AQUIFER SYSTEMS OF KERALA

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES

CENTRAL GROUND WATER BOARD
KERALA REGION, THIRUVANANTHAPURAM

SEPTEMBER 2012

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THIRUVANANTHAPURAM

SEPTEMBER 2012

ध्रुव विजय सिंह
DHRUV VIJAI SINGH

सत्यमेव जयते

सचिव
भारत सरकार
जल संसाधन मंत्रालय
श्रम शक्ति भवन
रफी मार्ग, नई दिल्ली-110 001

SECRETARY
GOVERNMENT OF INDIA
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SHRAM SHAKTI BHAWAN
RAFI MARG, NEW DELHI-110 001

13TH September 2012

MESSAGE

Ground water utilization has increased significantly during the last two decades. The unplanned and indiscriminate use of this vital resource has resulted in declining water levels and water quality deterioration in certain areas. The apparent stress on ground water resources is more often a management issue, and this needs to be addressed in a holistic manner, for its long term sustainability, through an integrated approach. Aquifer mapping is an essential step towards the effective management of ground water resources.

The atlas entitled **"Aquifer Systems of Kerala"** is a step towards achieving the ultimate goal of aquifer wise management of ground water resources in Kerala State.

I congratulate Central Ground Water Board, Ministry of Water Resources for its efforts to bring out this document containing data and information pertaining to various aspects of ground water including aquifer disposition in the State. I am sure this atlas will be of immense use to planners, policy makers, researchers and users involved in ground water sector.

(Dhruv Vijai Singh)

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जल संसाधन मंत्रालय
भूजल भवन एन.एच. 4 फरीदाबाद

Chairman
Government of India
Central Ground Water Board
Ministry of Water Resources
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Foreword

Availability of fresh water has always been a prime consideration in fostering the socio economic growth of the people. Rapid urbanization coupled with industrialization has resulted in increased demand of ground water at an alarming rate. Dependence on ground water is increasing continuously in order to supplement the domestic, agricultural and industrial requirements. In the last two decades there is a paradigm from development to management of Ground Water. The management of ground water is to be focussed on aquifers, which act as the repository of ground water.

To meet these challenges, it has become imperative to formulate aquifer management plan to establish the priorities for ground water use with community involvement at various levels of implementation. Central Ground Water Board over the years has generated enormous data on various aspects of ground water and has been utilised to prepare aquifer maps depicting their extent and characteristics and are compiled in the form of Atlas on "Aquifer Systems of Kerala".

This will provide a framework for prioritizing the aquifer level management strategies and build inventory of the aquifers for better understanding of the groundwater resources. An attempt has been made to present various aquifer systems in the form of maps by integrating all thematic information to formulate the aquifer wise ground water management plans.

The sincere efforts of the dedicated team of officers of Central Ground Water Board, Kerala Region, Trivandrum is highly appreciated. I am sure this atlas would be of immense use in formulating scientifically viable implementable strategies for efficient management of ground water resources ensuring sustainability.

(Dr. S.C. Dhiman)

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PREFACE

The tiny State of Kerala, located in the South-western tip of India, accounts for only 1.2 percent of its geographical area and is home to about 3 percent of its population. Though richly endowed with surface water sources such as rivers, tanks and ponds and having average annual rainfall exceeding 3000 mm, the topographic and geomorphic settings of the State allow utilization of only a small portion of the available resources. Nearly 88 percent of the total geographical area of the State is underlain by crystalline rocks devoid of any primary porosity, which limits the ground water prospects of the State as well. In alluvial formations with multiple aquifer systems in part of the coastal tract, quality is often a constraint in the optimal development of available resources. Increasing population, rapid urbanization, industrial development and human interventions in the ecosystem have resulted in increasing pressure on the limited ground water resources over the last few decades in the State. Judicious and planned development of ground water and its scientific management have become necessary to ensure long-term sustainability of this precious natural resource. This requires a proper understanding of the disposition, extents, characteristics, status of resource utilization and quality aspects of the water-bearing formations.

A vast amount of scientific information related to various aspects of the ground water regime has been generated over the years during various studies and investigations carried out by Central Ground Water Board and other Central and State Government organizations. The document entitled 'Aquifer Systems of Kerala' is an attempt by the Board to compile all the available information on the water-bearing formations in the State and to group them into a manageable number of categories based on their lithological, hydrological and hydrochemical characteristics. Accordingly, the water bearing formations of the State have been grouped into 10 principal aquifer groups and an equal number of major aquifer systems. Thematic maps depicting various aspects of the ground water regime such as water levels, chemical quality, status of ground water utilization and vulnerability to over-exploitation and contamination etc. have been prepared and presented in the document. Relevant information pertaining to rainfall distribution, population density, drainage particulars and feasibility of area for ground water development, artificial recharge & water conservation and ground water regulation has also been included. This document is intended as a guide and reference for various scientific interventions aimed at sustainable development and judicious management of ground water resources of Kerala.

This document has been prepared under the guidance of Dr. S C Dhiman, Chairman, Central Ground Water Board and through the sincere and painstaking efforts of the officers of the Central Ground Water Board, Kerala Region, Trivandrum. I take this opportunity to thank each and every one of them for their help and cooperation in the preparation of this report. I am also thankful to the Chairman, Members and officers of CGWB, Faridabad for their valuable guidance in finalizing this document. Thanks are also due to various organizations of Government of Kerala and Government of India for providing data required for the compilation of this document.

I hope this compilation will be of help to the planners, administrators and stakeholders in the water sector in Kerala and will serve as a useful guide for the optimal and sustainable management of its limited ground water resources.

Thiruvananthapuram
September 2012

(Dr. Nandakumaran. P)
Regional Director

AQUIFER SYSTEMS OF KERALA

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INTRODUCTION

Water is one of the most crucial elements in our national developmental planning for the 21st century. The proper management of our limited water resources will be essential to ensure food security for our growing population and to eliminate poverty. It will also be essential to avoid the growing conflicts and the possibility of social unrest in the country in future due to water scarcity.

Kerala State, with average annual rainfall exceeding 3000 mm, as many as 44 rivers traversing it and a large number of surface water bodies, is blessed with abundant water resources. Sustainable and equitable use of water in the State has traditionally been ensured by cultural adaptation to water availability through water conservation technologies, agricultural systems and cropping patterns adapted to different areas and conservation-based life styles. However, in spite of the apparent availability of fresh water resources in sufficient quantities, frequent incidents of severe drinking water scarcity are being reported from many areas of the State. This is partly due to natural reasons such as the undulating topography of land and the limited water holding and storage capacity of hard crystalline rocks which underlie as much as 88% area of the State. In addition, various anthropogenic activities including large scale destruction of surface water bodies, indiscriminate sand mining from rivers, rapid urbanization and changing life-styles have also contributed to increasing use of fresh water. The limited ground water resource available, which is one of the major sources of fresh water, especially in rural habitations in the State, has also come under increasing stress in recent decades due to increasing exploitation and contamination.

The annual replenishable ground water resources of Kerala have been reassessed at 6.7 billion cubic meters (bcm) as in March, 2011. The main source of ground water resources is recharge from rainfall which contributes about 82% of the total annual replenishable resources. The net annual ground water availability in the State has been assessed at 6.01 bcm after keeping a provision for natural discharge. The annual ground water draft in the State as in March, 2011 is about 2.8 bcm. The stage of ground water development for the State as a whole has been computed as 47%. The utilization pattern is, however, uneven across the State, with ground water stressed conditions in some parts and sub-optimal ground water development in some others. Out of the total of 152 assessment units (blocks) in the State for which the assessment was carried out, Chittoor block of Palakkad district has been categorized as ‘Over-exploited’, whereas Malampuzha block of Palakkad district and Kasaragod block of Kasaragod district have been categorized as ‘Critical’. A total of 23 blocks located in different districts have been categorized as ‘Semi-critical’ and the remaining 123 blocks as ‘Safe’. In spite of the relatively low level of ground water development in the State, problems related to shortage, mainly for drinking and domestic uses and contamination of water due to natural and anthropogenic causes are felt in different areas of the State.

The increasing stress on the limited ground water resources calls for immediate action for sustainable ground water resource management in the State. Groundwater resources available in aquifers needs to be managed with a combination of reasonable scientific knowledge, adequate monitoring and sustained political commitment and provisions for institutional arrangements. Considering the complexity of the ground water regime and the intrinsic variability of ground water systems and socio-economic situations, no single approach can fully relieve pressures on its groundwater resources. Incremental improvements in resource management and protection can, however, be achieved through suitable means. The added uncertainty of global environmental and climate change reinforces the need for sound resource management and for providing additional social and political impetus for scientific management interventions. Groundwater also needs to be considered as part of an integrated water resources management approach that co-ordinates land and water resources management, recognises water quantity and quality linkages, manages surface water and groundwater resources conjunctively and protects and restores natural systems. This integrated approach presents new challenges for groundwater management such as the need for better understanding of the effects on groundwater recharge quantity and quality of various ground water systems and many other issues.

It is in this context that systematic mapping of aquifer systems assumes great relevance in a State like Kerala. Aquifer mapping is a scientific process wherein a combination of geologic, geophysical, hydrologic, and chemical field and laboratory analyses are applied to characterize the quantity, quality, and “sustainability” of ground water in aquifers. The objective of aquifer mapping is to provide critically needed information on the State’s ground water for planning its sustainable development. The products of aquifer mapping studies improve our understanding of the geologic framework of aquifers, their hydrologic characteristics, water levels in the aquifers and how they change over time, and the occurrence of natural and anthropogenic contaminants that affect the quality of ground water. Results of aquifer mapping can significantly contribute to resource management tools such as long-term aquifer monitoring networks and conceptual and quantitative regional ground-water-flow models besides helping planners, policy makers and other stakeholders in taking scientifically defensible decisions.

Aquifer mapping, through ground water management studies, water level and quality monitoring, exploratory drilling and aquifer testing has been an on-going activity of Central Ground Water Board in Kerala since its inception. A vast amount of scientific data on various aspects of ground water occurrence, development and management have been generated by Central Ground Water Board and various other Central and State Government organizations over the years as part of their studies. This data has been of immense help in planning ground water resource management in the State. The present endeavour is an effort by the CGWB to compile the available information on the ground water resources in Kerala in terms of their areal extents and characteristics in the form of a publication entitled ‘Aquifer Systems of Kerala’. In this publication, the water bearing formations of the State have been grouped into 10 principal aquifer groups and an equal number of important aquifer systems based on their lithological, hydrological and hydrochemical characteristics.

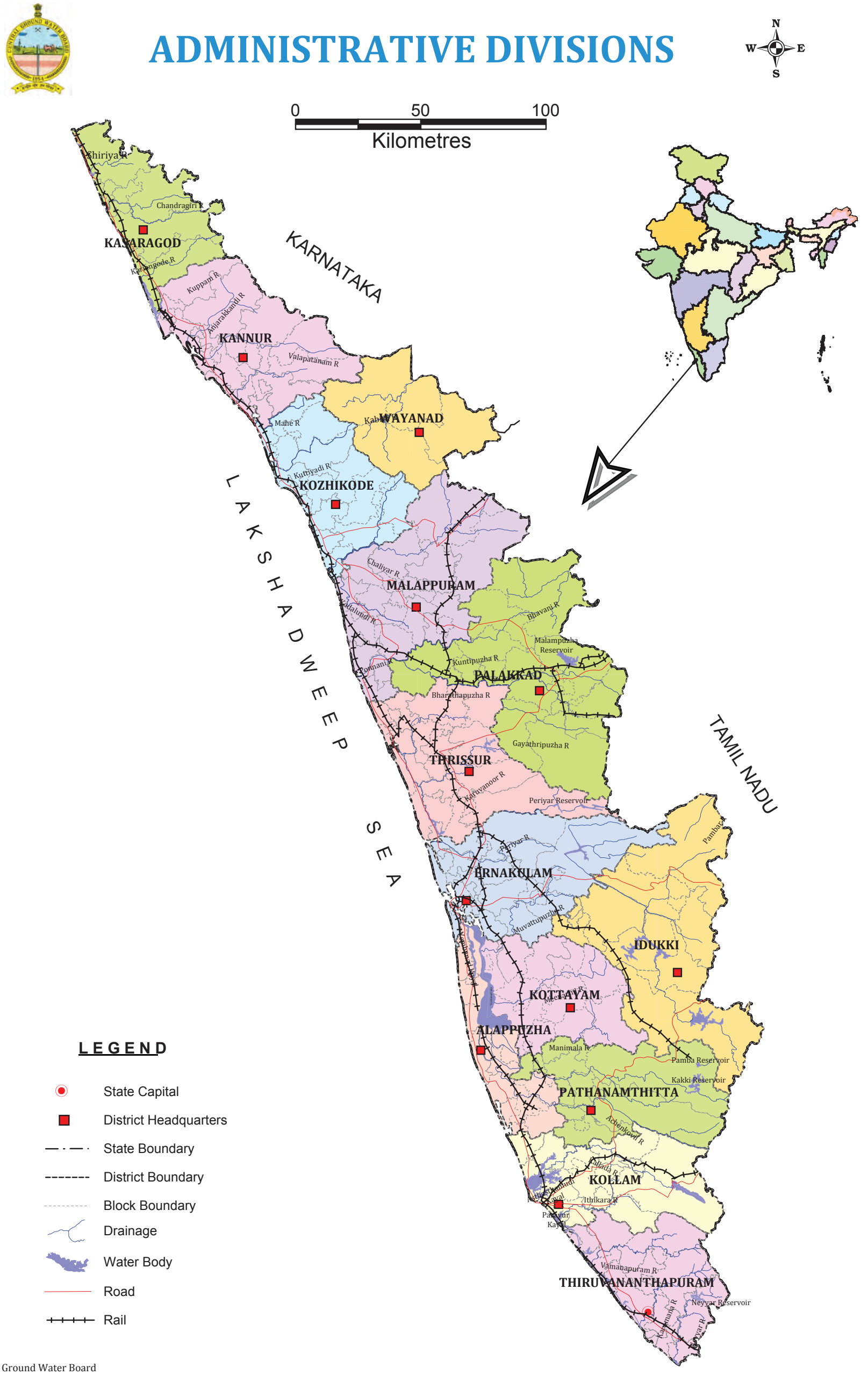
This publication provides an overview of the major aquifer systems in the State and will provide the base for the National Aquifer Mapping Programme for mapping the aquifer systems at scales of 1:50,000 or larger, being taken up by Central Ground Water Board during the XII and XIII Plans. This ambitious venture will involve compilation and synthesis of all relevant data collected by CGWB and various other agencies, to identify existing data gaps, fill them through suitable investigations and finally, to bring out comprehensive aquifer maps as well as realistic and scientific management plans to ensure their long-term sustainability. Detailed accounts of the aquifer types, their characteristics and spatial extents are given in the succeeding sections of this publication.

Table 1: Administrative Divisions of Kerala

Sl No	Name of the District	Area	Taluks	Development Blocks	Municipalities/ Corporations
1	Alappuzha	1414	6	12	5
2	Ernakulam	3068	7	14	11/1
3	Idukki	4358	4	8	1
4	Kannur	2966	3	11	6
5	Kasargod	1992	2	6	3
6	Kollam	2491	5	11	3/1
7	Kottayam	2208	5	11	4
8	Kozhikode	2344	3	12	2/1
9	Malappuram	3550	6	15	7
10	Palakkad	4480	5	13	4
11	Pathanamthitta	2637	5	8	3
12	Thiruvananthapuram	2192	4	11	4/1
13	Thrissur	3032	5	16	6/1
14	Wayanad	2131	3	4	1
Total		**38863**	**63**	**152**	**60/5**

Source : www.census2011.co.in
Area in Sq.Km

ADMINISTRATIVE DIVISIONS



LEGEND

- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Block Boundary
- Drainage
- Water Body
- Road
- Rail

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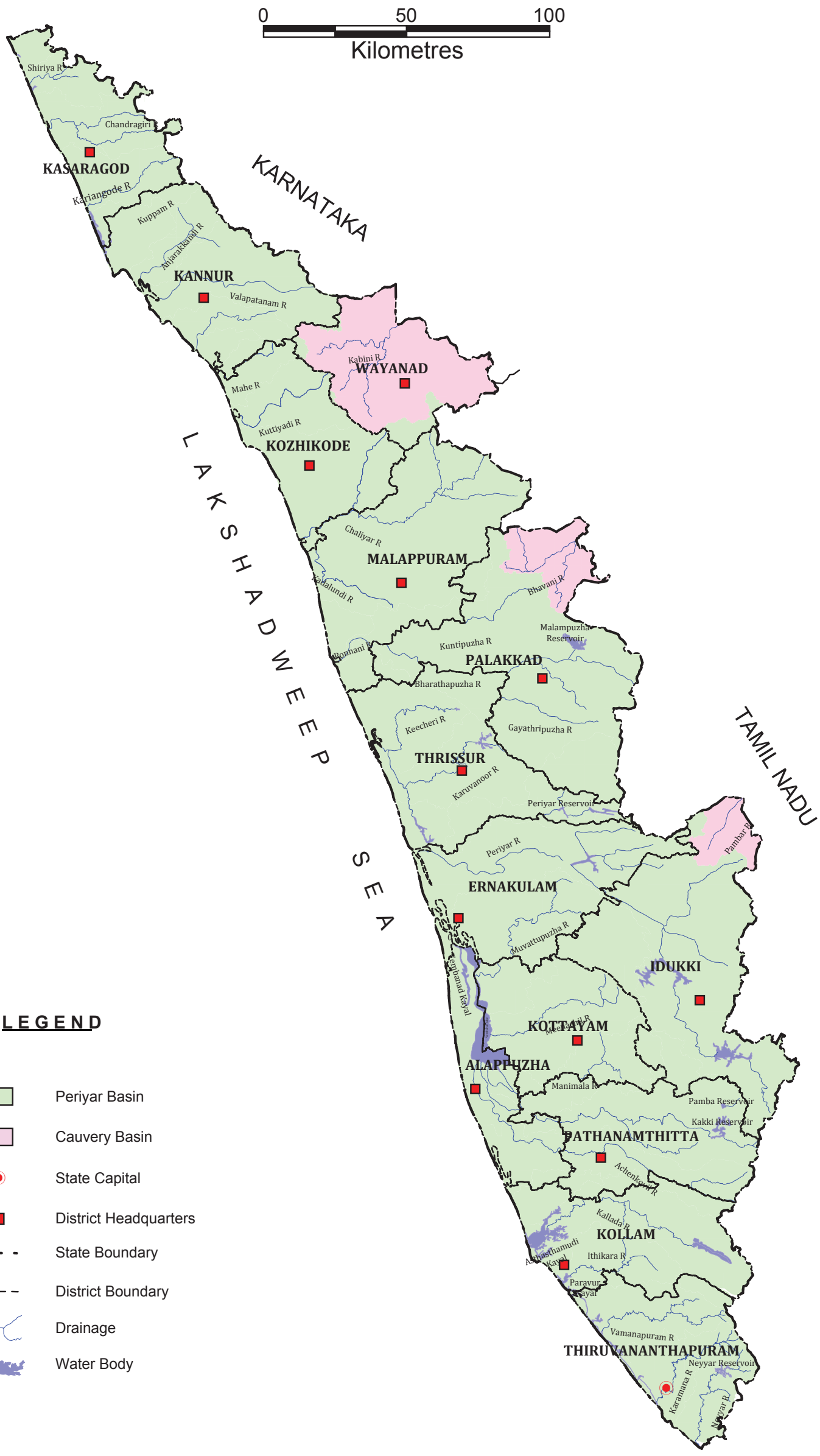
Table 2 : Major Basins and Sub Basins

