kanhangad and Nileshwar block which are in safe category

and limited groundwater development as per feasibility study in Manjeshwar block. In Kasargod block the groundwater development should be restricted.

3. The number of groundwater abstraction structures especially private borewells are on increasing trend, proper census of these structures are necessary for further development.

4. There is an increasing trend for groundwater development through bore wells in the recent years. The studies indicate that the potential fracture zones are encountered at shallower depths and hence the farmers need not go beyond 100m depth.

5. Groundwater development should be limited with conjunctive use of rainwater and surface water. More stress should be given for watershed management. The existing water resources, dug wells, ponds/tanks and streams should be cleaned and protected.

6. Micro level survey is recommended in critical and semi critical blocks to get more realistic picture of groundwater development and to study the scope for future development.

7. The springs seen in the hilly areas are to be developed and put to use.

8. The use of tunnel well is to be reduced, since it drains large quantity of water from the wells and slopes.

9. There should be proper water budgeting for the district. Priority should be given for small scale/micro water supply projects and proper maintenance of minor irrigation projects and water supply schemes.

10. Mass awareness programmes should be organized to bring awareness among the people about the importance of water conservation and protection at panchayat levels.

11. Artificial recharge schemes should be taken up in large scale along with rainwater harvesting schemes.

Figure 1: Index map of Kasargod District, Kerala

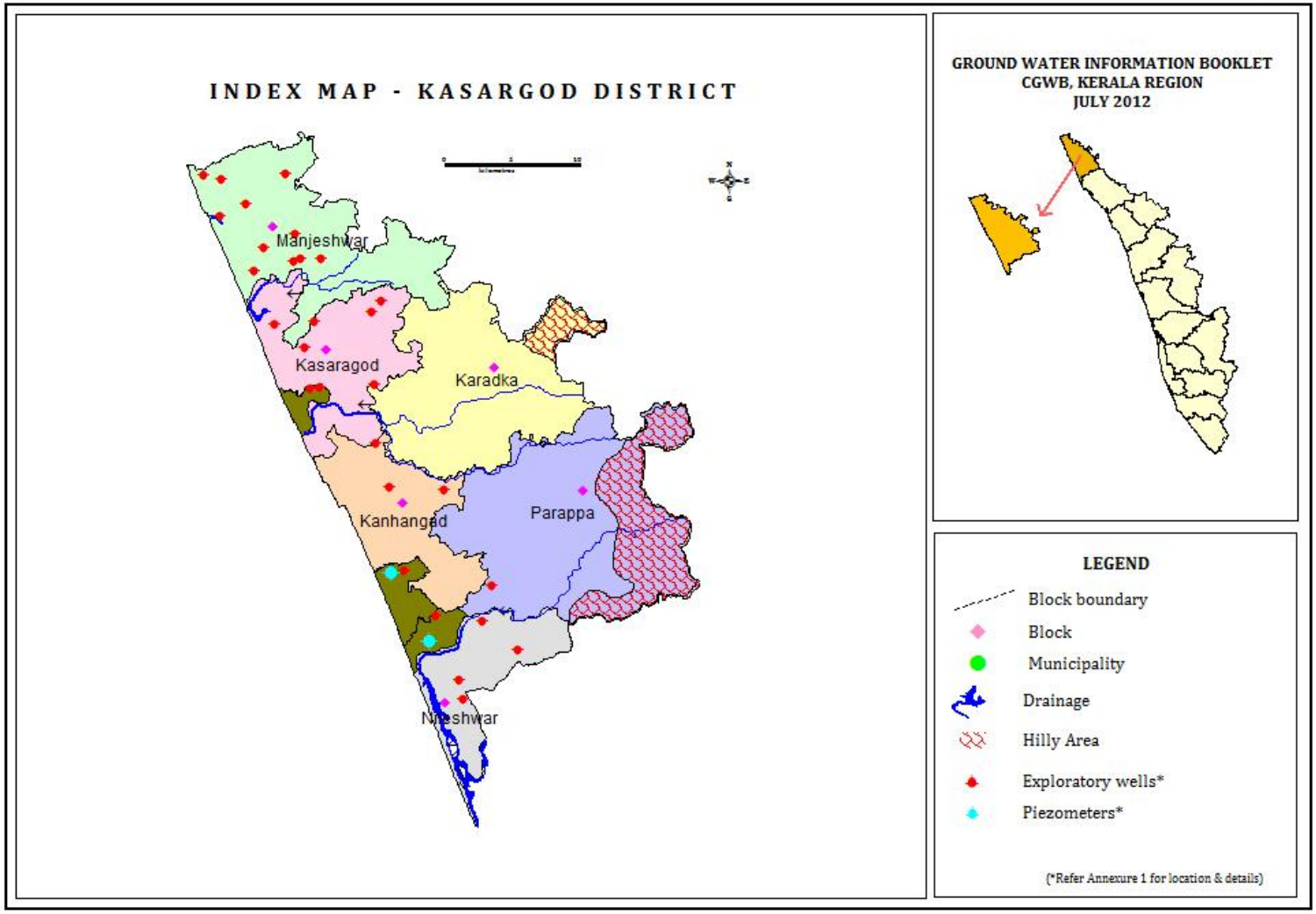


Figure 2: Pre-monsoon Depth to Water Level, Kasargod District (April 2002-11)

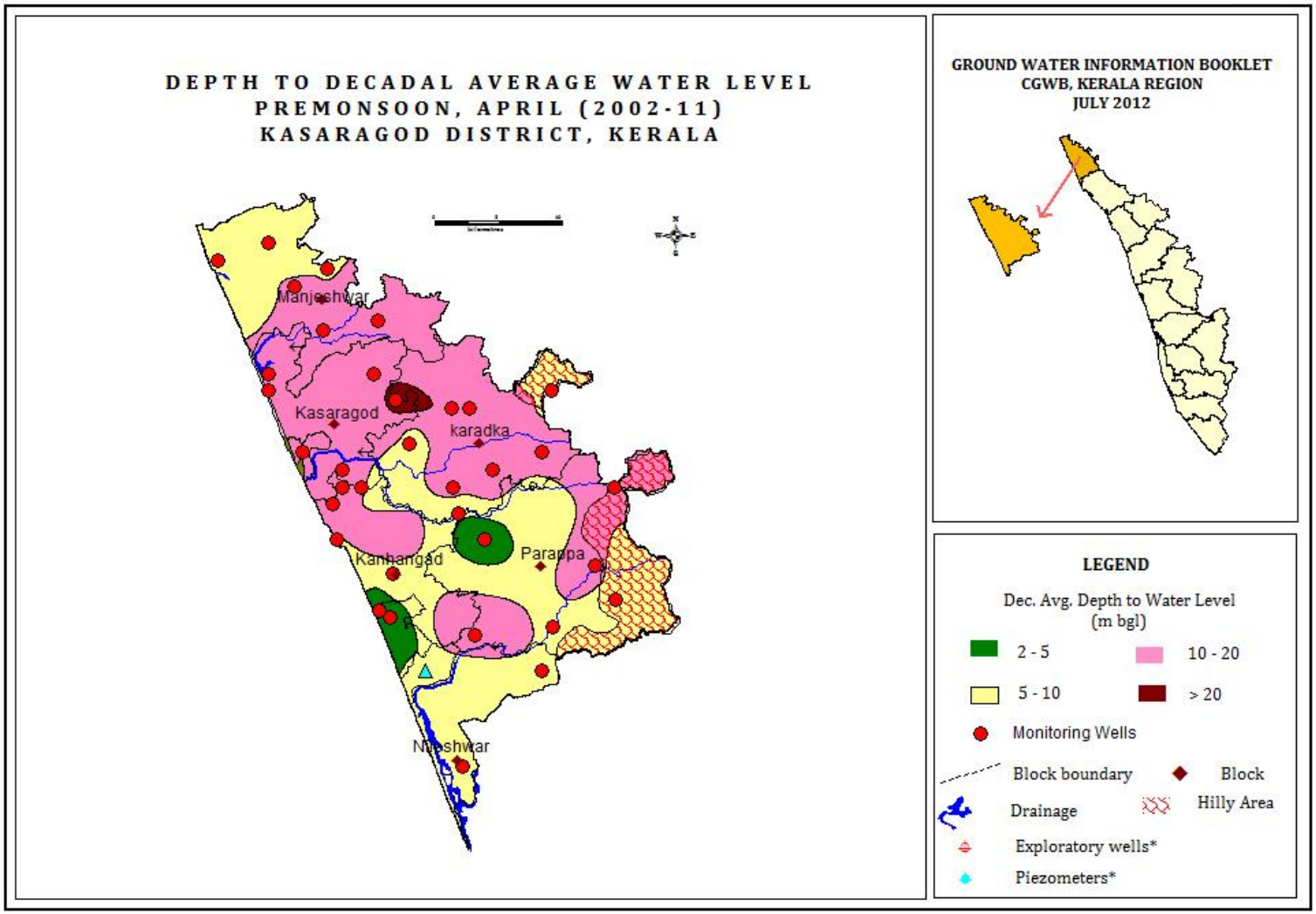


Figure 3: Post Monsoon Depth to Water Level, Kasargod District, Kerala (Nov-2002-2011)