Sl.No	Basin	Place of Origin of Main River	Catchment Area		Sub basin	No. of Watersheds	Sharing state	Sub Basin Area in Kerala
			Total	In Kerala				
1	Periyar (Rivers From Kanyakumari To Sharavati Flowing into Arabian Sea)	Sivagiri peaks of Sundaramala Tamil Nadu.	54580	35985	Netravati and Others	7	Kerala, Karnataka	4689
					Periyar and others	17	Kerala, Tamil Nadu	13208
					Varrar and others	8		18088
2	Cauvery	Talakaveri, Kodagu district, Karnataka.	81155	2879	Cauvery Middle	5	Kerala, Karnataka, Tamil Nadu	2879
Total			**135735**	**38863**		**37**		**38863**

Area in Sq.Km

RIVER BASINS



LEGEND

- Periyar Basin
- Cauvery Basin
- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

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Table 3 : District wise Distribution of Principal Aquifer Systems in Kerala

Sl No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		B G C		Gneiss		Intrusives		Total Area
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	
1	Alappuzha	1197	84.7	148	10.5	16	1.1					30	2.1	23	1.7			0	0.0			**1414**
2	Ernakulam	378	12.3	55	1.8							1872	61.0			479	15.6	286	9.3			**3068**
3	Idukki					63	1.4					2038	46.8			763	17.5	1495	34.3			**4358**
4	Kannur	322	10.8	78	2.6			9	0.3	71	2.4	399	13.4			1959	66.1			129	4.3	**2966**
5	Kasargod	169	8.5	86	4.3							1557	78.2					179	9.0			**1992**
6	Kollam	107	4.3	262	10.5							330	13.2	1470	59.0			322	12.9			**2491**
7	Kottayam	248	11.2	189	8.6							1710	77.5					61	2.8			**2208**
8	Kozhikode	134	5.7	43	1.8							801	34.2			1366	58.3					**2344**
9	Malappuram	285	8.0	53	1.5							2291	64.5			752	21.2	170	4.8			**3550**
10	Palakkad											1793	40.0					2663	59.4	24	0.5	**4480**
11	Pathanamthitta	45	1.7	43	1.6	11	0.4					2170	82.3	108	4.1			260	9.9			**2637**
13	Thiruvananthapuram	36	1.6	284	13.0									1872	85.4							**2192**
12	Thrissur	312	10.3	188	6.2							1842	60.8			98	3.2	593	19.5			**3032**
14	Wayanad					63	2.9	92	4.3			335	15.7			1524	71.5	19	0.9	99	4.6	**2131**
Total		**3232**	**8.3**	**1428**	**3.7**	**153**	**0.4**	**101**	**4.6**	**71**	**2.4**	**17167**	**44.2**	**3474**	**8.9**	**6940**	**17.9**	**6047**	**15.6**	**252**	**0.6**	**38863**

Area in Sq.Km

% - Percentage of total district area

PRINCIPAL AQUIFER SYSTEMS

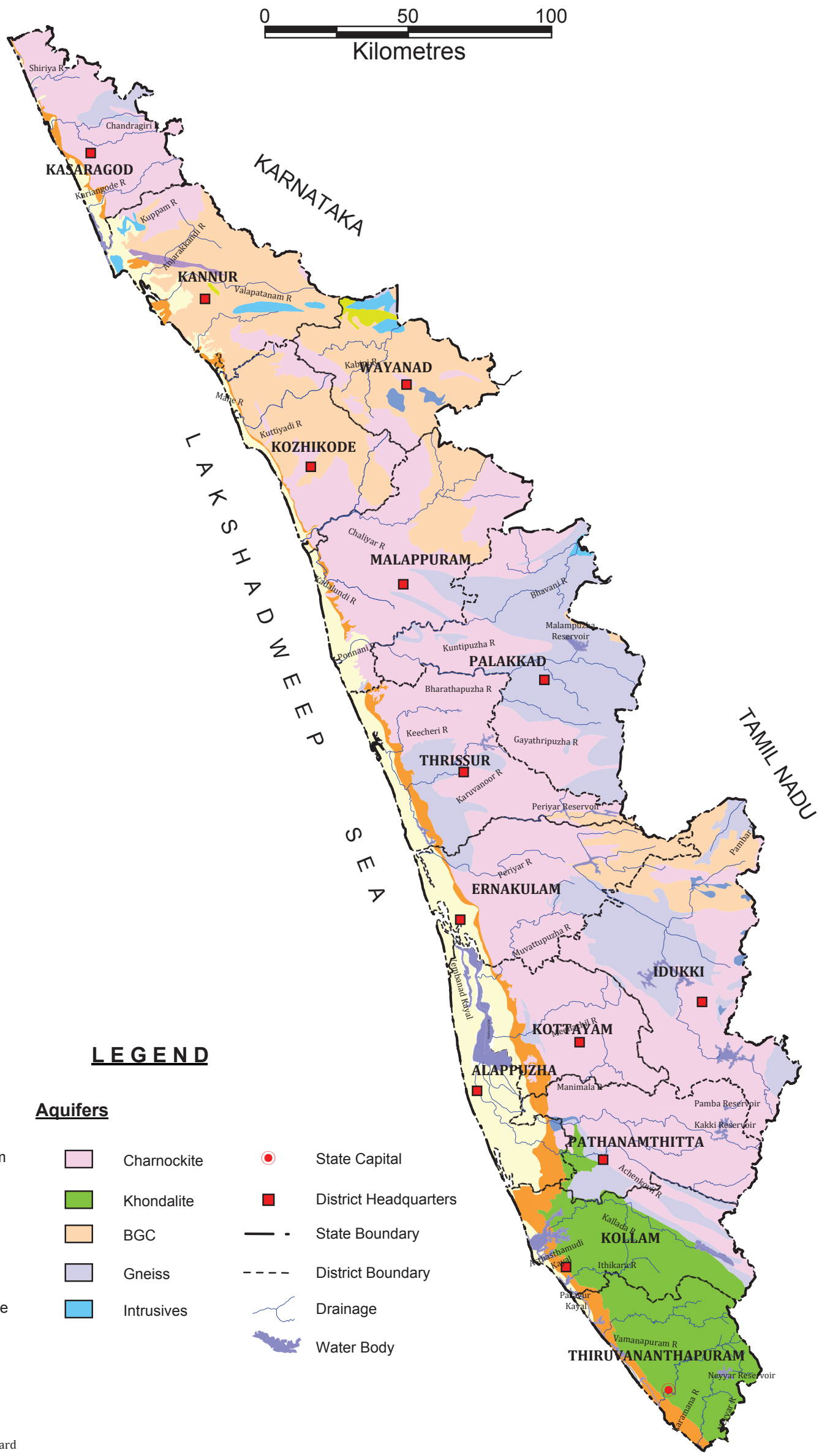

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Table 4: Aquifer Systems of Kerala

Sl.No	Principal Aquifer Code	Principal Aquifer	Major Aquifer Code	Major Aquifer	Area Covered	% of Total Area
1	AL	Alluvium	AL01	Fluvial Alluvium (Clay/Silt/Sand/ Calcareous concretions)	3232	8.3
2	LT	Laterite	LT01	Laterite / Ferruginous concretions	1428	3.7
3	GR	Granite	GR02	Acidic Rocks(Pegmatite, Granite, Syenite, Rhyolite etc.)	153	0.4
4	SC	Schist	SC01	Schist	101	0.3
5	QZ	Quartzite	QZ01	Quartzite	71	0.2
6	CK	Charnockite	CK01	Charnockite	17167	44.2
7	KH	Khondalite	KH01	Khondalite	3474	8.9
8	BG	Banded Gneissic Complex (BGC)	BG01	Banded Gneissic Complex (BGC)	6940	17.9
9	GN	Gneiss	GN02	Gneiss	6047	15.6
10	IN	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.)	129	0.3
			IN02	Ultra Basics (Epidiorite, Granophyre etc.)	123	0.3

Area in Sq.Km

MAJOR AQUIFERS

N
W E
S

0 50 100
Kilometres

KARNATAKA

TAMIL NADU

LAKSHADWEEP SEA

Shiriya R
Chandragiri R
KASARAGOD
Kariangode R
Kuppam R
Mogralkanni R
KANNUR
Valapatanam R
Kabani R
WAYANAD
Mahe R
Kuttiyadi R
KOZHIKODE
Chaliyar R
MALAPPURAM
Kadalundi R
Bhavani R
Malampuzha Reservoir
Kuntipuzha R
Ponnani R
PALAKKAD
Bharathapuzha R
Keecheri R
Gayathripuzha R
THRISSUR
Karuvanoor R
Periyar Reservoir
Periyar R
Pambar R
ERNAKULAM
Muvattupuzha R
Vembanad Kayal
IDUKKI
Meenachil R
KOTTAYAM
ALAPPUZHA
Manimala R
Pamba Reservoir
Kakki Reservoir
PATHANAMTHITTA
Achenkovil R
Kallada R
KOLLAM
Ithikara R
Vamanapuram R
THIRUVANANTHAPURAM
Neyyar Reservoir
Karamana R
Neyyar R

LEGEND

Aquifers

- Alluvium (AL 01)
- Laterite (LT 01)
- Acidic Rocks (Granite,Pegmatite etc) (GR 02)
- Schist (SC 01)
- Quartzite (QZ 02)
- Charnockite (CK 01)
- Khondalite (KH 01)
- BGC (BG 01)
- Undifferentiated Metasedimentaries/ Metamorphic (GN 01)
- Basic Rocks (Dolerite, Anorthosite etc) (IN 01)
- Ultrabasic Rocks (Epidiorite Granophyre etc) (IN 02)

- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

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Table 5 : Parliamentary Constituency wise Distribution of Aquifers in Kerala

Sl. No.	Parlimentary Constituency	Alluvium	Laterite	Granite	Schist	Quartzite	Charnockite	Khondalite	B G C	Gneiss	Intrusives
1	Adoor			62.5			2677.0		29.0	1540.4	
2	Alappuzha	980.4						23.0			
3	Chirayinkil	27.9	134.6					1247.2			
4	Ernakulam	293.2	19.4				97.6			4.2	
5	Idukki						1799.0		1540.4	263.8	
6	Kannur	125.0	33.9		99.8	10.9	239.7		1923.9	19.4	175.6
7	Kasaragod	339.5	104.0		1.2	60.0	1762.5		390.2	177.7	46.8
8	Kollam	99.4	258.6					1365.0		26.3	
9	Kottayam	261.7	187.8				593.5			50.3	
10	Kozhikode	28.1	9.5	62.3			667.9		1480.5		6.0
11	Manjeri	13.3	7.0				1746.1		431.0	8.6	
12	Mavelikara	290.2	191.5	28.2			297.7	218.4		17.2	
13	Mukundapuram	150.7	92.2				1231.0		105.4	350.1	
14	Muvattupuzha	16.1	21.3				1950.8		3.0	223.9	
15	Ottapalam		13.5				1275.0			342.8	
16	Palakkad						1106.1			2539.7	23.5
17	Ponnani	302.5	63.8				913.1			173.2	
18	Thiruvananthapuram	7.3	155.9					620.0			
19	Thrissur	192.7	87.0				600.4			309.1	
20	Vadakara	104.0	47.9				209.7		1036.2		
Total		**3232**	**1428**	**153**	**101**	**71**	**17167**	**3474**	**6940**	**6047**	**252**

Area in Sq.Km.

PARLIAMENTARY CONSTITUENCIES

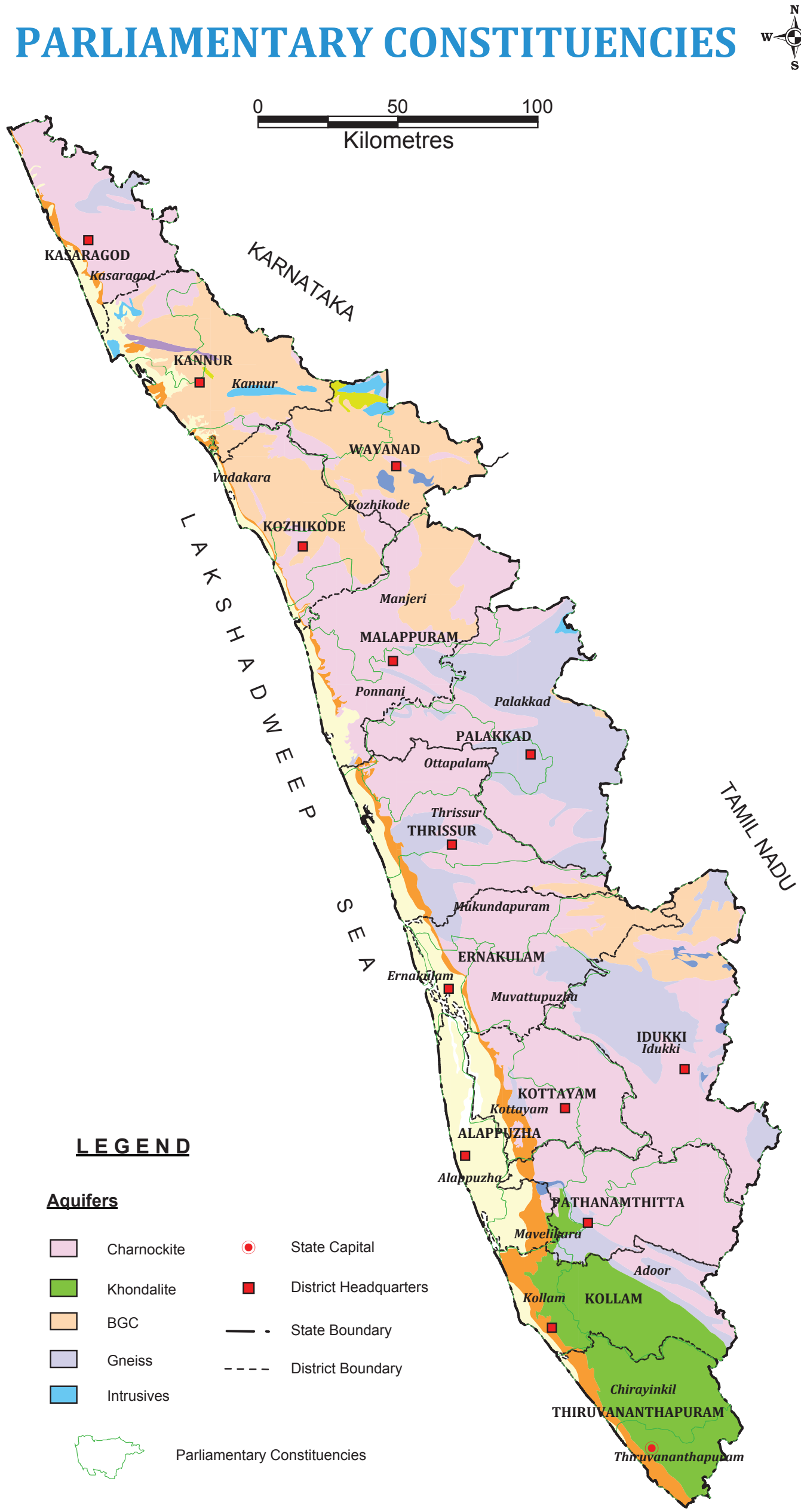

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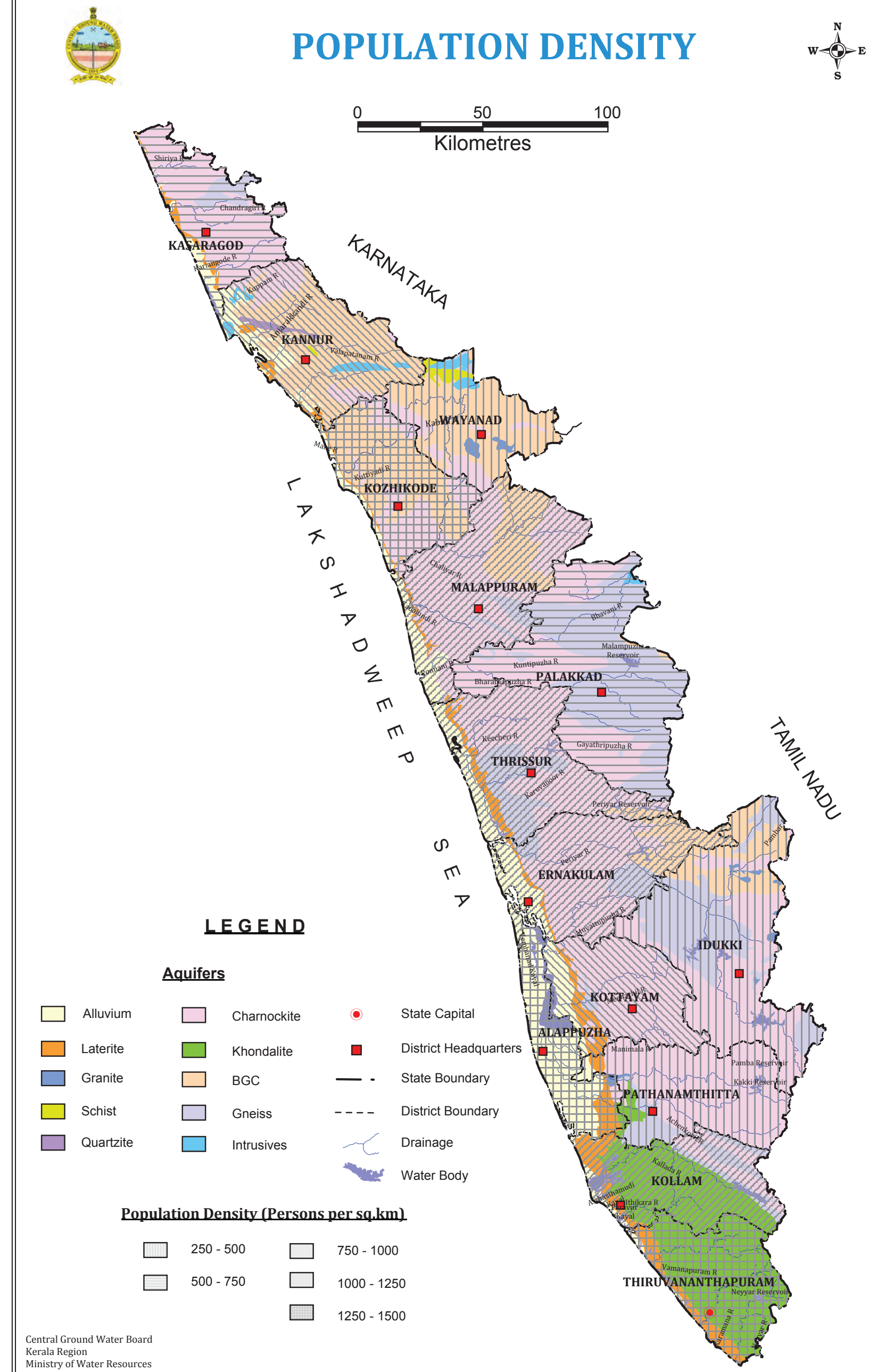
Table 6: Population Census – Kerala

Sl. No	Name of the District	Area	Population (2011)					
			Total			Density (per sq. km)	Decennial growth rate (2001-2011) (%)	Sex ratio (Females per 1000 Males)
			Males	Females	Total			
1	Alappuzha	1414	1010252	1111691	2121943	1500.7	0.61	1100
2	Ernakulam	3068	1617602	1662258	3279860	1069.1	5.6	1028
3	Idukki	4358	551944	555509	1107453	254.1	-1.93	1006
4	Kannur	2966	1184012	1341625	2525637	851.5	4.84	1133
5	Kasargod	1992	626617	675983	1302600	653.9	8.18	1079
6	Kollam	2491	1244815	1384888	2629703	1055.7	1.72	1113
7	Kottayam	2208	970140	1009244	1979384	896.5	1.32	1040
8	Kozhikode	2344	1473028	1616515	3089543	1318.1	7.31	1097
9	Malappuram	3550	1961014	2149942	4110956	1158	13.39	1096
10	Palakkad	4480	1360067	1450825	2810892	627.4	7.39	1067
11	Pathanamthitta	2637	561620	633917	1195537	453.4	-3.12	1129
12	Thiruvananthapuram	2192	1584200	1723084	3307284	1508.8	2.25	1088
13	Thrissur	3032	1474665	1635662	3110327	1025.8	4.58	1109
14	Wayanad	2131	401314	415244	816558	383.2	4.6	1035
	Total	**38863**	**16021290**	**17366387**	**33387677**	**911.2**	**4.05**	**1080**

Source : Census 2011

POPULATION DENSITY



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Source : Census of India (2011)

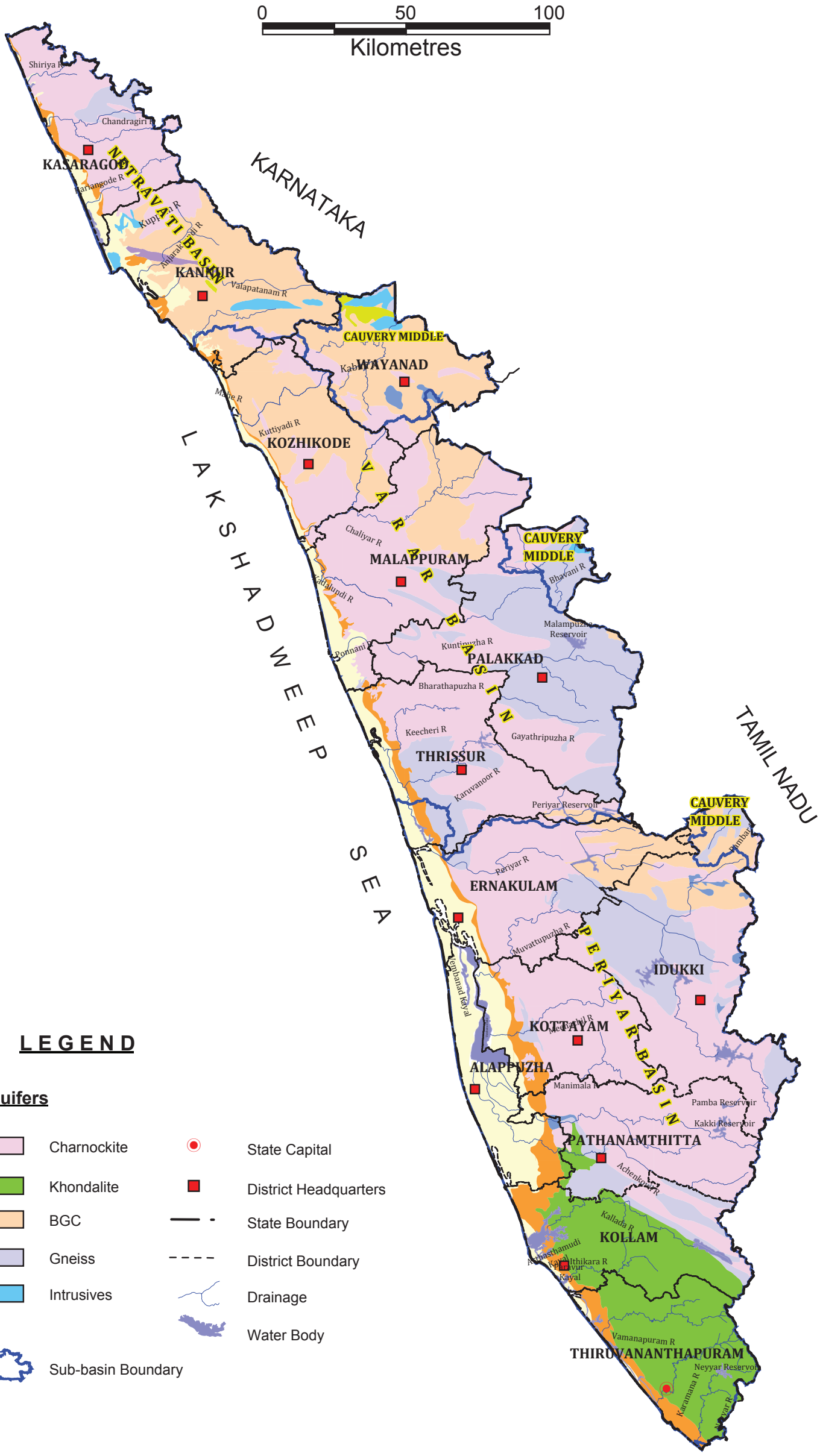
Table 7: River Sub-basin wise Distribution of Aquifers in Kerala

Sl.No.	Name of Basin	Name of Sub - Basin	Alluvium	Laterite	Granite	Schist	Quartzite	Charnockite	Khondalite	B G C	Gneiss	Intrusives	Total Area
			Area	Area	Area	Area	Area	Area	Area	Area	Area	Area	
1	Periyar (Rivers from Kanyakumari to Sharavati flowing into Arabian Sea)	Netravati	488	139		11	71	1859		1814	177	129	**4689**
2		Varar	675	260	14			6767	12	2430	3048	3	**13208**
3		Periyar	2069	1029	88			8063	3462	1038	2339		**18088**
4	Cauvery	Cauvery			51	90		478		1657	484	120	**2879**
Total			**3232**	**1428**	**152**	**101**	**71**	**17167**	**3474**	**6940**	**6047**	**252**	**38863**

Source : Watershed Atlas of India, CGWB

Area in Sq.Km

SUB BASIN WISE AQUIFER DISPOSITION



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives
- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body
- Sub-basin Boundary

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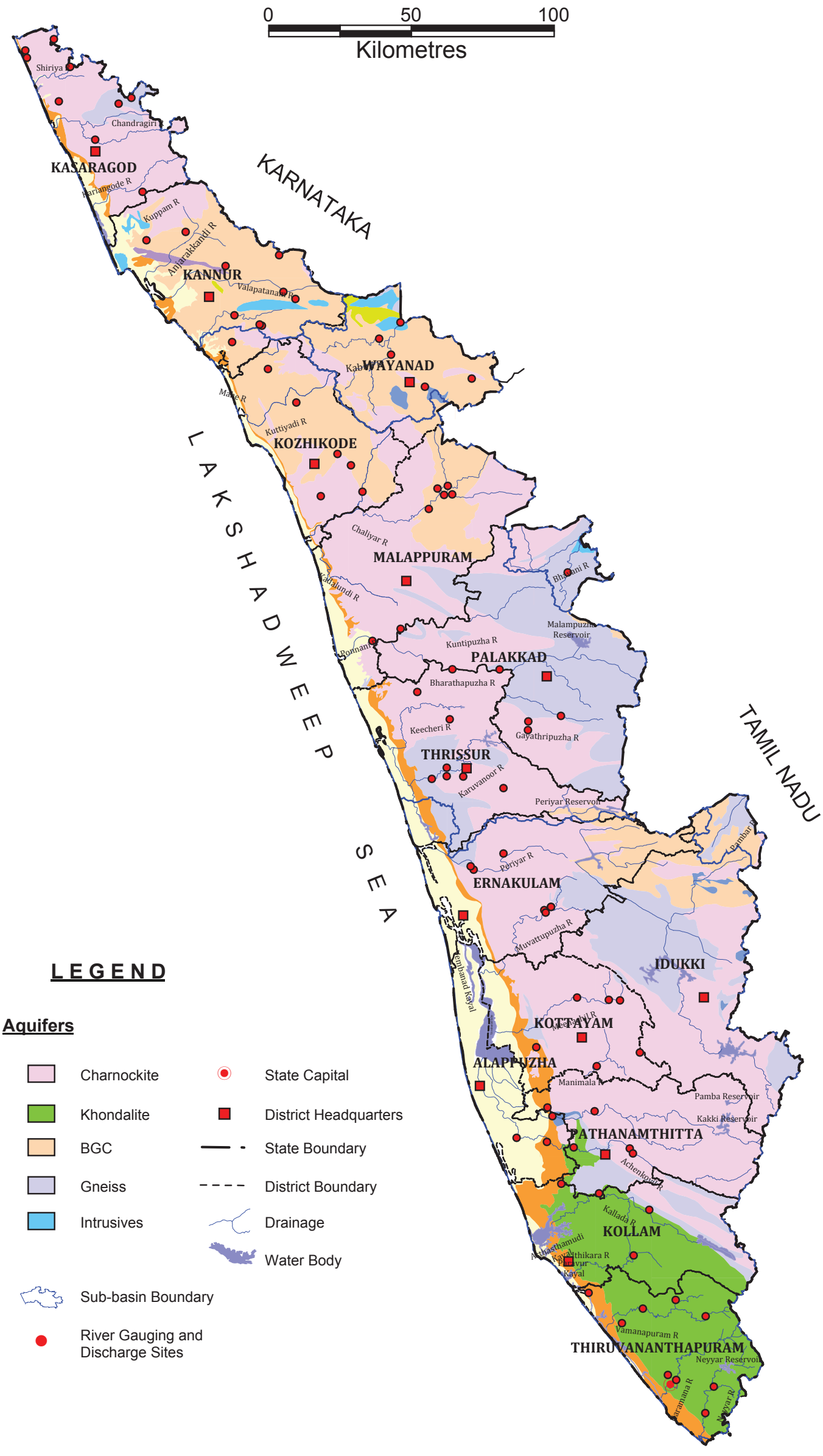
Table 8 : Aquifer wise Distribution of River Gauge and Discharge (G&D) Sites in Kerala

Sl. No.	Basin	Sub – Basin	Alluvim	Laterite	Granite	Schist	Quartzite	Charnockite	Khondalite	BGC	Gneiss	Intrusives	Total Nos
			Nos	Nos	Nos	Nos	Nos	Nos	Nos	Nos	Nos	Nos	
1	Periyar (Rivers From Kanyakumari to Sharavati flowing into Arabian Sea)	Netravati	0	1		0	0	7		9	2	0	**19**
2		Varar	0					12	0	10	4		**26**
3		Periyar	1	5	1			15	10		2		**34**
4	Cauvery	Cauvery			1	0				3	1	1	**6**
Total			**1**	**6**	**2**	**0**	**0**	**34**	**10**	**22**	**9**	**1**	**85**

Source : Irrigation Department, Government of Kerala.

RIVER GAUGE AND DISCHARGE SITES



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives
- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body
- Sub-basin Boundary
- River Gauging and Discharge Sites

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Source :Irrigation Department, Kerala

Table 9 : District wise Distribution of Aquifer Systems in Kerala

Sl. No	Name of the District	Multiple		Single		Total Area
		Area	%	Area	%	
1	Alappuzha	1197.0	85	217.0	15	**1414**
2	Ernakulam	377.5	12	2691.0	88	**3068**
3	Idukki	0.0	0	4357.9	100	**4358**
4	Kannur	0.0	0	2965.5	100	**2966**
5	Kasargod	0.0	0	1991.7	100	**1992**
6	Kollam	107.3	4	2383.5	96	**2491**
7	Kottayam	248.0	11	1959.6	89	**2208**
8	Kozhikode	0.0	0	2343.7	100	**2344**
9	Malappuram	0.0	0	3550.5	100	**3550**
10	Palakkad	0.0	0	4480.2	100	**4480**
11	Pathanamthitta	44.6	2	2592.6	98	**2637**
12	Thiruvananthapuram	35.7	2	2156.4	98	**2192**
13	Thrissur		0	3031.8	100	**3032**
14	Wayanad	0.0	0	2131.2	100	**2131**
Total		**2010.1**	**5**	**36852.5**	**95**	**38863**

Area in Sq.Km

% - wrt total district area

AQUIFER SYSTEMS

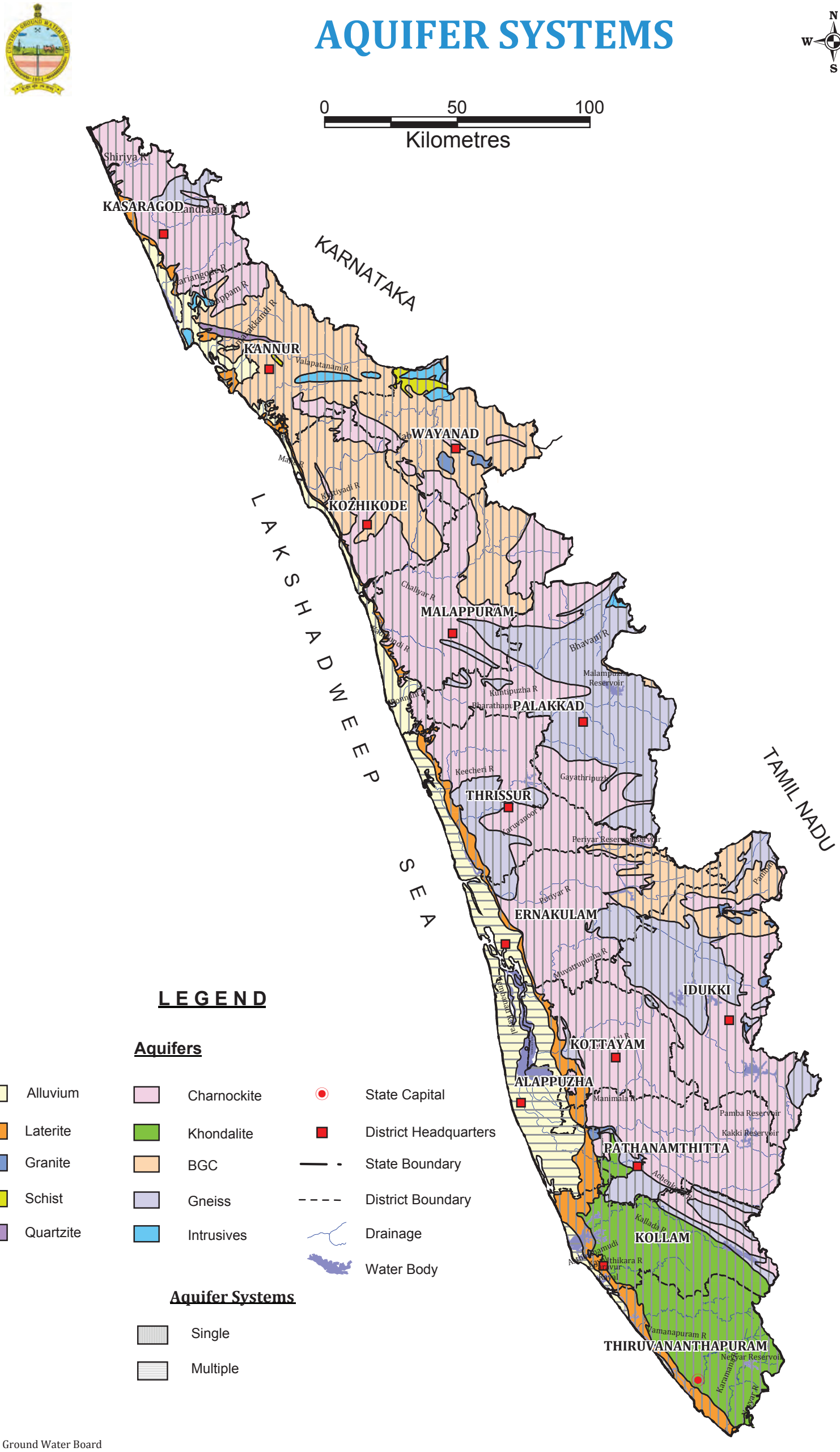

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Table 10a : District wise Details of Ground Water Exploration in Kerala

Sl No	Name of the District	Area	Depth Range (m bgl)	Discharge Range (lps)	As on March 2011			
					EW	OW	PZ	Total
1	Alappuzha	1414	200-601	1 - 33	38	-	29	67
2	Ernakulam	3068	130-296	1 - 20	34	-	17	51
3	Idukki	4358	34-233	0.1 - 14	20	-	9	29
4	Kannur	2966	86-200	0.2 - 14	16	-	17	33
5	Kasargod	1992	60-200	0.5 - 7	31	-	24	55
6	Kollam	2491	114-416	0.3 - 20	57	-	17	74
7	Kottayam	2208	86-200	0.5 - 20	16	-	11	27
8	Kozhikode	2344	114-200	0.2 - 17	17	-	21	38
9	Malappuram	3550	89-300	0.3 - 15	28	-	33	61
10	Palakkad	4480	59-300	0.5 - 38	58	-	36	94
11	Pathanamthitta	2637	44-257	0.5 -29	50	-	8	58
12	Thiruvananthapuram	2192	52-200	0.2 - 20	40	-	23	63
13	Thrissur	3032	69-301	0.2 - 24	40	-	13	53
14	Wayanad	2131	60-200	0.3 - 11	17	-	9	26
Total		**38863**	**34-601**	**0.10 - 38**	**462**		**267**	**729**

m bgl - metre below ground level

lps - litre per second

Table 10b : District-wise and Aquifer- wise Number of Ground Water Exploratory Wells

Sl No	Name of the District	Alluvial	Laterite	Granite	Charnockite	Khondalite	BGC	Geniss	Total
1	Alappuzha	33	3	1	1	-	NA	-	**38**
2	Ernakulam	22	-	NA	10	NA	-	2	**34**
3	Idukki	NA	NA	-	13	NA	-	7	**20**
4	Kannur	4	2	NA	-	NA	10	NA	**16**
5	Kasargod	4	3	NA	24	NA	NA	-	**31**
6	Kollam	4	8	NA	6	37	NA	2	**57**
7	Kottayam	4	3	NA	8	NA	NA	1	**16**
8	Kozhikode	3	-	NA	4	NA	10	NA	**17**
9	Malappuram	6	1	NA	18	NA	3	-	**28**
10	Palakkad	NA	NA	NA	7	NA	NA	51	**58**
11	Pathanamthitta	2	2	-	40	2	NA	4	**50**
12	Thiruvananthapuram	3	6	NA	NA	31	NA	NA	**40**
13	Thrissur	14	2	NA	18	NA	-	6	**40**
14	Wayanad	NA	NA	-	3	NA	14	-	**17**
	Total	**99**	**30**	**1**	**152**	**70**	**37**	**73**	**462**

NA - Aquifer not available

*No exploration done in Schist and Quartzite Aquifers

GROUND WATER EXPLORATORY WELLS

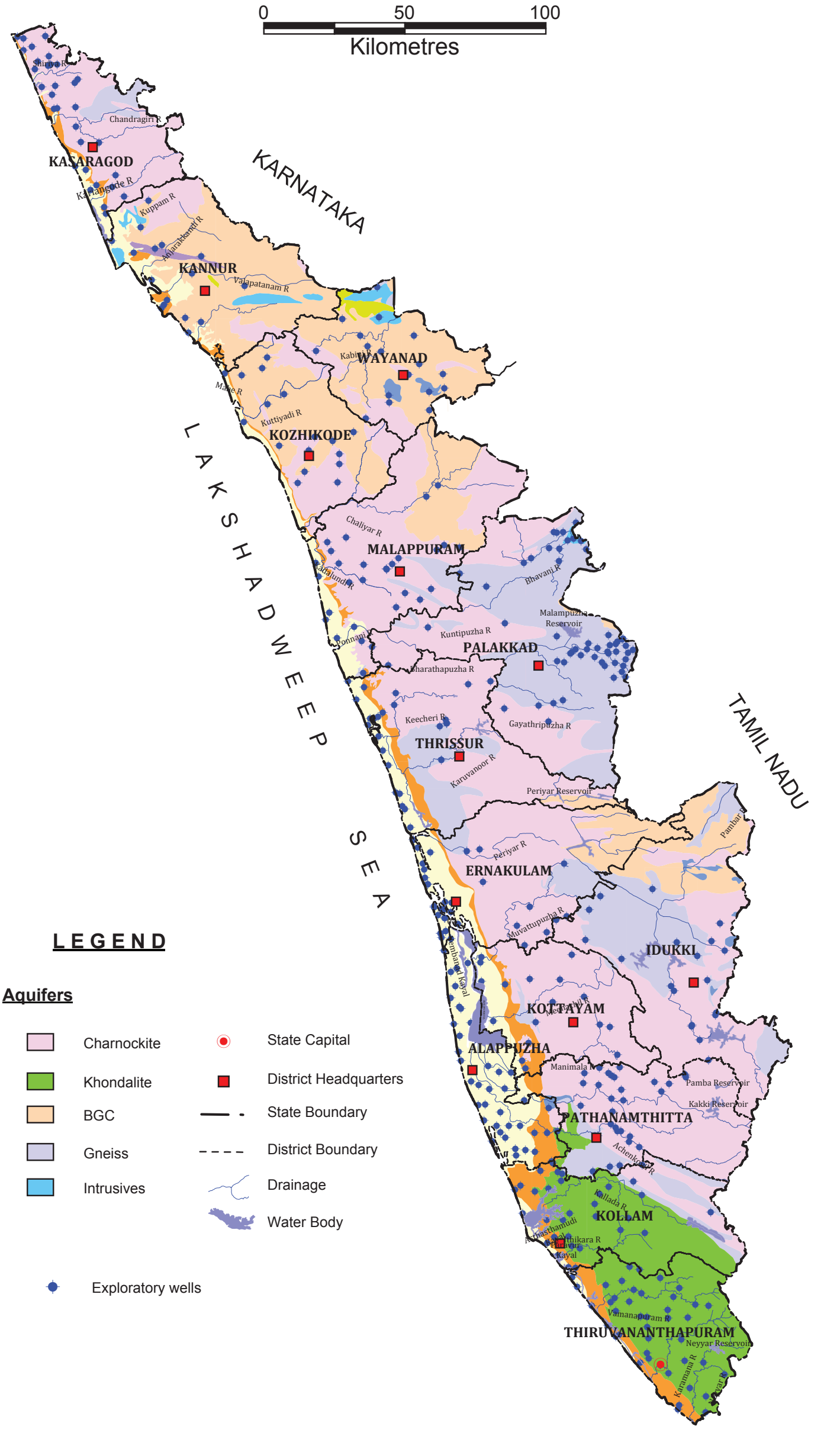

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Table 11 : District wise and Aquifer wise Number of Ground Water Monitoring Wells (Dug wells/ Piezometers)