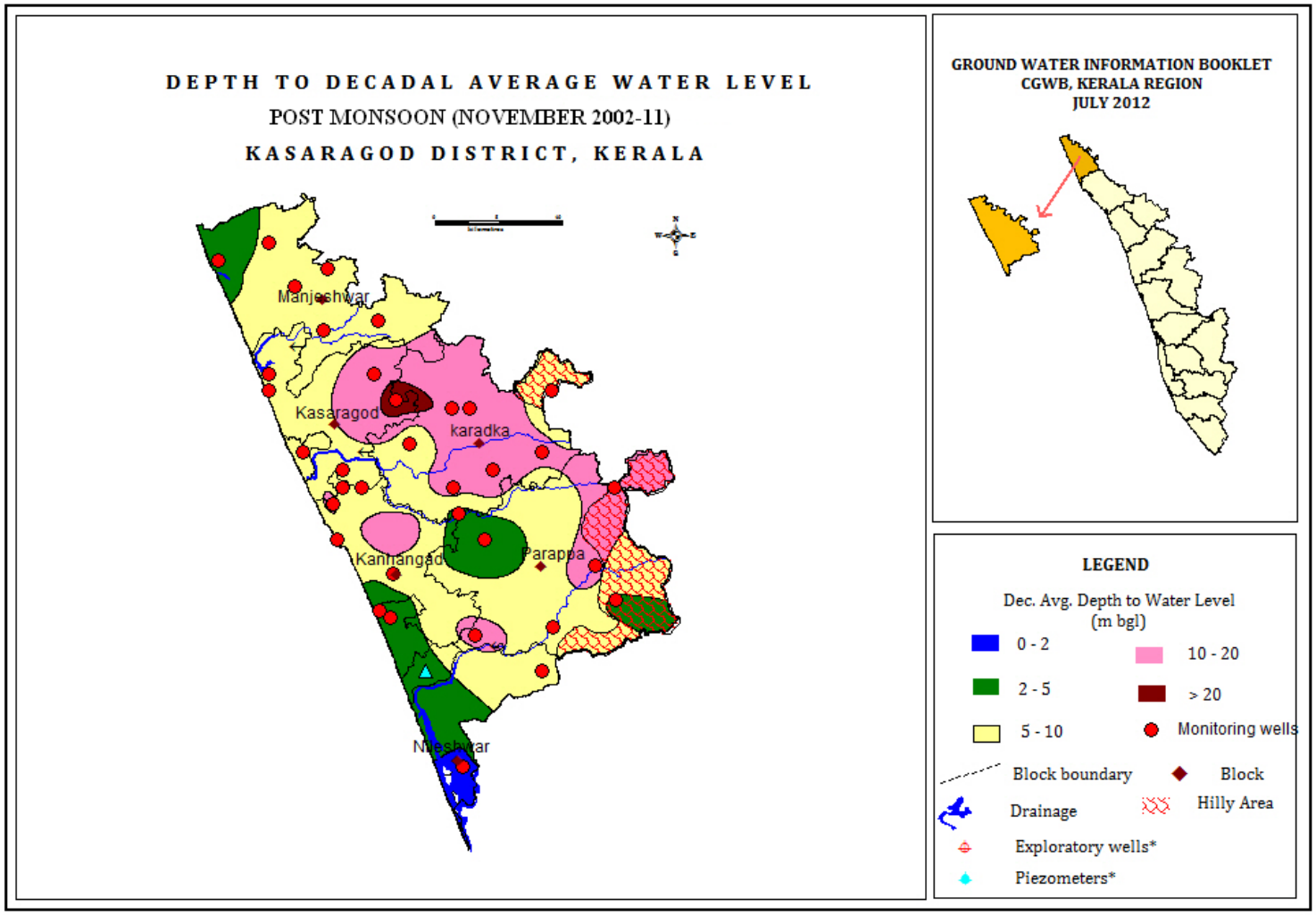


Figure 4: Hydrogeology of Kasargod District, Kerala State

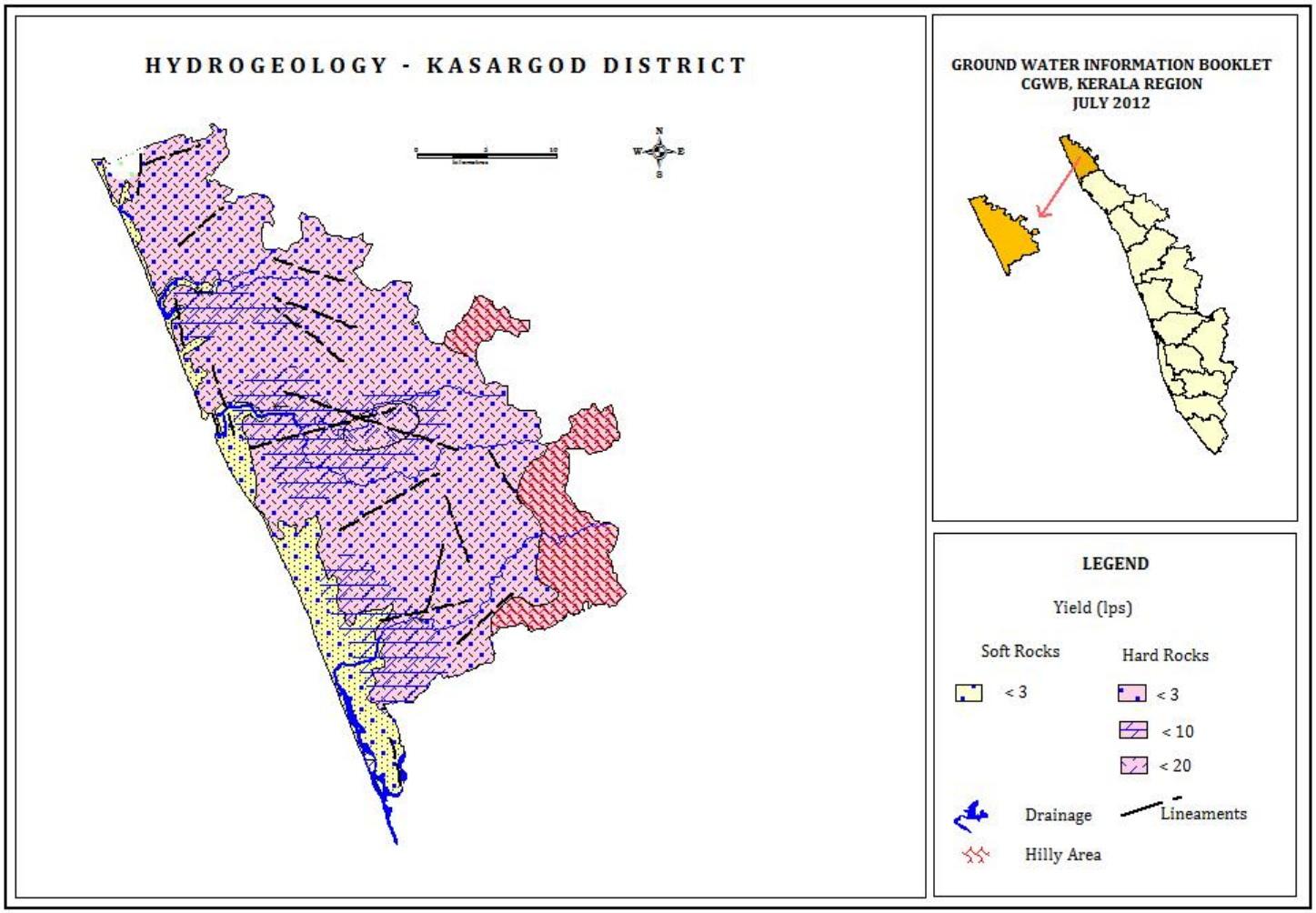