Sl No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		BGC		Gneiss		Intrusives		Total	
		DW	Pz	DW	Pz	DW	Pz	DW	Pz	DW	Pz	DW	Pz	DW	Pz	DW	Pz	DW	Pz	DW	Pz	DW	Pz
1	Alappuzha	40	29	0	0	0	0	NA	N.A	N.A	N.A	0	0	0	0	N.A	N.A	0	0	N.A	N.A	**40**	**29**
2	Ernakulam	14	1	0	1	NA	N.A	N.A	N.A	N.A	N.A	36	14	N.A	N.A	0	0	7	1	N.A	N.A	**57**	**17**
3	Idukki	N.A	N.A	N.A	N.A	1	0	N.A	N.A	N.A	N.A	18	6	N.A	N.A	0	0	16	3	N.A	N.A	**35**	**9**
4	Kannur	7	1	4	1	N.A	N.A	0	0	1	1	5	1	N.A	N.A	26	11	N.A	N.A	3	2	**46**	**17**
5	Kasaragod	6	4	4	2	N.A	N.A	N.A	N.A	N.A	N.A	23	16	N.A	N.A	N.A	N.A	5	1	N.A	N.A	**38**	**23**
6	Kollam	3	2	6	4	N.A	N.A	N.A	N.A	N.A	N.A	0	0	37	11	N.A	N.A	0	0	N.A	N.A	**46**	**17**
7	Kottayam	5	3	8	1	N.A	N.A	N.A	N.A	N.A	N.A	35	7	N.A	N.A	N.A	N.A	1	0	N.A	N.A	**49**	**11**
8	Kozhikode	8	5	2	0	N.A	N.A	N.A	N.A	N.A	N.A	14	8	N.A	N.A	18	8	N.A	N.A	N.A	N.A	**42**	**21**
9	Malappuram	11	2	0	0	N.A	N.A	N.A	N.A	N.A	N.A	32	24	N.A	N.A	13	6	4	1	N.A	N.A	**60**	**33**
10	Palakkad	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	25	17	N.A	N.A	N.A	N.A	49	19	1	0	**75**	**36**
11	Pathanamthitta	2	0	1	0	0	0	N.A	N.A	N.A	N.A	18	4	3	1	N.A	N.A	6	3	N.A	N.A	**30**	**8**
12	Thiruvananthapuram	2	3	17	2	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	37	18	N.A	N.A	N.A	N.A	N.A	N.A	**56**	**23**
13	Thrissur	12	1	1	2	N.A	N.A	N.A	N.A	N.A	N.A	30	5	N.A	N.A	0	0	11	5	N.A	N.A	**54**	**13**
14	Wayanad	N.A	N.A	N.A	N.A	1	0	2	0	N.A	N.A	4	2	N.A	N.A	21	7	0	0	3	0	**31**	**9**
	Total	**110**	**51**	**43**	**13**	**2**	**0**	**2**	**0**	**1**	**1**	**240**	**104**	**77**	**30**	**78**	**32**	**99**	**33**	**7**	**2**	**659**	**266**

DW - Dug Well; Pz – Piezometer

GROUND WATER OBSERVATION WELLS

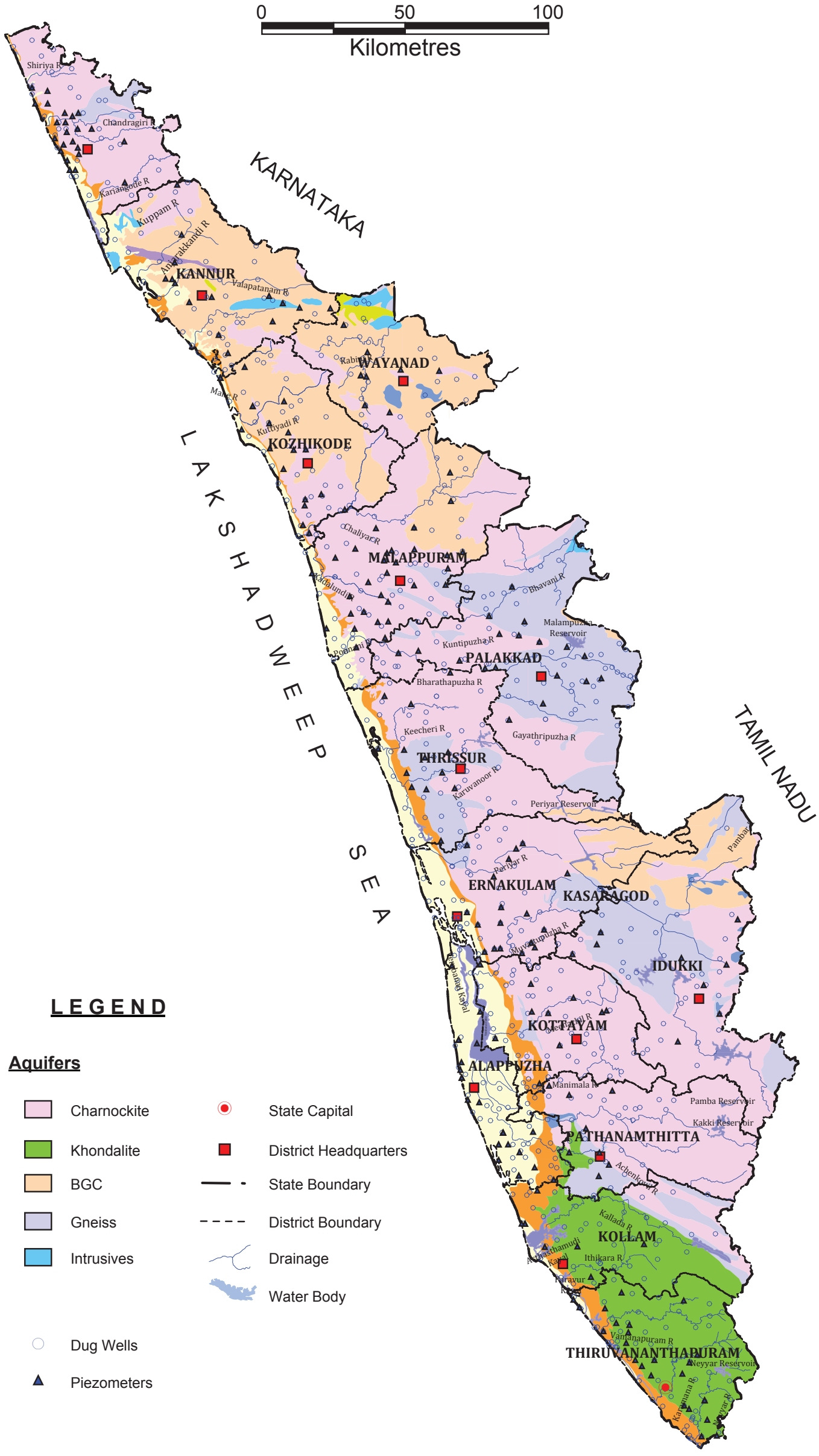

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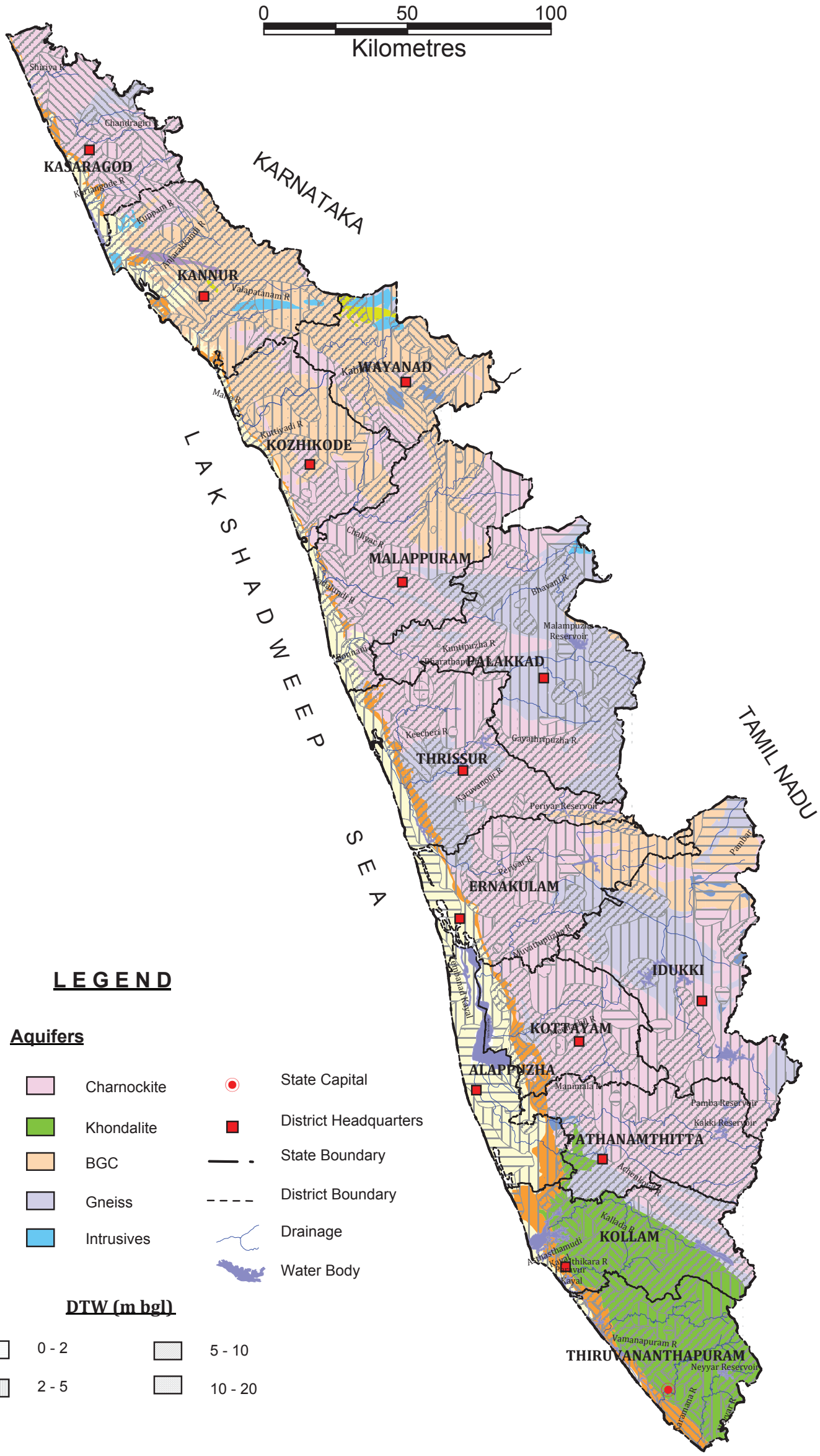
Table 12 : District wise and Aquifer wise Pre-monsoon Depth to Water Level (April,2011) in Kerala

Sl No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		BGC		Gneiss		Intrusives	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Alappuzha	0.5	5.9	3.3	5.1	4.4	4.4	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
2	Ernakulam	0.8	3.0	2.5	8.3	N.A	N.A	N.A	N.A	N.A	N.A	1.2	12.1	N.A	N.A	N.A	N.A	1.7	8.3	N.A	N.A
3	Idukki	N.A	N.A	N.A	N.A	2.0	2.0	N.A	N.A	N.A	N.A	1.2	8.2	N.A	N.A	N.A	N.A	1.5	9.1	N.A	N.A
4	Kannur	1.5	13.4	10.2	10.2	N.A	N.A	N.A	N.A	N.A	N.A	6.5	19.5	N.A	N.A	1.9	12.8	N.A	N.A	2.0	8.5
5	Kasaragod	2.9	5.6	5.9	12.0	N.A	N.A	N.A	N.A	N.A	N.A	3.1	20.0	N.A	N.A	N.A	N.A	6.5	19.7	N.A	N.A
6	Kollam	3.2	6.5	1.4	13.6	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	1.0	25.3	N.A	N.A	5.5	9.2	N.A	N.A
7	Kottayam	1.4	11.9	2.4	13.6	N.A	N.A	N.A	N.A	N.A	N.A	0.3	7.4	N.A	N.A	N.A	N.A	11.8	11.8	N.A	N.A
8	Kozhikode	3.7	6.6	7.0	16.1	N.A	N.A	N.A	N.A	N.A	N.A	1.1	9.3	N.A	N.A	2.4	9.2	N.A	N.A	N.A	N.A
9	Malappuram	2.0	11.2	11.6	11.6	N.A	N.A	N.A	N.A	N.A	N.A	1.3	13.7	N.A	N.A	1.6	9.5	4.4	6.2	N.A	N.A
10	Palakkad	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	1.9	9.9	N.A	N.A	N.A	N.A	1.4	11.2	N.A	N.A
11	Pathanamthitta	2.1	3.3	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	1.0	8.8	7.0	7.1	N.A	N.A	6.0	9.1	N.A	N.A
12	Thiruvananthapuram	1.3	14.2	2.1	15.8	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	1.5	13.6	N.A	N.A	N.A	N.A	N.A	N.A
13	Thrissur	1.7	5.4	8.2	9.1	N.A	N.A	N.A	N.A	N.A	N.A	1.8	12.4	N.A	N.A	N.A	N.A	2.7	10.7	N.A	N.A
14	Wayanad	N.A	N.A	N.A	N.A	9.0	9.0	N.A	N.A	N.A	N.A	1.4	17.5	N.A	N.A	1.7	18.0	N.A	N.A	5.0	15.0
		0.5	**14.2**	**1.4**	**16.1**	**2.0**	**9.0**	**N.A**	**N.A**	**N.A**	**N.A**	**0.3**	**20.0**	**1.0**	**25.3**	**1.6**	**18.0**	**1.4**	**11.8**	**2.0**	**15.0**

Unit : m bgl - metre below ground level

DEPTH TO WATER LEVEL

(PRE-MONSOON, 2011)



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives

- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

DTW (m bgl)

- 0 - 2
- 2 - 5
- 5 - 10
- 10 - 20

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Table 13: District wise and Aquifer wise Post-monsoon Depth to Water Level (November - 2011) in Kerala.

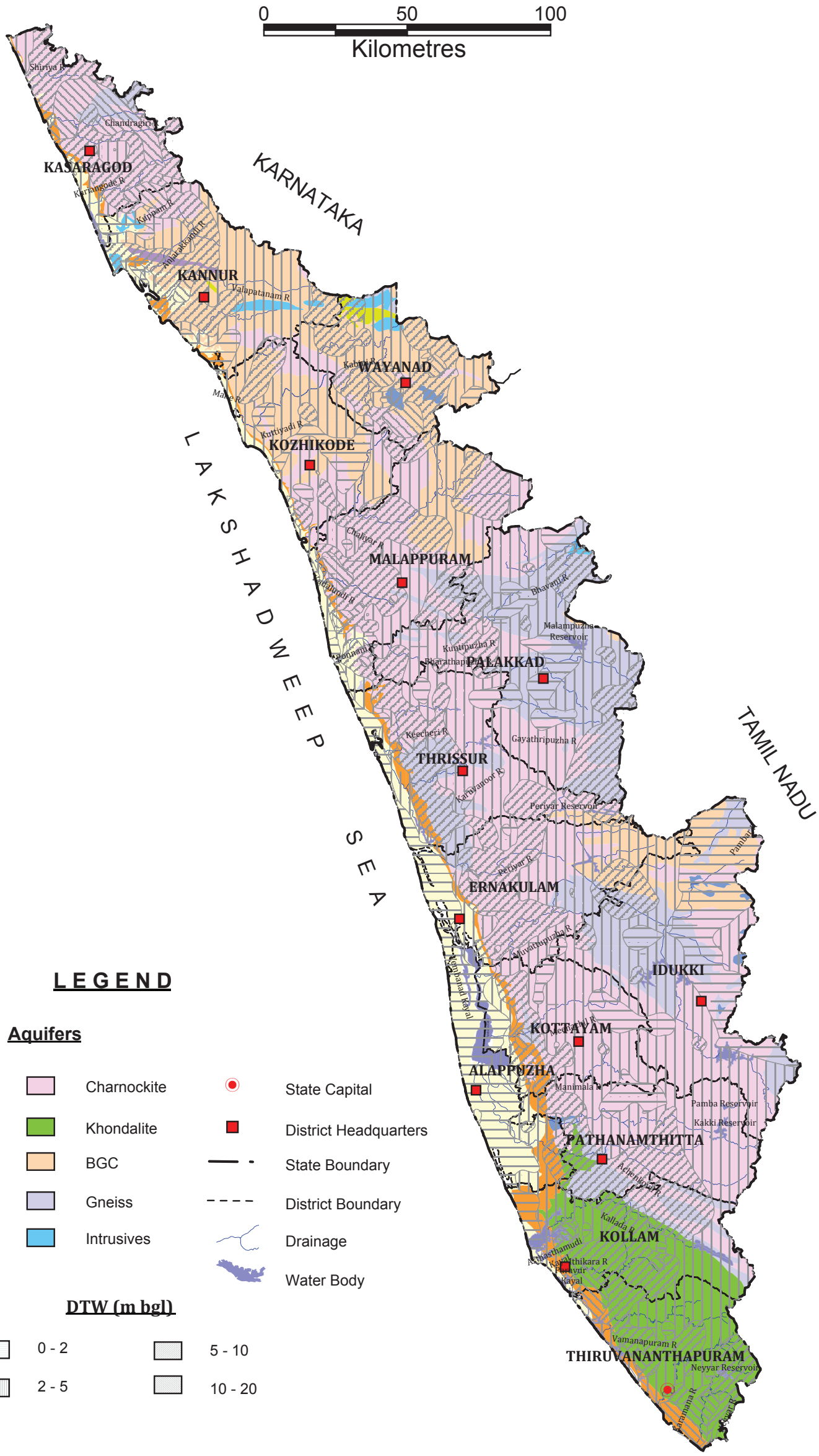
Sl No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		BGC		Gneiss		Intrusives	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Alappuzha	0.25	5.76	3.05	9.65	3.77	3.77	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
2	Ernakulam	0.46	2.52	2.73	7.48	N.A	N.A	N.A	N.A	N.A	N.A	1.41	11.17	N.A	N.A	N.A	N.A	2.07	5.18	N.A	N.A
3	Idukki	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.59	6.2	N.A	N.A	N.A	N.A	1.25	7.48	N.A	N.A
4	Kannur	0.91	10.65	N.A	N.A	N.A	N.A	N.A	N.A	8.1	8.1	1.55	7.95	N.A	N.A	1.05	10.35	N.A	N.A	N.A	N.A
5	Kasaragod	1.2	3.2	3.5	11.2	N.A	N.A	N.A	N.A	N.A	N.A	1.95	20	N.A	N.A	N.A	N.A	5.65	17.35	N.A	N.A
6	Kollam	2.22	2.58	0.72	1.3	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.88	19.97	N.A	N.A	N.A	N.A	N.A	N.A
7	Kottayam	0.73	5.55	1.16	11.85	N.A	N.A	N.A	N.A	N.A	N.A	0.15	7.2	N.A	N.A	N.A	N.A	7.72	12.19	N.A	N.A
8	Kozhikode	1.6	4.79	10.62	10.62	N.A	N.A	N.A	N.A	N.A	N.A	0.5	7.89	N.A	N.A	1.7	8.12	N.A	N.A	N.A	N.A
9	Malappuram	0.26	12.4	11.18	11.18	N.A	N.A	N.A	N.A	N.A	N.A	0.66	12.85	N.A	N.A	2.47	9.24	2.66	5.35	N.A	N.A
10	Palakkad	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.9	8.13	N.A	N.A	N.A	N.A	0.75	8.67	N.A	N.A
11	Pathanamthitta	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.45	8.65	6.7	6.7	N.A	N.A	5.05	6.72	N.A	N.A
12	Thiruvananthapuram	1.15	14.96	1.05	20	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	1.26	15.55	N.A	N.A	N.A	N.A	N.A	N.A
13	Thrissur	0.62	3.21	5.83	6.22	N.A	N.A	N.A	N.A	N.A	N.A	0.53	11.73	N.A	N.A	N.A	N.A	2.52	8.45	N.A	N.A
14	Wayanad	N.A	N.A	N.A	N.A	7.6	7.6	N.A	N.A	N.A	N.A	1	16.32	N.A	N.A	0.82	15.15	N.A	N.A	N.A	N.A
		0.25	**14.96**	**0.72**	**20**	**3.77**	**7.6**	**N.A**	**N.A**	**8.1**	**8.1**	**0.15**	**20**	**0.88**	**19.97**	**0.82**	**15.15**	**0.75**	**17.35**	**N.A**	**N.A**

Unit : m bgl - metre below ground level

N.A : Aquifer Not Available

DEPTH TO WATER LEVEL

(POST-MONSOON, 2011)



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives

- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

DTW (m bgl)

- 0 - 2
- 2 - 5
- 5 - 10
- 10 - 20

Central Ground Water Board
Kerala Region
Ministry of Water Resources
Government of India

Table 14: District wise and Aquifer wise Seasonal Ground Water Level Fluctuation (April 2011 vs Nov 2011) in Kerala

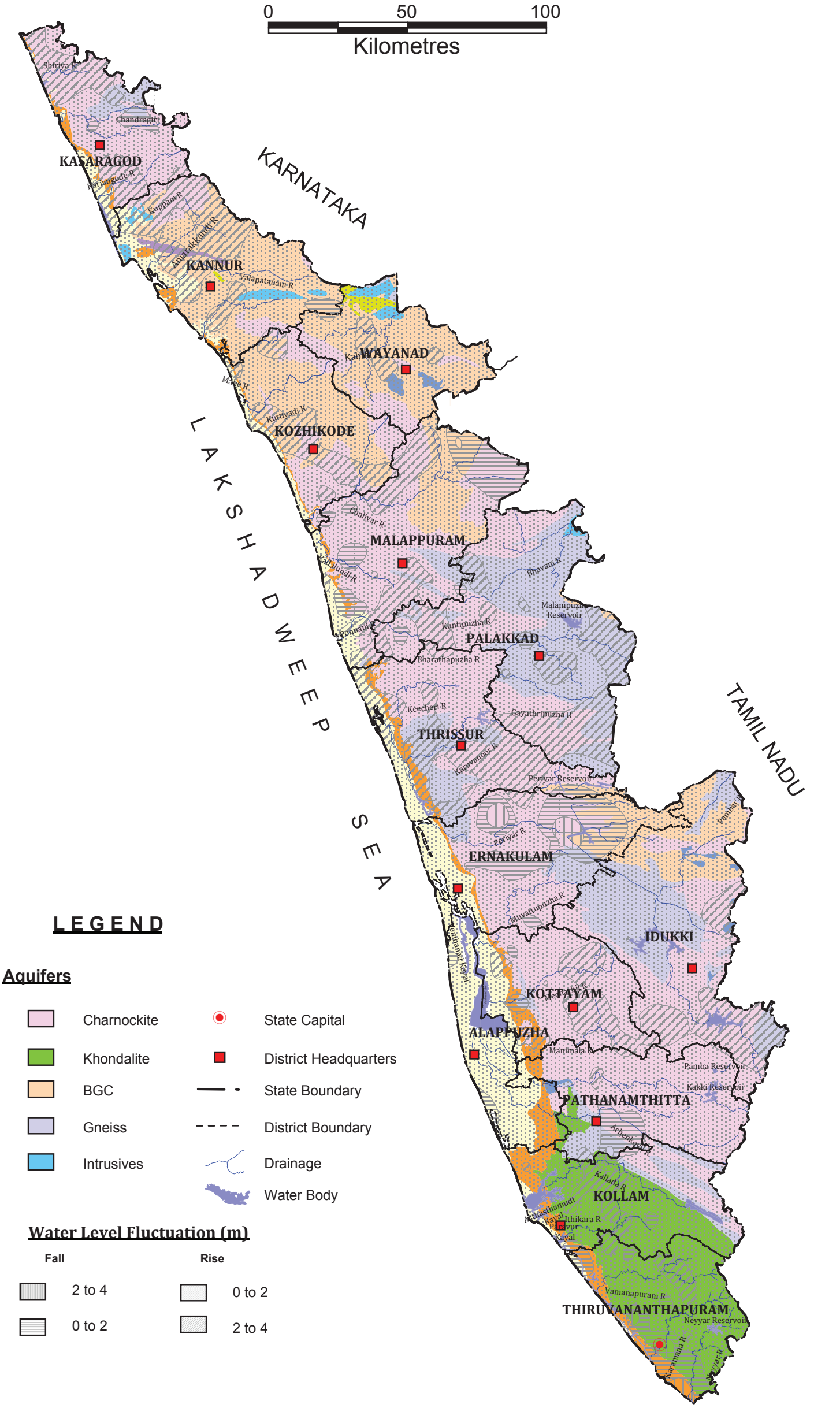
Sl No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		BGC		Gneiss		Intrusives	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Alappuzha	-0.81	1.81	0.23	0.23	0.58	0.58	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
2	Ernakulam	0.1	1.17	0.29	0.79	N.A	N.A	N.A	N.A	N.A	N.A	-3.32	1.66	N.A	N.A	N.A	N.A	-0.22	1.72	N.A	N.A
3	Idukki	N.A	N.A	N.A	N.A	0.6	0.6	N.A	N.A	N.A	N.A	0.3	3.8	N.A	N.A	N.A	N.A	0.2	2.05	N.A	N.A
4	Kannur	0.04	2.77	1.22	1.22	N.A	N.A	N.A	N.A	N.A	N.A	1.5	3.94	N.A	N.A	-1.02	3.92	N.A	N.A	N.A	N.A
5	Kasaragod	0.98	2.68	0.84	2.44	N.A	N.A	N.A	N.A	N.A	N.A	-1.19	3.72	N.A	N.A	N.A	N.A	0.49	4.0	N.A	N.A
6	Kollam	0.58	0.58	0.72	2.17	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	-0.18	2.93	0.94	1.99	N.A	N.A	N.A	N.A
7	Kottayam	0.09	3.35	0.55	3.4	N.A	N.A	N.A	N.A	N.A	N.A	-0.65	3.62	N.A	N.A	N.A	N.A	-0.35	-0.35	N.A	N.A
8	Kozhikode	1.16	2.52	2.18	2.18	N.A	N.A	N.A	N.A	N.A	N.A	0.47	3.84	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
9	Malappuram	-1.58	2.6	0.42	0.42	N.A	N.A	N.A	N.A	N.A	N.A	-0.73	3.83	N.A	N.A	-2.18	2.28	0.15	2.14	N.A	N.A
10	Palakkad	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	-0.9	3.75	N.A	N.A	N.A	N.A	-0.52	3.72	N.A	N.A
11	Pathanamthitta	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	-0.2	2.6	0.25	0.25	N.A	N.A	-0.75	4.0	N.A	N.A
12	Thiruvananthapuram	-0.8	0.35	-2.52	1.5	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	-3.47	3.53	N.A	N.A	N.A	N.A	N.A	N.A
13	Thrissur	0.47	3.05	2.32	2.88	N.A	N.A	N.A	N.A	N.A	N.A	0.02	3.99	N.A	N.A	N.A	N.A	0.62	3.42	N.A	N.A
14	Wayanad	N.A	N.A	N.A	N.A	1.4	1.4	N.A	N.A	N.A	N.A	0.42	1.32	N.A	N.A	0.37	3.66	N.A	N.A	N.A	N.A
		-1.58	**3.35**	**-2.52**	**3.4**	**0.58**	**1.4**	**N.A**	**N.A**	**N.A**	**N.A**	**-3.32**	**3.99**	**-3.47**	**3.53**	**-2.18**	**3.92**	**-0.75**	**4.0**	**N.A**	**N.A**

Unit : m bgl - metre below ground level

N.A : Aquifer Not Available

GROUND WATER LEVEL FLUCTUATION

(PRE-MONSOON, 2011 *vs* POST-MONSOON, 2011)



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives

- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

Water Level Fluctuation (m)

Fall		Rise	
2 to 4		0 to 2	
0 to 2		2 to 4	

Central Ground Water Board
Kerala Region
Ministry of Water Resources
Government of India

Table 15: District wise and Aquifer wise Depth to Water Level (Pre-Monsoon Decadal Mean 2002-11) in Kerala

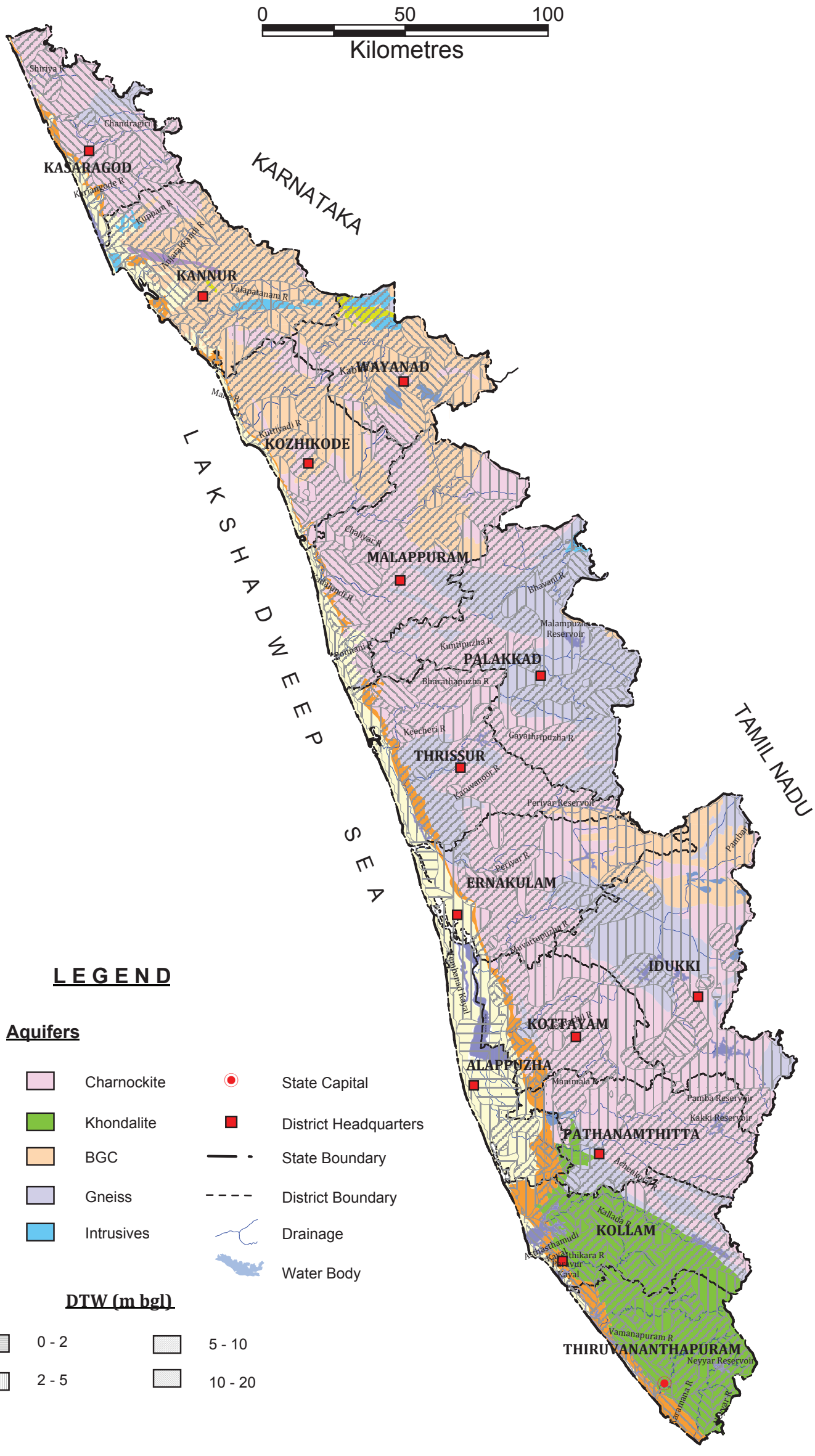
Sl. No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		B G C		Gneiss		Intrusives	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Alappuzha	0.44	12.25	2.40	12.31	4.30	4.30	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
2	Ernakulam	0.61	4.44	2.24	9.08	N.A	N.A	N.A	N.A	N.A	N.A	2.09	12.58	N.A	N.A	N.A	N.A	2.74	10.98	N.A	N.A
3	Idukki	N.A	N.A	N.A	N.A	2.15	2.15	N.A	N.A	N.A	N.A	1.45	19.80	N.A	N.A	N.A	N.A	2.06	9.64	N.A	N.A
4	Kannur	1.66	19.70	5.08	10.48	N.A	N.A	N.A	N.A	7.73	13.35	5.94	20.00	N.A	N.A	1.86	13.79	N.A	N.A	N.A	N.A
5	Kasargod	2.11	11.30	8.40	13.32	N.A	N.A	N.A	N.A	N.A	N.A	3.49	19.99	N.A	N.A	7.02	7.02	19.04	19.04	N.A	N.A
6	Kollam	3.67	19.98	1.56	18.00	N.A	N.A	N.A	N.A	N.A	N.A	6.45	6.45	2.54	20.00	N.A	N.A	0.64	9.75	N.A	N.A
7	Kottayam	1.28	12.40	3.28	13.61	N.A	N.A	N.A	N.A	N.A	N.A	1.10	9.92	N.A	N.A	N.A	N.A	12.39	12.39	N.A	N.A
8	Kozhikode	3.84	6.77	15.81	15.81	N.A	N.A	N.A	N.A	N.A	N.A	1.50	9.81	N.A	N.A	2.40	9.35	N.A	N.A	N.A	N.A
9	Malappuram	2.67	13.48	11.21	11.21	N.A	N.A	N.A	N.A	N.A	N.A	2.49	23.80	N.A	N.A	3.46	10.62	6.17	9.56	N.A	N.A
10	Palakkad	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	2.42	9.92	N.A	N.A	N.A	N.A	1.51	18.86	N.A	N.A
11	Pathanamthitta	2.36	3.58	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	1.64	9.76	1.73	7.16	N.A	N.A	4.66	8.15	N.A	N.A
12	Thiruvananthapuram	12.57	18.14	2.25	19.97	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	2.30	20.00	N.A	N.A	N.A	N.A	N.A	N.A
13	Thrissur	1.91	5.48	7.31	8.99	N.A	N.A	N.A	N.A	N.A	N.A	2.06	18.90	N.A	N.A	N.A	N.A	2.52	11.50	N.A	N.A
14	Wayanad	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	1.35	19.02	N.A	N.A	1.65	17.99	N.A	N.A	N.A	N.A
		0.44	**19.98**	**1.56**	**19.97**	**2.15**	**4.30**	**N.A**	**N.A**	**7.73**	**13.35**	**1.10**	**20.00**	**1.73**	**20.00**	**1.65**	**17.99**	**0.64**	**19.04**	**N.A**	**N.A**

Unit : m bgl - metre below ground level

N.A : Aquifer Not Available

DEPTH TO WATER LEVEL

(PRE-MONSOON DECADAL MEAN, 2002 - 2011)



Central Ground Water Board
Kerala Region
Ministry of Water Resources
Government of India

Table 16: District wise and Aquifer wise Depth to Water Level (Post-Monsoon Decadal Mean 2002-11) in Kerala