Figure 5: Categorization of Blocks in Kasargod District

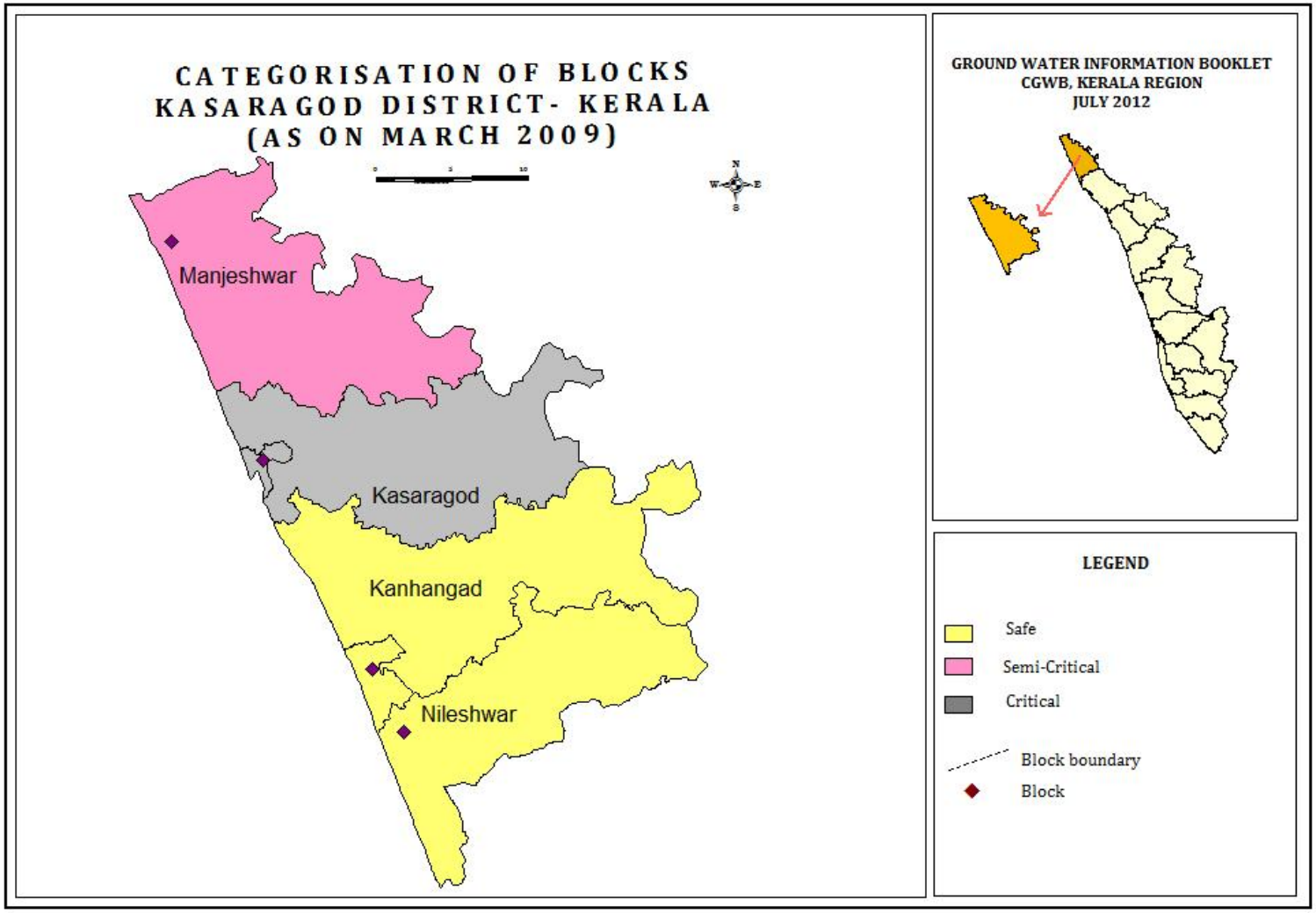
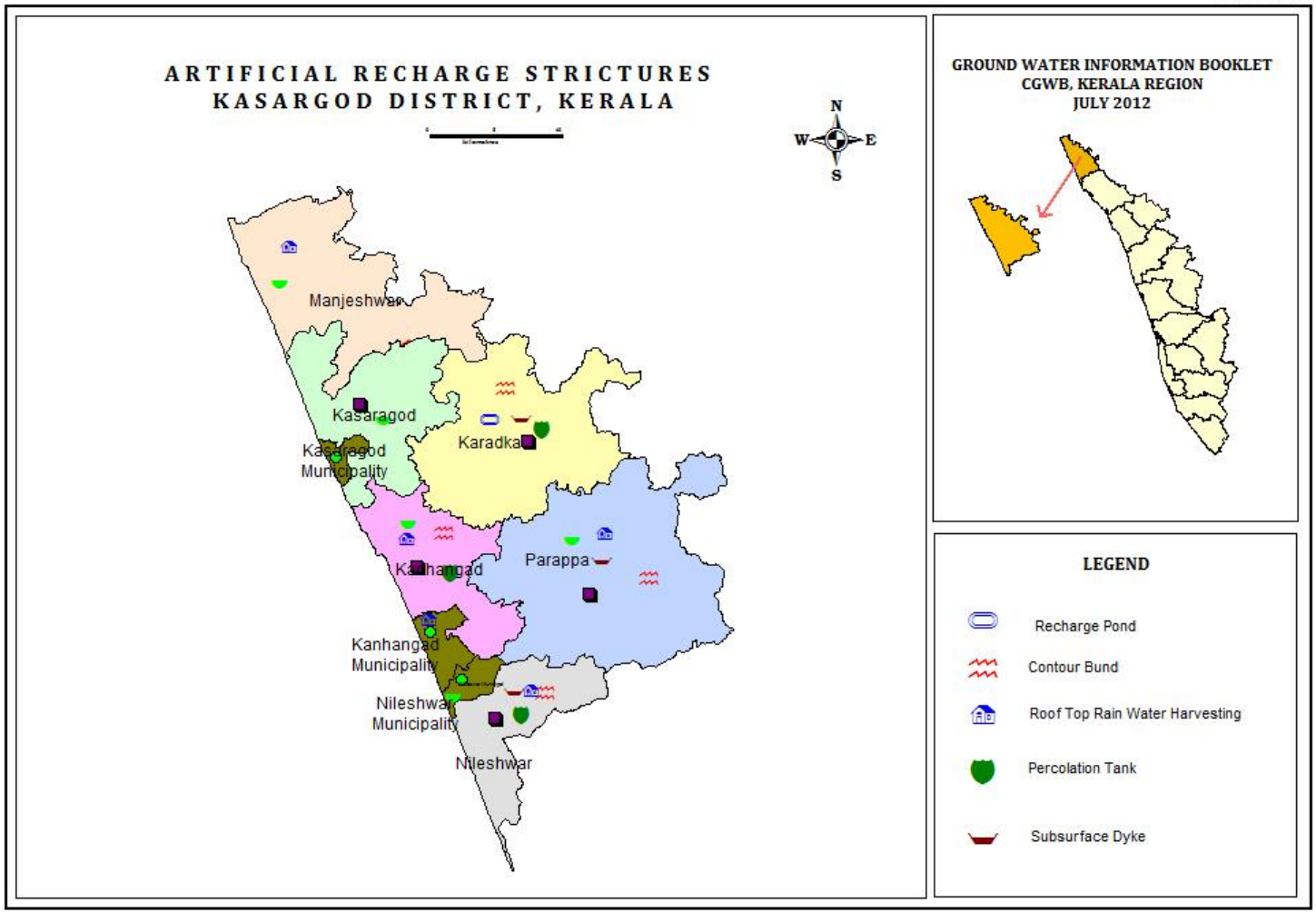