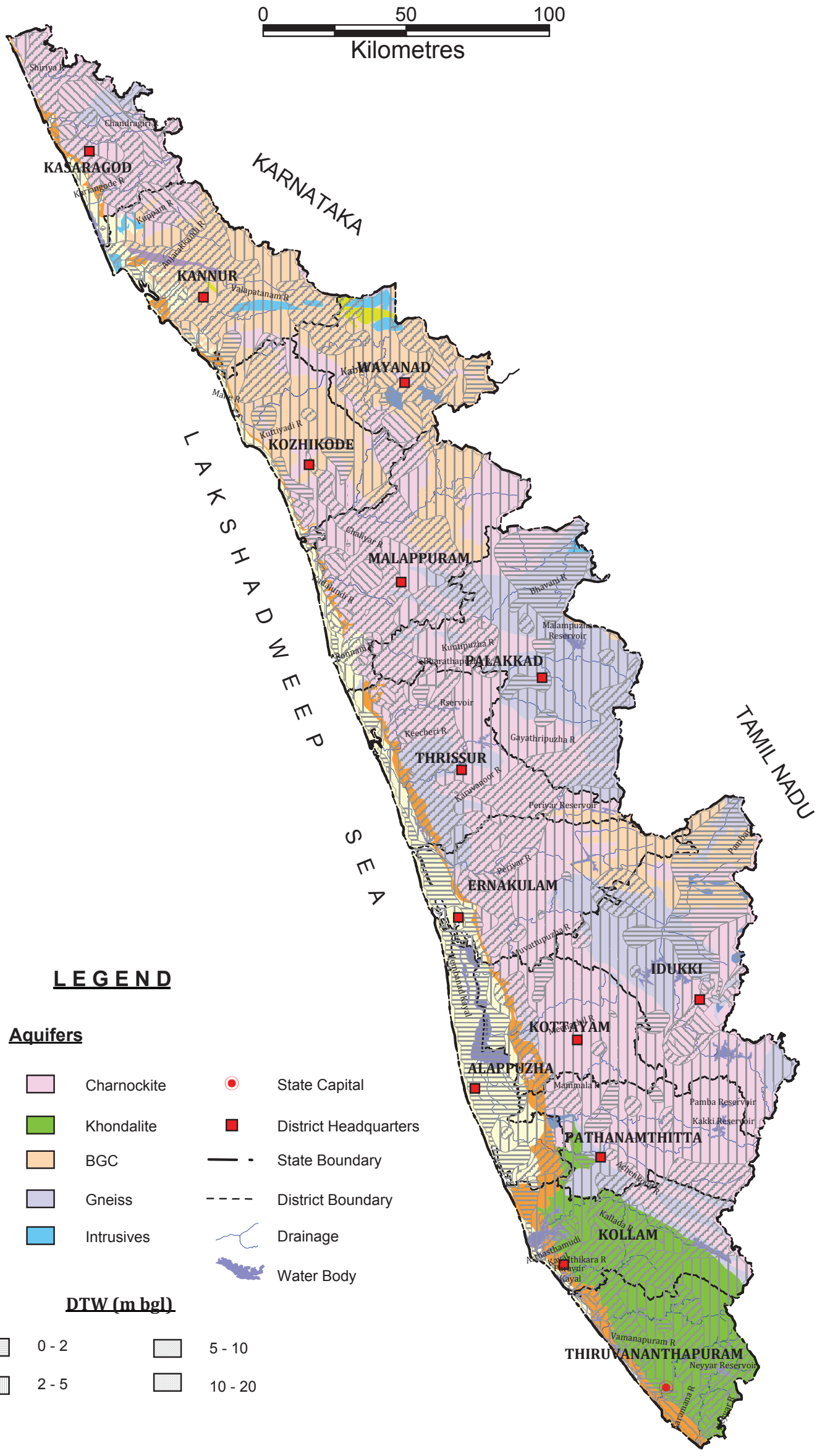
Sl. No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		B G C		Gneiss		Intrusives	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Alappuzha	0.24	11.20	1.21	9.33	2.65	2.65	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
2	Ernakulam	0.58	4.41	7.00	7.00	N.A	N.A	N.A	N.A	N.A	N.A	0.90	15.11	N.A	N.A	N.A	N.A	1.34	8.18	N.A	N.A
3	Idukki	N.A	N.A	N.A	N.A	1.51	1.51	N.A	N.A	N.A	N.A	0.66	20.00	N.A	N.A	N.A	N.A	1.21	7.42	N.A	N.A
4	Kannur	0.68	10.48	8.07	8.56	N.A	N.A	N.A	N.A	8.01	8.03	2.22	19.12	N.A	N.A	1.30	10.00	N.A	N.A	N.A	N.A
5	Kasargod	1.29	10.09	6.19	11.37	N.A	N.A	N.A	N.A	N.A	N.A	2.40	19.90	N.A	N.A	N.A	N.A	5.36	17.42	N.A	N.A
6	Kollam	1.54	4.23	0.56	6.06	N.A	N.A	N.A	N.A	N.A	N.A	6.42	6.42	1.38	19.80	N.A	N.A	5.41	6.84	N.A	N.A
7	Kottayam	0.59	7.13	1.60	10.61	N.A	N.A	N.A	N.A	N.A	N.A	0.35	7.15	N.A	N.A	N.A	N.A	6.95	9.48	N.A	N.A
8	Kozhikode	1.17	4.53	11.61	11.61	N.A	N.A	N.A	N.A	N.A	N.A	0.74	7.36	N.A	N.A	1.61	7.84	N.A	N.A	N.A	N.A
9	Malappuram	0.75	12.25	9.38	9.38	N.A	N.A	N.A	N.A	N.A	N.A	1.06	19.69	N.A	N.A	1.97	8.32	4.28	6.45	N.A	N.A
10	Palakkad	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	1.15	9.21	N.A	N.A	N.A	N.A	0.88	12.20	N.A	N.A
11	Pathanamthitta	2.20	2.20	2.33	2.33	N.A	N.A	N.A	N.A	N.A	N.A	0.87	8.98	0.84	5.28	N.A	N.A	2.58	5.39	N.A	N.A
12	Thiruvananthapuram	13.52	13.52	1.29	18.03	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.80	18.99	N.A	N.A	N.A	N.A	N.A	N.A
13	Thrissur	0.92	3.13	6.40	10.54	N.A	N.A	N.A	N.A	N.A	N.A	0.67	14.59	N.A	N.A	N.A	N.A	2.26	8.80	N.A	N.A
14	Wayanad	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.75	15.94	N.A	N.A	0.71	16.06	N.A	N.A	N.A	N.A
		0.24	**13.52**	**0.56**	**18.03**	**1.51**	**2.65**	**N.A**	**N.A**	**8.01**	**8.03**	**0.35**	**20.00**	**0.80**	**19.80**	**0.71**	**16.06**	**0.88**	**17.42**	**N.A**	**N.A**

Unit : m bgl - metre below ground level

N.A : Aquifer Not Available

DEPTH TO WATER LEVEL

(POST-MONSOON DECADAL MEAN, 2002 - 2011)



Central Ground Water Board
Kerala Region
Ministry of Water Resources
Government of India

Table 17 : District wise and Aquifer wise Water Table Elevation in Kerala (2011)

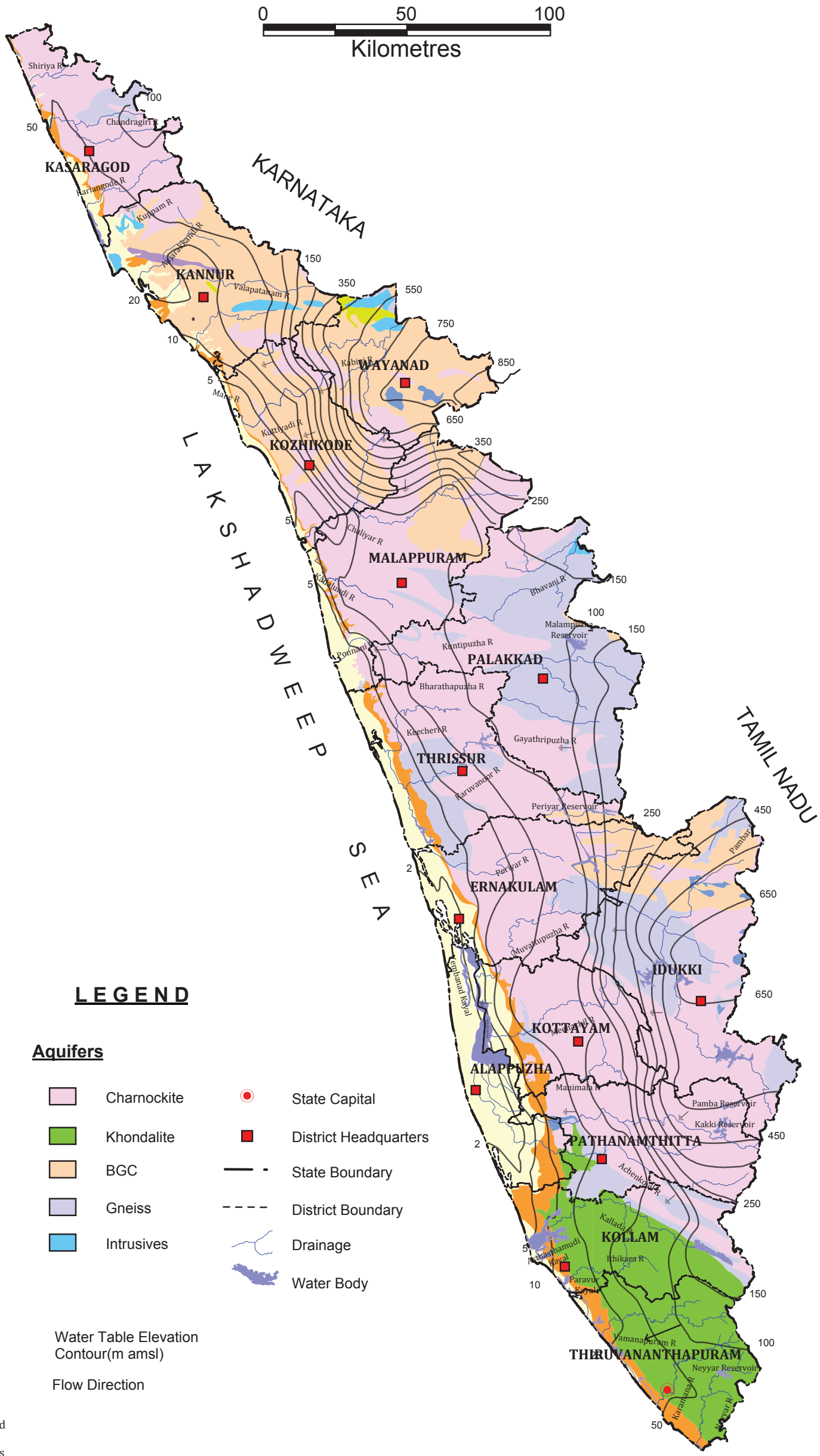
Sl. No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		B G C		Gneiss		Intrusives	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Alappuzha	-1.2	8.1	5.1	26.7	1.0	1.0	N.A	N.A	N.A	N.A	15.0	20.0	15.0	20.0	N.A	N.A	N.A	N.A	N.A	N.A
2	Ernakulam	-0.3	3.7	2.3	8.1	N.A	N.A	N.A	N.A	N.A	N.A	0.7	39.0	N.A	N.A	50.0	450.0	0.7	14.0	N.A	N.A
3	Idukki	N.A	N.A	N.A	N.A	550.0	750.0	N.A	N.A	N.A	N.A	25.8	874.1	N.A	N.A	250.0	650.0	33.0	729.1	N.A	N.A
4	Kannur	0.1	17.7	4.4	6.7	N.A	N.A	20.0	20.0	9.8	71.9	6.8	156.4	N.A	N.A	1.9	133.9	N.A	N.A	N.A	N.A
5	Kasargod	-0.2	3.4	1.0	9.2	N.A	N.A	N.A	N.A	N.A	N.A	0.6	191.9	N.A	N.A	N.A	N.A	25.2	66.7	N.A	N.A
6	Kollam	-0.2	7.4	-0.2	13.7	N.A	N.A	N.A	N.A	N.A	N.A	215.1	215.1	-1.3	134.5	N.A	N.A	62.8	161.4	N.A	N.A
7	Kottayam	-0.6	7.8	-0.3	24.5	N.A	N.A	N.A	N.A	N.A	N.A	0.1	100.9	N.A	N.A	N.A	N.A	14.7	14.7	N.A	N.A
8	Kozhikode	2.1	2.2	4.8	4.8	N.A	N.A	N.A	N.A	N.A	N.A	1.7	2.0	N.A	N.A	16.2	16.2	N.A	N.A	N.A	N.A
9	Malappuram	-0.1	8.9	5.0	10.0	N.A	N.A	N.A	N.A	N.A	N.A	2.5	63.2	N.A	N.A	29.2	42.0	48.0	61.0	N.A	N.A
10	Palakkad	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	18.7	94.6	N.A	N.A	N.A	N.A	61.9	219.0	N.A	N.A
11	Pathanamthitta	-0.8	0.7	7.5	12.0	N.A	N.A	N.A	N.A	N.A	N.A	2.1	367.0	19.1	20.0	N.A	N.A	3.0	3.0	N.A	N.A
12	Thiruvananthapuram	16.6	27.4	N.A	16.6	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	11.0	140.5	N.A	N.A	N.A	N.A	N.A	N.A
13	Thrissur	-1.1	2.9	2.7	5.6	N.A	N.A	N.A	N.A	N.A	N.A	0.7	82.2	N.A	N.A	25.0	250.0	-1.2	20.1	N.A	N.A
14	Wayanad	N.A	N.A	N.A	N.A	N.A	N.A	450.0	550.0	N.A	N.A	732.5	849.7	N.A	N.A	715.4	932.1	N.A	N.A	N.A	N.A
		-1.2	**27.4**	**-0.3**	**26.7**	**1.0**	**750.0**	**20.0**	**550.0**	**9.8**	**71.9**	**0.1**	**874.1**	**-1.3**	**140.5**	**1.9**	**932.1**	**-1.2**	**729.1**	**N.A**	**N.A**

Unit : m amsl - metre above mean sea level

N.A : Aquifer Not Available

WATER TABLE ELEVATION

(2011)



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives
- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

250 Water Table Elevation Contour(m amsl)

Flow Direction

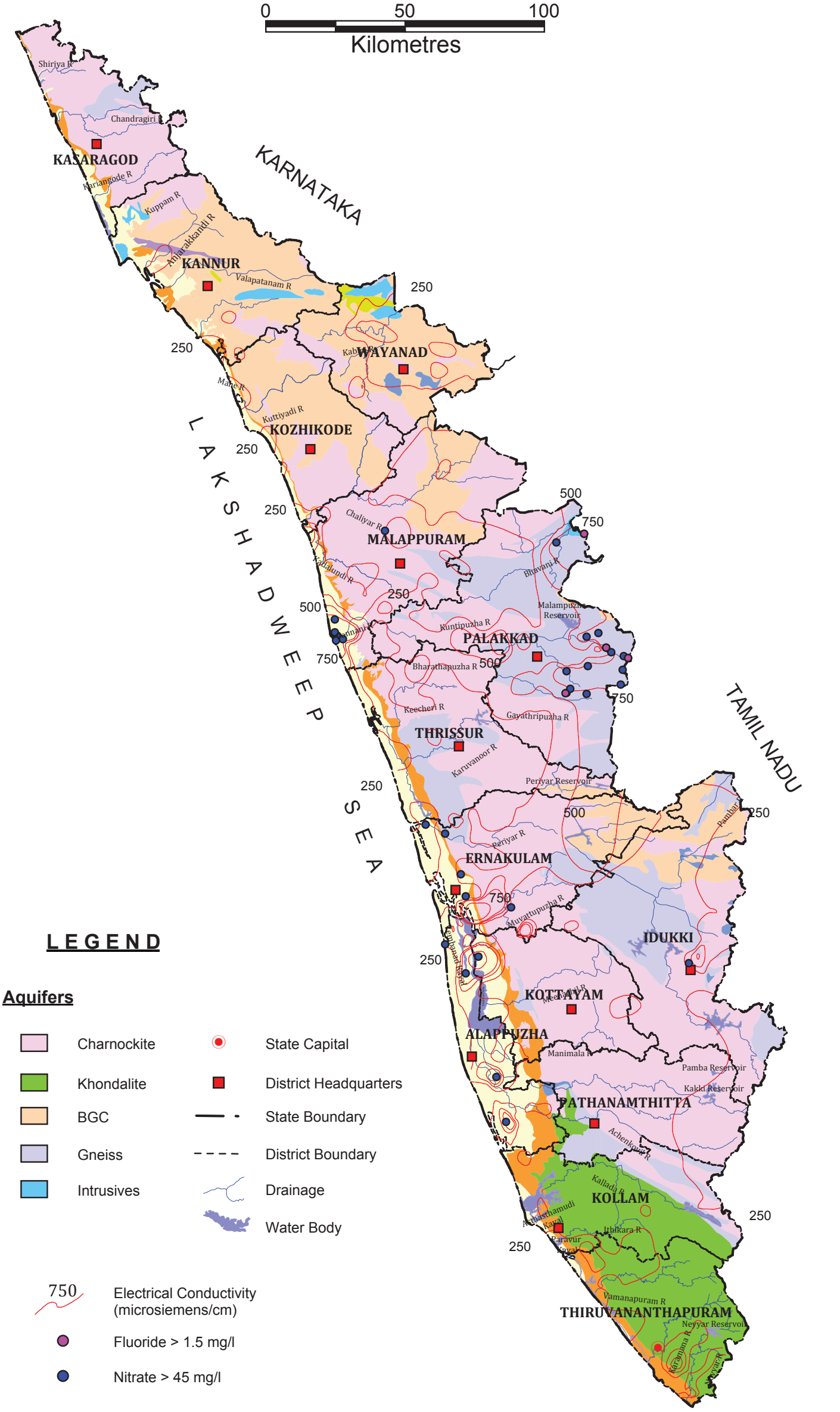
Central Ground Water Board
Kerala Region
Ministry of Water Resources
Government of India

Table 18 : Locations having Salinity, Fluoride and Nitrate in excess of Permissible Limits in Shallow Aquifers in Kerala

Sl. No	District Name	Electrical Conductivity (> 750 µS/cm)	Fluoride (> 1.5 mg/l)	Nitrate (> 45 mg/l)
1	Alappuzha	Pacha, Pattiyur, Sherthalai		Pattiyur
2	Ernakulam	Anchalpetty, Chalakka, Chellanum, Irumbanam, Paravur North		Angamali, Chengamanad, Tripunithura
3	Idukki	Kattapana		Kattapana
4	Kannur			Chakkarakkale
5	Kasargod			Mulleria
6	Kollam			Kadakkal, Kulathupuzha, Pathanapuram, Vadakkunthala west
7	Kottayam	Vaikom		Kuttikal, Kuvapalli
8	Kozhikode			Beypore
9	Malappuram	Chamravattom, Iswaramangalam, Kadalundi, Mangalam, Ponnani		Kottakkal, Nilambur, Mangalam, Valancheri, Vylattur
10	Palakkad	Agali, Athikode, Chittoor, Chullimade, Gopalapuram, Kanjikode, Kozhippara, Mattathukkad, Meenakshipuram, Meenkara, Nadupeni, Oottara, Pudhunagaram, RVP Pudur, Vaniyamkulam,Walayar	Athikode, Kollengode, Kopanur, Mattathukkad, Nadupeni	Gopalapuram, Kongad, Mattathukkad, Meenakshipuram, Palappuram, Vaniyamkulam
11	Thiruvananthapuram	Balaramapuram, Parassala, Perumathura, Pozhiyoor, Pudukurichi, Puvar		Balaramapuram, Edavai, Kadakkavur, Kazhakuttam, Pangode, Puvar
12	Thrissur			Keecheri, Ollur

GROUND WATER QUALITY

(SHALLOW AQUIFERS - EC, F, NO_3)



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives
- State Capital
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- State Boundary
- District Boundary
- Drainage
- Water Body
- 750 Electrical Conductivity (microsiemens/cm)
- Fluoride > 1.5 mg/l
- Nitrate > 45 mg/l

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Table 19a : Aquifer wise Area Under Over Exploited (OE) Blocks in Kerala

Sl. No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		B G C		Gneiss		Intrusives		Total Area
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	
1	Palakkad																	276	6			276
Total																		**276**	**6**			**276**

Categorization Based on Dynamic Ground Water Resource of Kerala 2009

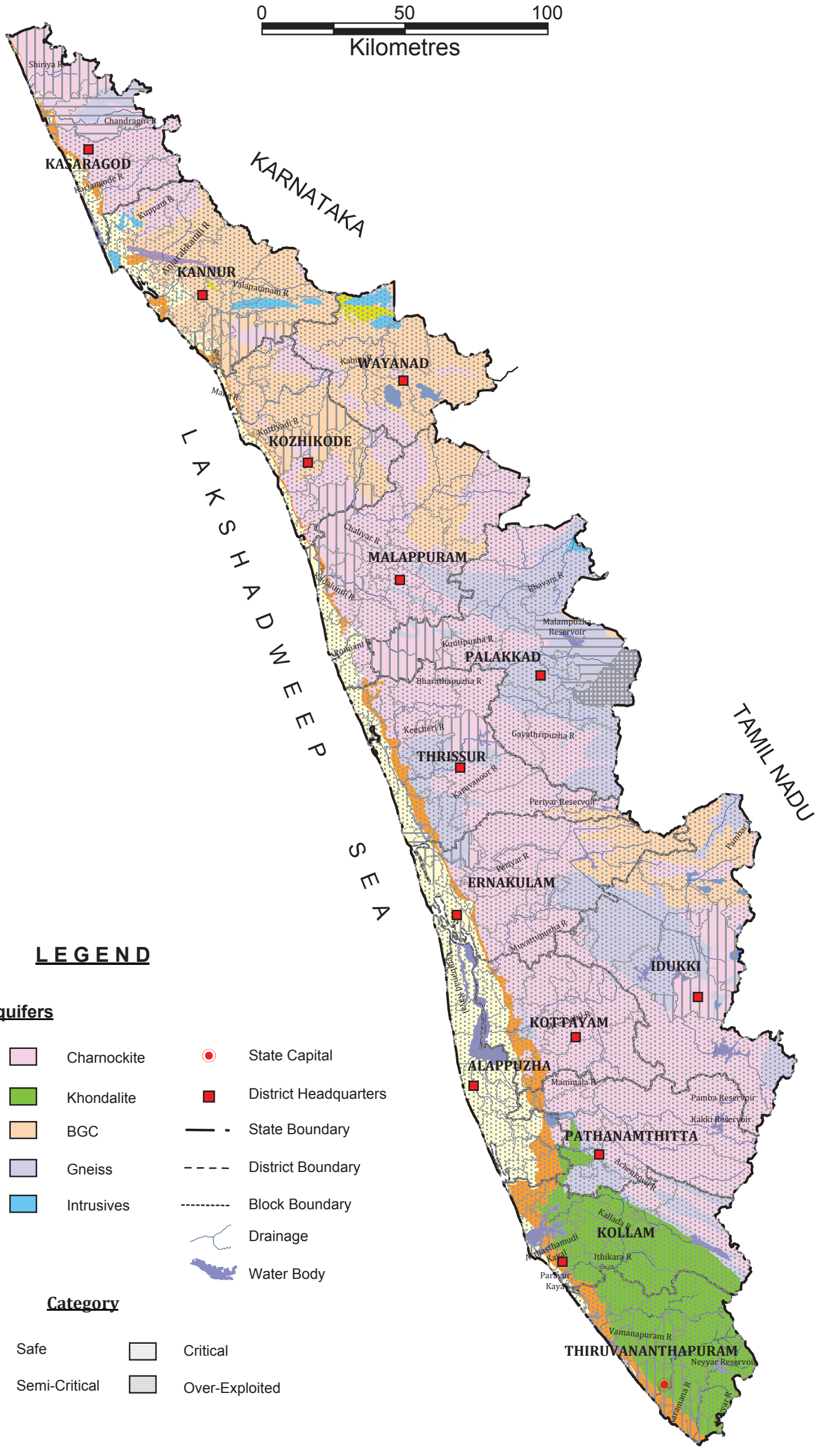
Table 19b : Aquifer wise Area in Critical Blocks in Kerala

Sl. No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		B G C		Gneiss		Intrusives		Total Area
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	
1	Kasargod	7	0.3	28	1							281	14					170	9			**486**
2	Palakkad											6	0.1					443	10	21	0.5	**470**
3	Thrissur	45	1.5	7	0.2																	**52**
Total		**52**		**35**								**287**				**21**		**613**				**1008**

Categorization Based on Dynamic Ground Water Resource of Kerala 2009
% - Percentage of district area
Area in Sq.km

CATEGORISATION OF GW ASSESSMENT UNITS

(AS ON MARCH, 2009)



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives

- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Block Boundary
- Drainage
- Water Body

Category

- Safe
- Semi-Critical
- Critical
- Over-Exploited

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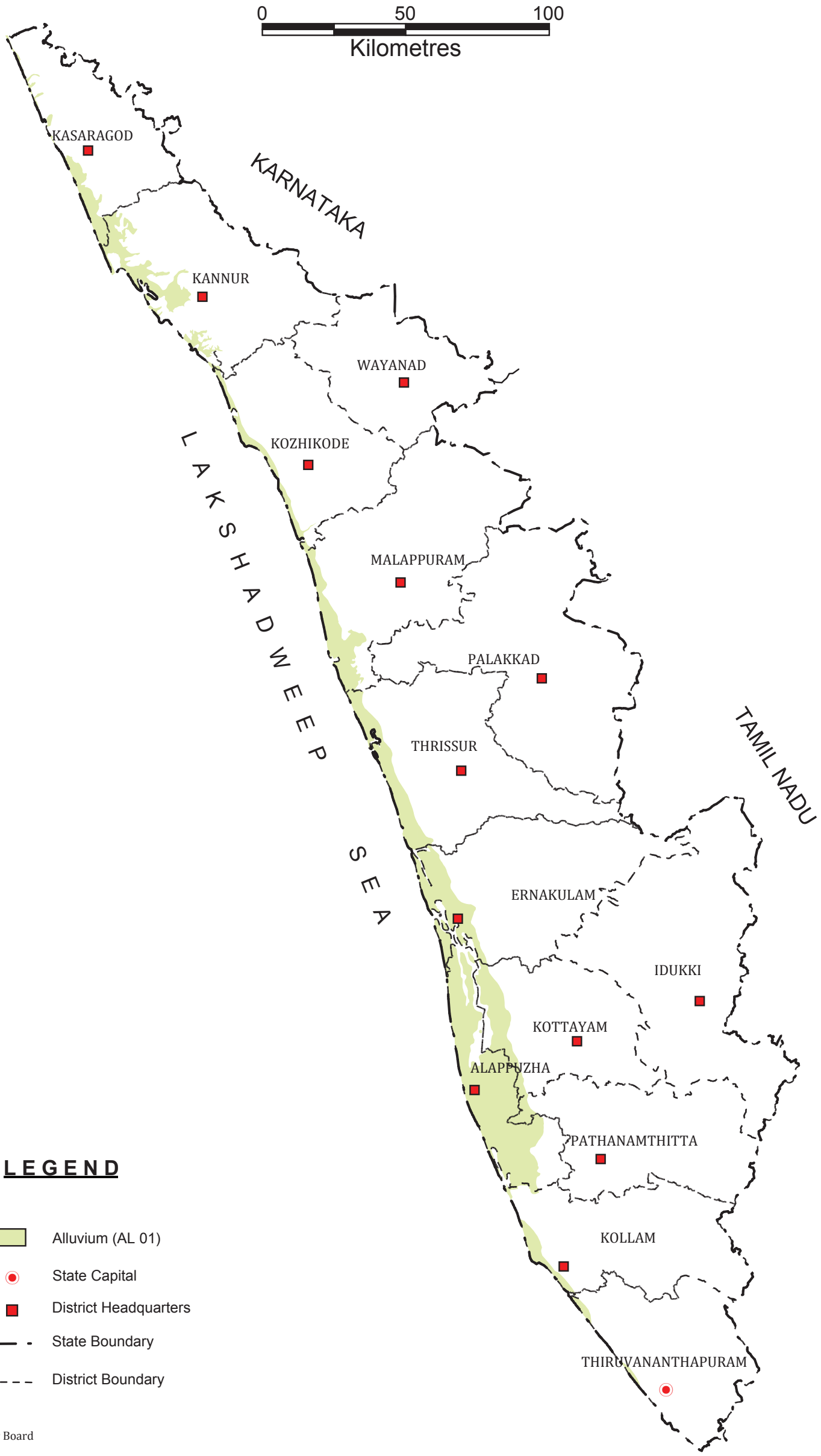
Table 20: District wise Distribution and Characteristics of Alluvium Aquifers in Kerala

Sl. No	Name of the District	*Major Aquifers (Area in Sq.Km)*	*Aquifer Properties*							
		Alluvium	Aquifer System	Type of Aquifer	DTW (Dec Avg)	Granular Zones encountered	Transmissivity	Yield	Specific Yield	Quality
		AL 01			m bgl	m bgl	(m^2/day)	(m^3/day)	%	(EC in µS/cm)
1	Alappuzha	1197	Multiple	Unconfined to Confined	1-5	90-200	30 - 300	170-1700	10-16	250-750
2	Ernakulam	378	Multiple	Unconfined to Confined	1-10	85-190	25 – 200	130-860	10-16	250-1300
3	Idukki									
4	Kannur	322	Single	Unconfined	2-10	18-30	50 - 130	150-950	10-16	100-2000
5	Kasargod	169	Single	Unconfined	5-10		15 - 30	100-600	10-16	250-750
6	Kollam	107	Multiple	Unconfined to confined	3-10	50-110	20 - 150	170-1200	10-16	250-750
7	Kottayam	248	Multiple	Unconfined	2-10	20-60	30 - 350	130-1300	10-16	250-1000
8	Kozhikode	134	Single	Unconfined	2-10	10-30	60 - 120	170-900	10-16	250-2500
9	Malappuram	285	Single	Unconfined	1.5-10	15-60	50 - 170	30-2000	10-16	250-1500
10	Palakkad									
11	Pathanamthitta	45	Multiple	Unconfined to Semi-confined	2-10	25-65	30 - 200	50-1400	10-16	250-750
12	Thiruvananthapuram	36	Multiple	Semi-confined	5-30	21-70	20 - 100	170-2000	10-16	150-2000
13	Thrissur	312	Multiple	Unconfined to	1-10	21-70	20 - 100	170-2000	10-16	150-2000
14	Wayanad									
Total		**3232**								

DTW: Depth To Water Level, m bgl - metres below ground level
Dec. Avg : Decadal Average

ALLUVIUM AQUIFER SYSTEM



LEGEND

- Alluvium (AL 01)
- State Capital
- District Headquarters
- State Boundary
- District Boundary

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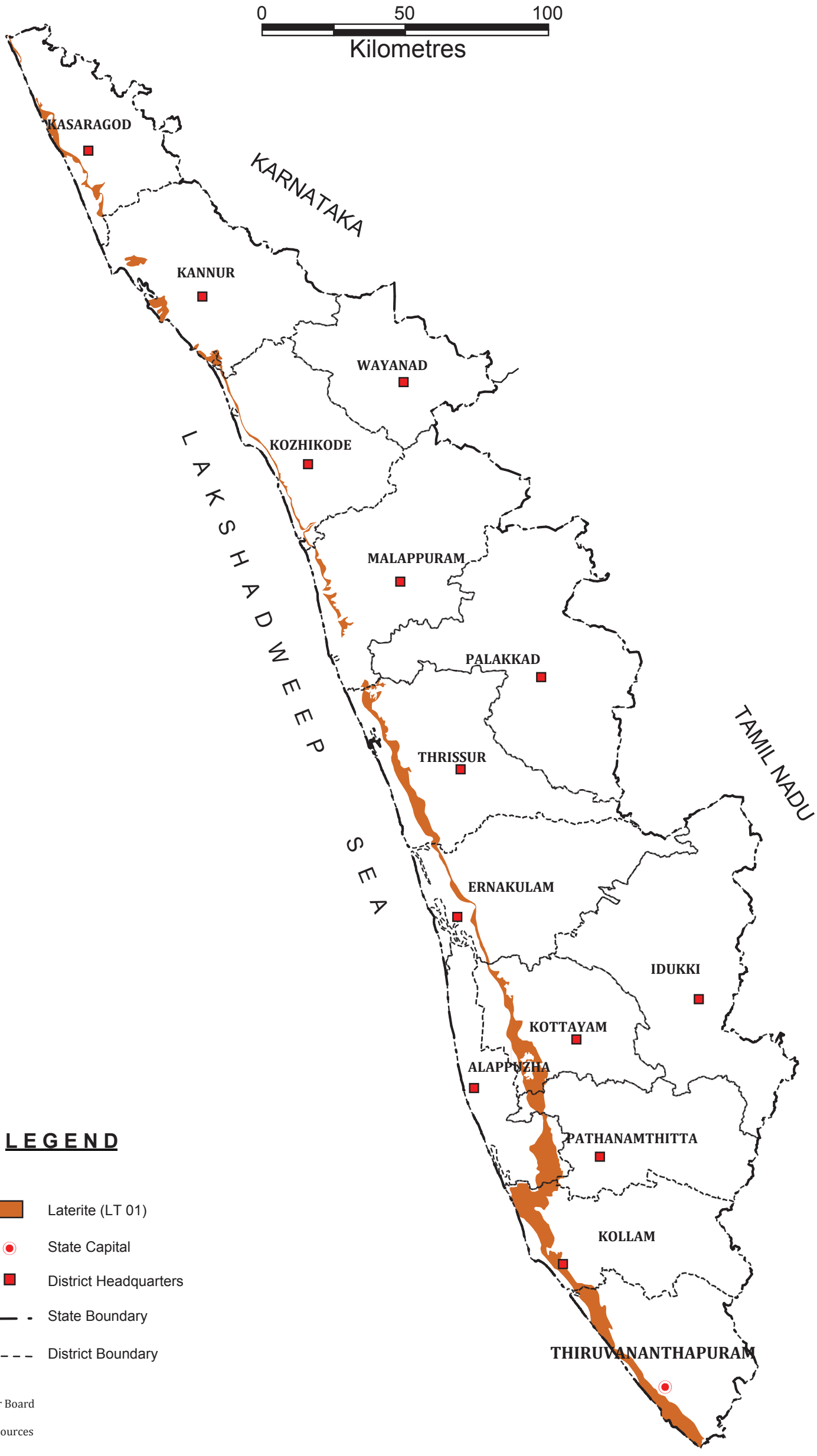
Table 21: District wise Distribution and Characteristics of Laterite Aquifers in Kerala

Sl. No	Name of the District	*Major Aquifers (Area in Sq.Km)*	*Aquifer Properties*								
		Laterite	**Aquifer System**	**Type of Aquifer**	**Thickness of Weathered Zone**	**DTW (Dec Avg)**	**Granular Zones encountered**	**Transmissivity**	**Yield**	**Specific Yield**	**Quality**
		LT 01			**m**	**m bgl**	**m bgl**	**(m^2/day)**	**(m^3/day)**	**%**	**(EC in µS/cm)**
1	Alappuzha	148	Single	Unconfined	2-8	1-5	N.A	1-50	10-50	4	100-500
2	Ernakulam	55	Single	Unconfined	2-10	2-10	N.A	5-40	10-50	2.5	100-500
3	Idukki										
4	Kannur	78	Single	Unconfined	2-5	3-15	N.A	5-50	10-50	4	100-500
5	Kasargod	86	Single	Unconfined	2-20	4-11	N.A	5-70	10-50	3	100-500
6	Kollam	262	Single	Unconfined	2-10	1-10	N.A	5-30	10-50	2.5	100-500
7	Kottayam	189	Single	Unconfined	1-5	2-12	N.A	5-25	10-50	2.5	100-500
8	Kozhikode	43	Single	Unconfined	2-15	5-15	N.A	5-70	10-50	3	100-500
9	Malappuram	53	Single	Unconfined	2-10	5-25	N.A	5-100	10-50	3	100-500
10	Palakkad										
11	Pathanamthitta	43	Single	Unconfined	2-10	5-15	N.A	5-30	10-50	2	100-500
12	Thiruvananthapuram	284	Single	Unconfined	1-15	2-25	N.A	10-50	10-50	2.5	100-500
13	Thrissur	188	Single	Unconfined	2-10	2-10	N.A	10-30	10-50	2	100-500
14	Wayanad										
Total		**1428**									

DTW: Depth To Water Level, m bgl - metres below ground level
Dec. Avg : Decadal Average

LATERITE AQUIFER SYSTEM



LEGEND

- Laterite (LT 01)
- State Capital
- District Headquarters
- State Boundary
- District Boundary

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Table 22a: District wise Distribution and Characteristics of Granite Aquifers in Kerala

Sl. No	Name of the District	*Major Aquifers (Area in Sq.Km)*	*Aquifer Properties*								
		Granite	Aquifer System	Type of Aquifer	Thickness of Weathered Zone	DTW (Dec Avg)	Fracture Zones encountered	Transmissivity	Yield	Specific Yield	Quality
		GR			m	m bgl	m. bgl	(m^2/day)	(m^3/day)	%	(EC in µS/cm)
1	Alappuzha	16	Single	Un confined to Semi- Confined							
2	Idukki	63	Single	Un confined to Semi- Confined	2-10	3-8	25-100	5-50	50-600	2	100-500
3	Pathanamthitta	11	Single	Un confined to Semi- Confined							
4	Wayanad	63	Single	Un confined to Semi- Confined	5-10	3-8	25-100	5-50	50-600		100-500
Total		**153**									

Table 22b: District-wise Distribution and Characteristics of Schist Aquifers in Kerala

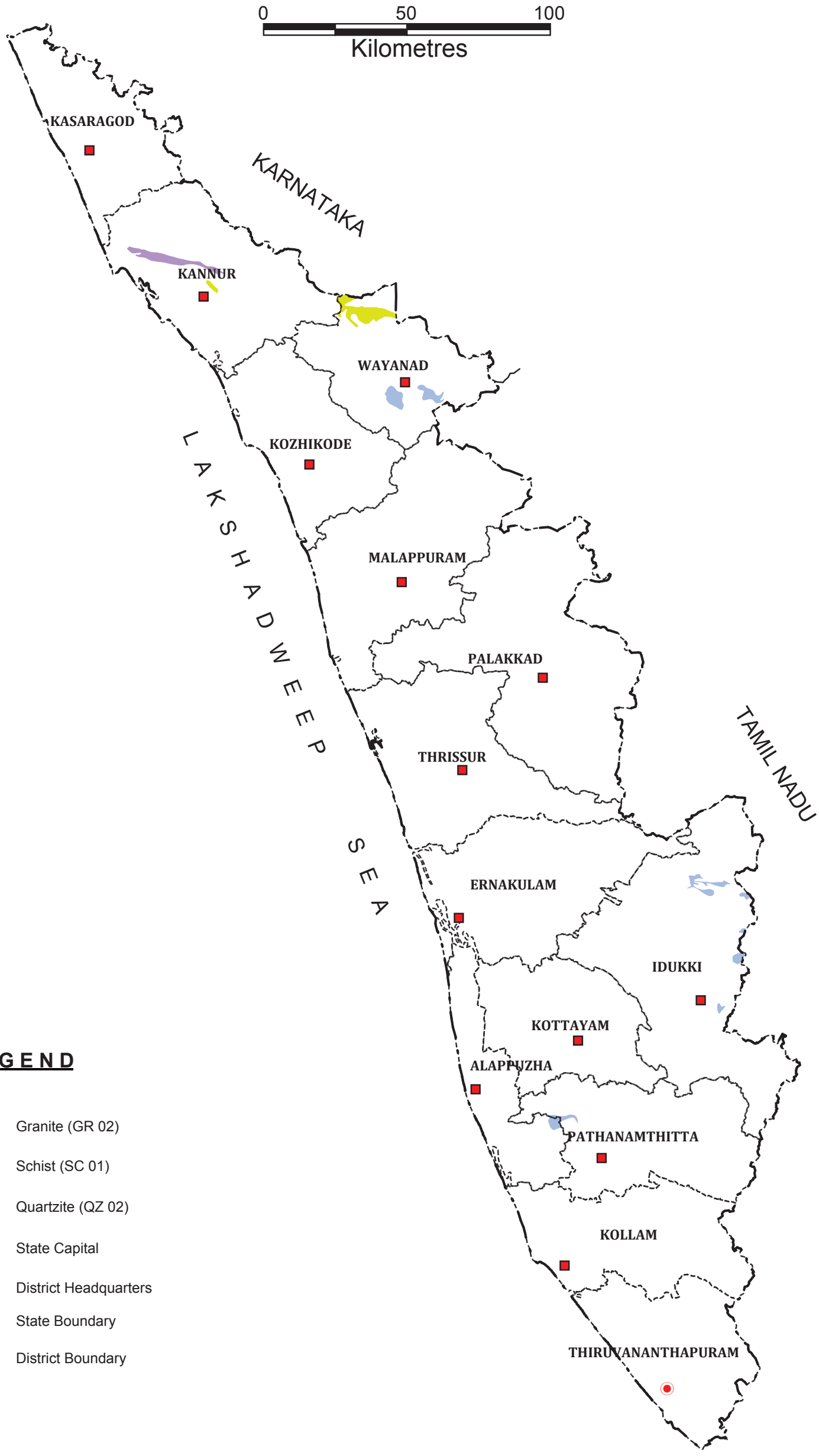
Sl. No	Name of the District	*Major Aquifers (Area in Sq.Km)*	*Aquifer Properties*								
		Schist	Aquifer System	Type of Aquifer	Thickness of Weathered Zone	DTW (Dec Avg)	Fracture Zones encountered	Transmissivity	Yield	Specific Yield	Quality
		SC			M	m bgl	m. bgl	(m^2/day)	(m^3/day)	%	(EC in µS/cm)
1	Kannur	9		N.E							
2	Wayanad	92		N.E							
Total		**101**									

Table 22c: District-wise Distribution and Characteristics of Quartzite Aquifers in Kerala

Sl. No	Name of the District	*Major Aquifers (Area inSq.Km)*	*Aquifer Properties*								
		Quartzite	Aquifer System	Type of Aquifer	Thickness of Weathered Zone	DTW (Dec Avg)	Fracture Zones encountered	Transmissivity	Yield	Specific Yield	Quality
		QZ			M	m bgl	m. bgl	(m^2/day)	(m^3/day)	%	(EC in µS/cm)
1	Kannur	70		N.E							
Total		**70**									

DTW: Depth To Water Level, m bgl - metres below ground level; Dec. Avg : Decadal Average ; N.E : Not Explored.