Figure 6: Artificial Recharge Structures proposed in Kasargod District



Annexure-1

Details of exploratory wells drilled by CGWB in Kasargod district

Sl No.	Location	Year of construction	Coordinates	Lineament Direction	Depth drilled	Depth of casing mbgl	Fracture zones	Discharge lpm during drilling	SWL mbgl	T m2/day	EC µs/cm at 250C	Cl ppm	Rock type
1	Vidyanagar		$12^0$31'03", $75^0$00'50"	EW	68.00	6.15	17-68/360	378	4.85	14.03	110	14	Garnetifuous garnite gneiss
2	Yednir		$12^0$31'20", $75^0$04'25"	NW-SE	88.00	4.85	6.55, 19.00, 29.00	52	5.11	4.584	185	14	Charnockite
3	Santipalla		$12^0$35'15", $74^0$57'45"	N-S	50.50	5.71	13.5-13.8, 13.8-50.5	600	3.20	98.23	135	14	Charnockite
4	Sitamguli		$12^0$35'25", $75^0$00'25"	EW	63.00	3.95	3, 4-5, 15-16, 30, 63	261	2.29	13.752	1100	298	Charnockites calc-granulites
5	Karambila		$12^0$36'00", $75^0$04'15"	NW-SE	94.00	4.83	5.5, 30, 44.7, 53.5, 69.15	72	5.33	1.31	120	14	Charnockite gneiss
6	Pallathadka		$12^0$36'45", $75^0$04'50",	NW-SE	69.00	NA	32-33.6, 36.1-39.0, 50-52,	375	7.90	13.4	340	14	Charnockite
7	Ichlangodu		$12^0$38'40", $74^0$56'25"	N-S	81.50	4.14	13.5, 22-24, 32-33, 36-37, 68-69	88	4.29	9.024	80	21	Granite gneiss
8	Kokkechal		$12^0$39'20", $74^0$59'0",	N-S	73.00	4.13	6-7, 13-14, 69-70, 73	76	4.13	0.86	NA	NA	Charnockite gneiss
9	Kundalmarkala		$12^0$39'30", $75^0$0'50",	N-S	78.50	5.88	4-5, 21-22, 56-57, 61-62, 70-71, 75-76	200	5.80	12.38	58	14	Gneiss with pegmitite veins & bands of Dolerite dyke
10	Kubanuru		$12^0$40'10", $74^0$57'00"	NW-SE	87.60	9.20	13-14, 16-17, 34, 38.9, 51-52	50	9.70	3.58	51	14	Pyroxene granulite
11	Paivalike		$12^0$41'05", $74^0$59'10"	N-S	81.50	4.37	27.5, 69.5	66	4.57	3.438	110	18	Garnite gneiss
12	Kadambaru		$12^0$43',00" $74^0$55'50"	NW-SE	72.00	5.45	8, 34-35, 35-36, 60-61, 66-67, 68-69	102	4.12	8.778	120	11	Horneblende biotite gneiss

13	Kodlamogar		12^{0}45',00" 74^{0}58'30",	N-S	63.00	2.14	4.5, 8-9, 14-15, 35-36	30	2.60	1.528	NA	NA	Charnockite gneiss
14	Langanaduka	2002-03	12^0'39'30, 74^{0}59'30",	E-W	200.00	20.50	21.5-28.0, 108.0-110.0 148.0-150.0	30	8.32		199	5.7	Granite gneiss
15	Hosangadi	2002-03	12^{0}42'15, 74^{0}54'10"	NE-SW	62.30	30.20	53 - 55	180		2.38		349	Hornblende gneiss
16	Gerukatte	2002-03	12^{0}44'37", 74^{0}54'12"	NE-SW	120.20	11.60	61-62 86-88	660	10.79	43.51	261	5.7	Syenite
17	Kunjathur	2002-03	12^{0}44'54", 74^{0}53'03"	NE-SW	122.50	11.20	11-14 88-89 105-108 122-122.5	600	11.07	161.4	312	9.9	Horneblende gneiss
18	Mayippadi	2002-03	12^{0}33'45", 74^{0}59'25"	NE-SW	200.00	11.25	10.0-14.0	30	1.35	0.65	231	7.1	Horneblende gneiss
19	Chemmattam-vayal	2004-05	12^{0}19'13", 75^{0}01'25"		199.5	13.4	53.10-54.10	30	5.87		423	9.9	Charnockite
20	Periye	2004-05	12^{0}24'37", 75^{0}05'26"		200.4	23.6	27.70-28.70 76.50-77.50 113.0-114.0 154-155	90	11.5	2.96	154	5.7	Charnockite
21	Kalliot	2004-05	12^{0}24'30", 75^{0}09'00"		112.5	21.0	24.60-25.60 64.20-65.20 70.30-71.30 111-112.50	510	4.25	15.82	169	5.7	Granite gneiss
22	Chirapuram	2004-05	12^{0}16'15", 75^{0}08'30"		200	31.7	37.0-38.0 128.0-129.0 198.0-199.0	120	3.93	9.8	167	4.2	Granite gneiss
23	Chamakuzhy (koovatty)	2004-05	12^{0}18'14", 75^{0}12'16"		72.3	28.5	38.30-39.80 54.0-55.0 60.10-61.10	420	36.05	60.0	268	7.1	Hornblende biotite gneiss

24	Kayyur	2004-05	$12^0$15'58", $75^0$11'36"		200	22.9	25.60-28.60	120	10.3	7.9	184	4.3	Charnockite
25	Cheemeni	2004-05	$12^0$14'05", $75^0$13'55"		98	20.4	28.60-29.60 40.8-41.8	660	5.8	27.0	242	5.7	Charnockite
26	Chandera	2004-05	$12^0$10'50", $75^0$10'20"		200	31.7	34.7-35.7	96	9.25	6.66	268	11	Charnockite
27	Pilicode	2004-05	$12^0$12'05", $75^0$10'00"		135	38.2	41.2-42.2 126.2-127.0 132.3-1333.3	420	19.35		232	8.5	Charnockite & Granitic gneiss
28	Karicherri	2004-05	$12^0$27'30", $75^0$04'30"		86.6	18.4	23.0-23.5 43.5-44.0 48.5-49.0	600	16		204	4.3	Charnockite
29	Kasargod	2004-05	$12^0$31'10", $75^0$00'48"		90	23.3	34.7-35.7 40.8-41.50	555	12.3		179	5.7	Quartzo feldspathic gneiss

Annexure II: Chemical Analysis data of GWMW samples collected from Kasargod district during April 2009

Sl. No	Location	pH	EC in µs/cmat 25^0C	TH as CaCO3	Ca	Mg	Cl	F	NO_3
1	Badiadka	7.81	159	50	18	1.5	9.9	0.18	1.7
2	Bandadka	7.6	97	28	8	1.9	9.9	0.02	0
3	Bedadka	7.24	51	16	3.2	1.9	7.1	0.09	2
4	Bekal	7.44	173	26	5.6	2.9	27	0.29	30
5	Bhimanadi	7.44	84	24	6.4	1.9	8.5	0.22	3.7
6	Chayankod	7.98	168	54	14	4.9	5.7	0.26	0.11
7	Chittarikkal	8.11	84	26	4.8	3.4	5.7	0.02	0.39
8	Kasargod	7.1	196	32	9.6	1.9	43	0.22	14
9	Koliyarpadavu(nearby well)	7.6	74	22	8	0.49	7.1	0.06	0.63
10	Kuttikolu	7.41	36	8	3.2	0	5.7	0.06	0
11	Manjeshwar	7.28	192	34	8	3.4	40	0.07	8.6
12	Mogaral	7.61	148	42	12	2.9	16	0.29	2
13	Mulligadde	6.72	54	14	3.2	1.5	9.9	0.45	5.4
14	Muliyar	7.35	95	18	4.8	1.5	17	0.43	1.4
15	Mulleria	7.03	196	38	8	4.4	33	0.19	52
16	Nattakkal	7.74	115	40	7.2	5.4	11	0.22	5.5
17	Neeleshwaram	-	101	34	11	1.5	17	0.15	0
18	Odayanchal	7.76	52	14	3.2	1.5	7.1	0.09	1.9
19	Paivallke	7.45	74	14	4.8	0.49	13	0.27	3.7
20	Panathadi	6.86	84	22	5.6	1.9	14	0.23	13
21	Parappa North	7.44	70	28	4.8	3.9	9.9	0.45	0
22	Peraladkam	7.33	33	8	3.2	0	8.5	0.06	0.4
23	Poinachi	7.31	65	20	4.8	1.9	9.9	0.15	0.9
24	Pullur	7.62	53	16	5.6	0.49	8.5	0.17	0
25	Thaniyadi	7.49	69	20	4	2.4	7.1	0.34	2
26	Trikkarippur	7.37	36	10	3.2	0.49	9.9	0.36	1.6
27	Udma	8.23	195	94	28	5.8	11	0.32	6.2
28	Kumbla	8.22	180	80	25	4.4	11	0.3	0