GRANITE/SCHIST/QUARTZITE AQUIFER SYSTEM



LEGEND

- Granite (GR 02)
- Schist (SC 01)
- Quartzite (QZ 02)
- State Capital
- District Headquarters
- State Boundary
- District Boundary

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Table 23: District wise Distribution and Characteristics of Charnockite Aquifers in Kerala

Sl. No	Name of the District	*Major Aquifers (Area in Sq.Km)*	*Aquifer Properties*								
		Charnockite	Aquifer System	Type of Aquifer	Thickness of Weathered Zone	DTW (Dec Avg)	Fracture Zones encountered	Transmissivity	Yield	Specific Yield	Quality
		CK 01			m	m bgl	m. bgl	(m^2/day)	(m^3/day)	%	(EC in µS/cm)
1	Alappuzha	30	Single	Unconfined to Confined	2-10						
2	Ernakulam	1872	Single	Unconfined to Confined	2-10	1-10	20-160	15-100	20-1300	1-3	50-17000
3	Idukki	2038	Single	Unconfined to Confined	1-12	2-15	10-180	5-100	20-1200	1-3	100- 750
4	Kannur	399	Single	Unconfined to Confined	1-10	2-15	20-120	5-150	20-1100	1-3	100 - 500
5	Kasargod	1557	Single	Unconfined to Confined	2-12	2-15	20-150	5-150	20-1200	1-3	100 - 500
6	Kollam	330	Single	Unconfined to Confined	2-10	4-12	20-100	5-100	20-1000	1-3	250-1000
7	Kottayam	1710	Single	Unconfined to Confined	2-8	1-8	20-140	2-100	30-1300	1-4	200- 500
8	Kozhikode	801	Single	Unconfined to Confined	2-10	2-10	25-130	2-100	20-1000	1-4	250- 1000
9	Malappuram	2291	Single	Unconfined to Confined	2-15	2-10	30-160	2-100	25-1400	1-4	100- 500
10	Palakkad	1793	Single	Unconfined to Confined	1-10	2-10	20-150	5-150	20-2000	1-4	250- 750
11	Pathanamthitta	2170	Single	Unconfined to Confined	1-10	1-15	20-185	2-150	25-1000	1-4	100- 500
12	Thiruvananthapuram										
13	Thrissur	1842	Single	Unconfined to Confined	1-10	2-10	20-100	20-150	25-2500	1-4	250-1500
14	Wayanad	335	Single	Unconfined to Confined	1-15	1-8	20-160	20-52	20-1000	1-4	100-500
Total		**17167**									

DTW: Depth To Water Level, m bgl - metres below ground level
Dec. Avg : Decadal Average

CHARNOCKITE AQUIFER SYSTEM

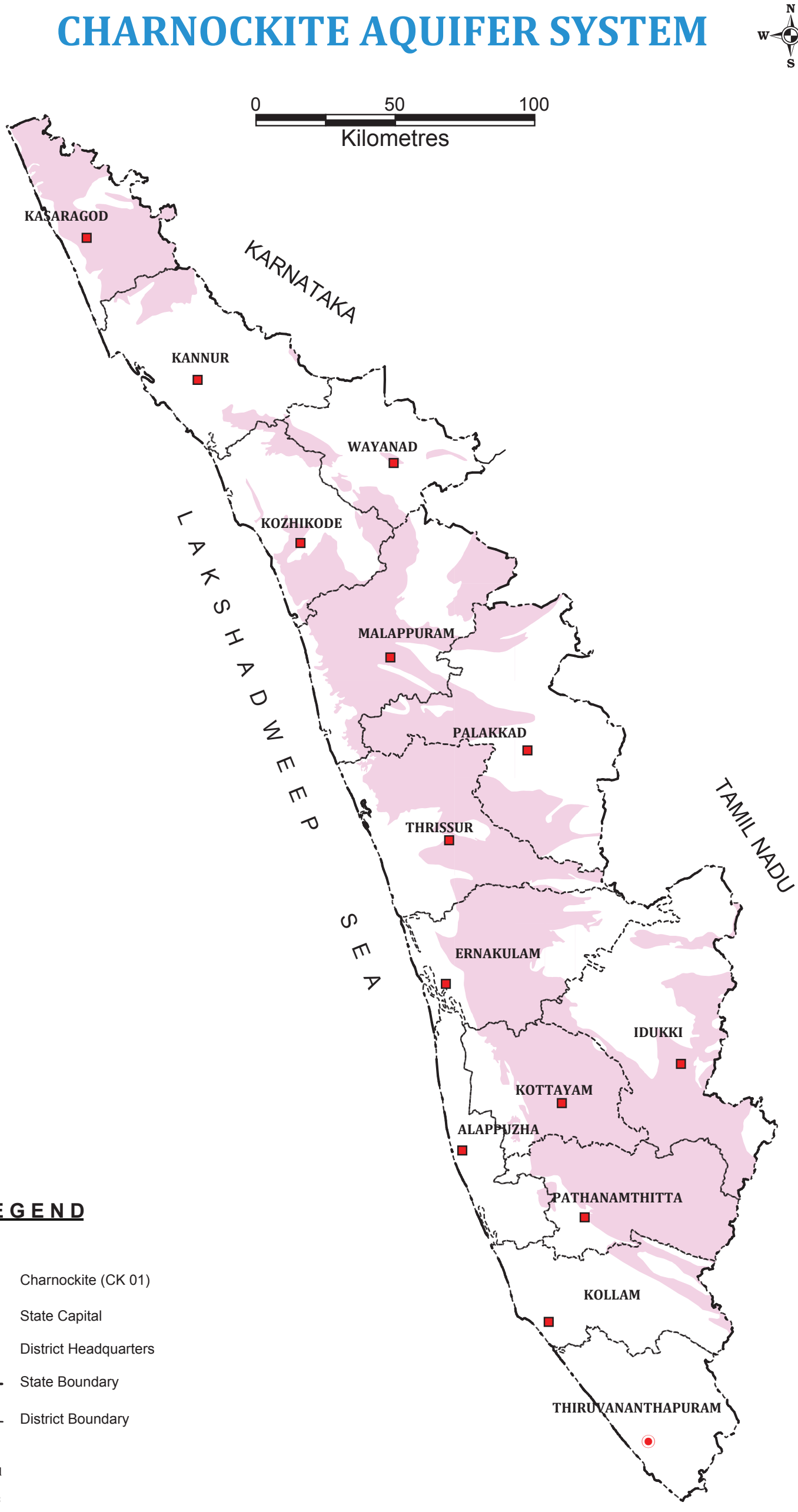

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Table 24: District wise Distribution and Characteristics of Khondalite Aquifers in Kerala

Sl. No	Name of the District	*Major Aquifers (Area in Sq.Km)*	*Aquifer Properties*								
		Khondalite	**Aquifer System**	**Type of Aquifer**	**Thickness of Weathered Zone**	**DTW (Dec Avg)**	**Fracture Zones encountered**	**Transmissivity**	**Yield**	**Specific Yield**	**Quality**
		KH 01			m	m bgl	m. bgl	(m^2/day)	(m^3/day)	%	(EC in µS/cm)
1	Alappuzha	23	Single	Unconfined to Confined	4-8	1-5					
2	Ernakulam										
3	Idukki										
4	Kannur										
5	Kasargod										
6	Kollam	1470	Single	Unconfined to Confined	3-12	2-20	50-100	2-80	25-1500	1-3	250-1050
7	Kottayam										
8	Kozhikode										
9	Malappuram										
10	Palakkad										
11	Pathanamthitta	108	Single	Unconfined to Confined	1-12	2-15				1-4	100- 500
12	Thiruvananthapuram	1872	Single	Unconfined to Confined	1-10	2-10	50-80	2-80	30-1500	1-4	250-1000
13	Thrissur										
14	Wayanad		Single	Unconfined to Confined	1-10	1-15	10-196	0.5-18	11-864	0.2-0.5	100-750
Total		**3474**									

DTW: Depth To Water Level, m bgl - metres below ground level
Dec. Avg : Decadal Average

KHONDALITE AQUIFER SYSTEM

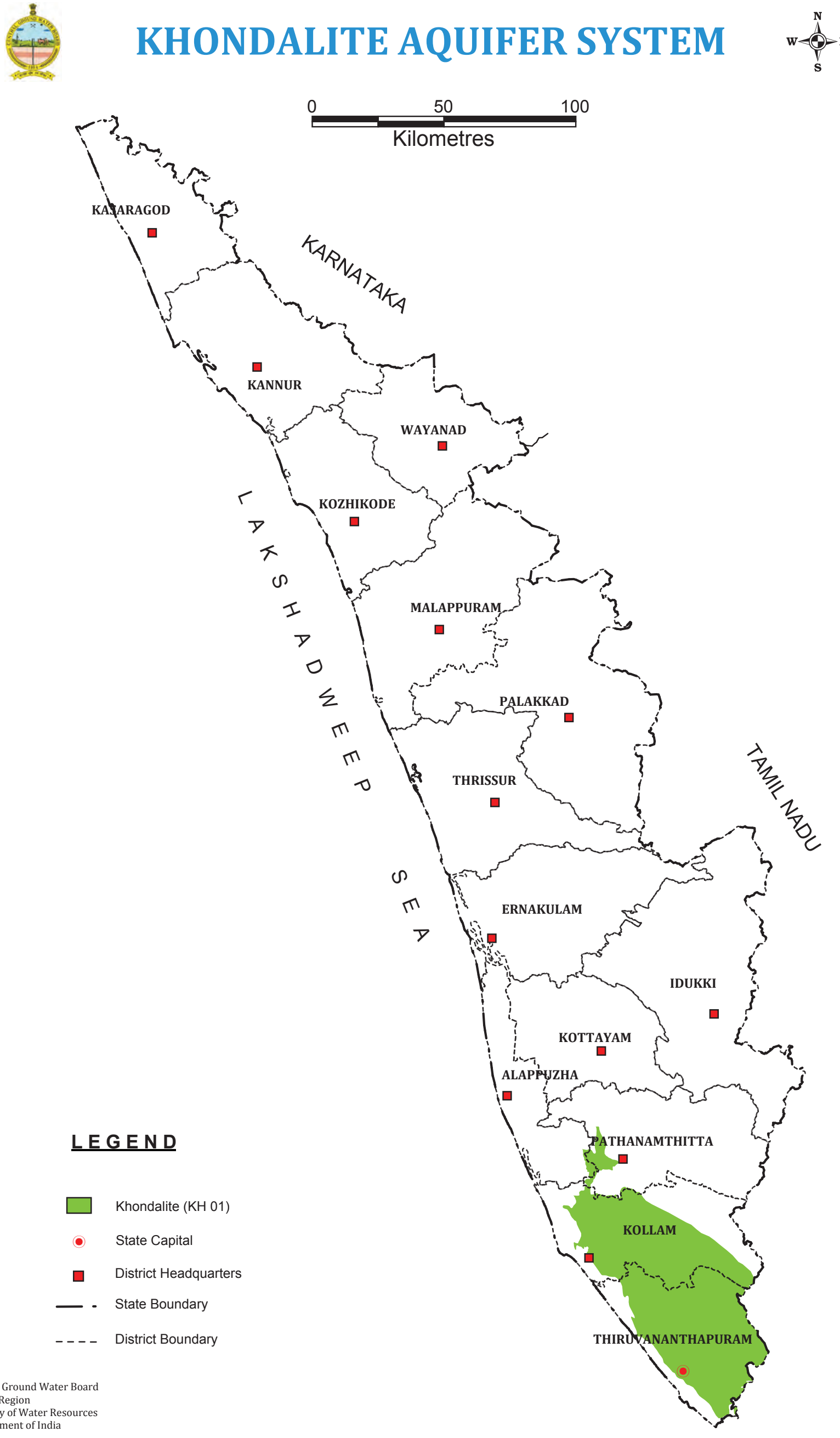

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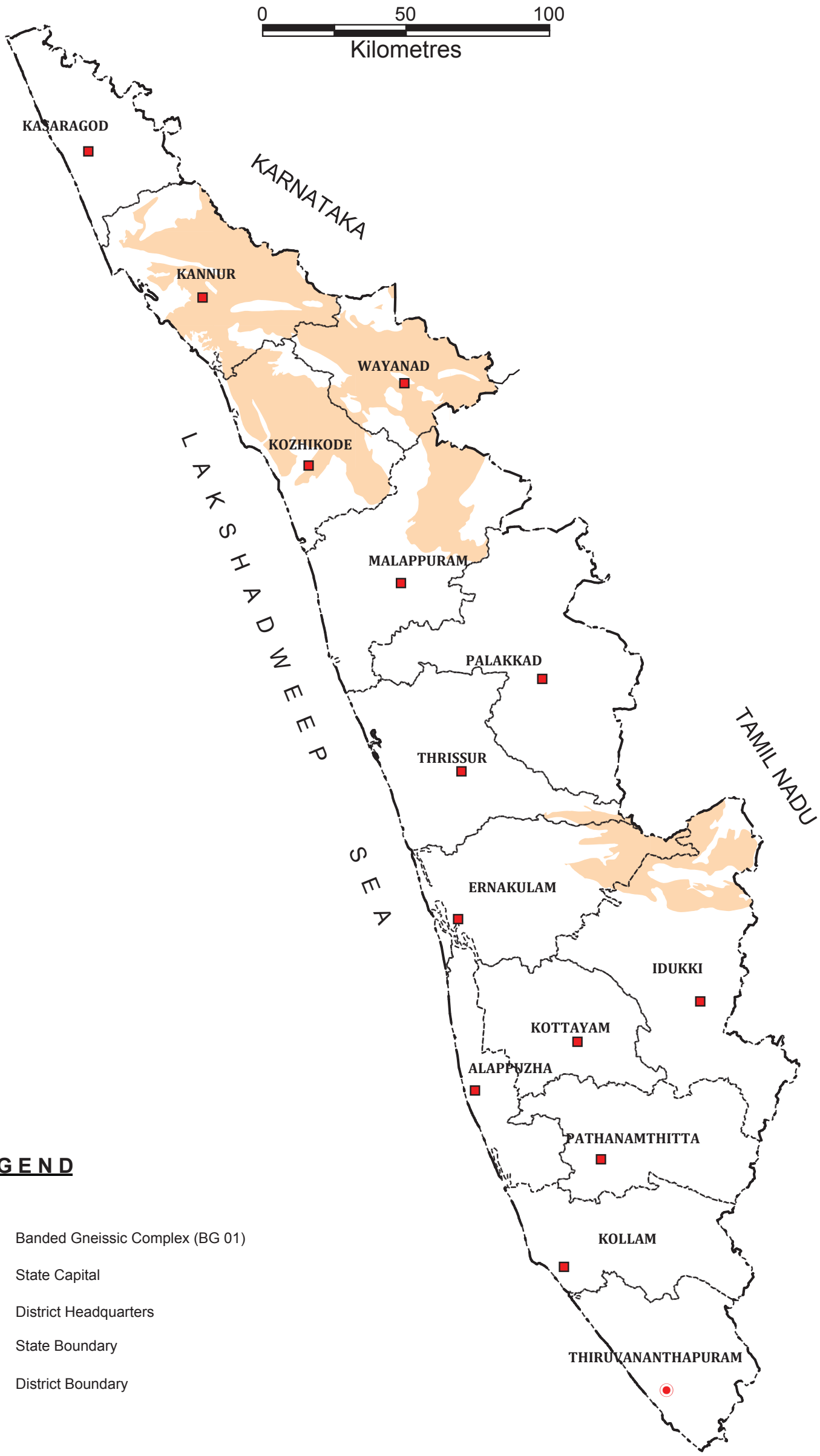
Table 25: District wise Distribution and Characteristics of Banded Gneissic Complex Aquifers in Kerala

Sl. No	Name of the District	*Major Aquifers (Area in Sq.Km)*	*Aquifer Properties*								
		BGC	Aquifer System	Type of Aquifer	Thickness of Weathered Zone	DTW (Dec Avg)	Fracture Zones encountered	Transmissivity	Yield	Specific Yield	Quality
		BG 01			m	m bgl	m. bgl	(m^2/day)	(m^3/day)	%	(EC in µS/cm)
1	Alappuzha										
2	Ernakulam	479	Single	Unconfined to Semi-Confined	2-10	2-15	30-180	15-300	20-2000	1-4	50-17000
3	Idukki	762	Single	Unconfined to Semi-Confined	1-20	2-18	40-150	5-50	20-850	1-4	100-500
4	Kannur	1959	Single	Unconfined to Semi-Confined	3-15	3-12	50-150	2-85	25-1200	1-4	250-800
5	Kasargod										
6	Kollam										
7	Kottayam										
8	Kozhikode	1366	Single	Unconfined to Semi-Confined	2-15	2-10	40-160	5-100	20-1500	1-4	250-1500
9	Malappuram	752	Single	Unconfined to Semi-Confined	2-18	2-15	30-100	10-150	80- 1100	1-4	100-1000
10	Palakkad										
11	Pathanamthitta										
12	Thiruvananthapuram										
13	Thrissur	98	Single	Unconfined to Semi-Confined	2-15	1-10	35-100	5-100	50-1500	1-4	100-750
14	Wayanad	1524	Single	Unconfined to Semi-Confined	2-20	2-18	25-150	5-60	20-850	1-4	50-250
Total		**6940**									

DTW: Depth To Water Level, m bgl - metres below ground level
Dec. Avg : Decadal Average

BANDED GNEISSIC COMPLEX AQUFER SYSTEM (BGC)



LEGEND

- Banded Gneissic Complex (BG 01)
- State Capital
- District Headquarters
- State Boundary
- District Boundary

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Table 26 : District wise Distribution and Characteristics of Gneiss Aquifers in Kerala

Sl. No	Name of the District	*Major Aquifers (Area in Sq.Km)*	*Aquifer Properties*								
		Gneiss	Aquifer System	Type of Aquifer	Thickness of Weathered Zone	DTW (Dec Avg)	Fracture Zones encountered	Transmissivity	Yield	Specific Yield	Quality
		GN 01			m	m bgl	m. bgl	(m^2/day)	(m^3/day)	%	(EC in µS/cm)
1	Alappuzha										
2	Ernakulam	286	Single	Unconfined to Semi-Confined	2-7	1-4	30-100	20-150	40-1000	1-4	200-7000
3	Idukki	1495	Single	Unconfined to Semi-Confined	1-10	3-35	40-120	5-100	80-700	1-4	100-500
4	Kannur										
5	Kasargod	179	Single	Unconfined to Semi-Confined	2-12	5-12	20-80	5-100	10-100	1-4	100-500
6	Kollam	322	Single	Unconfined to Semi-Confined	2-10	2-10	50-180	3-30	40-1400	1-4	200-1100
7	Kottayam	61	Single	Unconfined to Semi-Confined							
8	Kozhikode										
9	Malappuram	170	Single	Unconfined to Semi-Confined	2-10	2-8	25-75	10-150	10- 1050	1-4	100-900
10	Palakkad	2663	Single	Unconfined to Semi-Confined	2-15	2-15	20-170	10-270	10-2000	1-4	250-2200
11	Pathanamthitta	260	Single	Unconfined to Semi-Confined	2-10	2-15	30-100	1-30	20-200	1-4	100-500
12	Thiruvananthapuram										
13	Thrissur	593	Single	Unconfined to Semi-Confined	1-10	0.5-5	15-80	20-200	40-1080	1-4	250-7000
14	Wayanad	19	Single	Unconfined to Semi-Confined	1-10	2-10	30-100		40-1100	1-4	100-500
Total		**6047**									

DTW: Depth To Water Level, m bgl - metres below ground level
Dec. Avg : Decadal Average

GNEISS AQUIFER SYSTEM

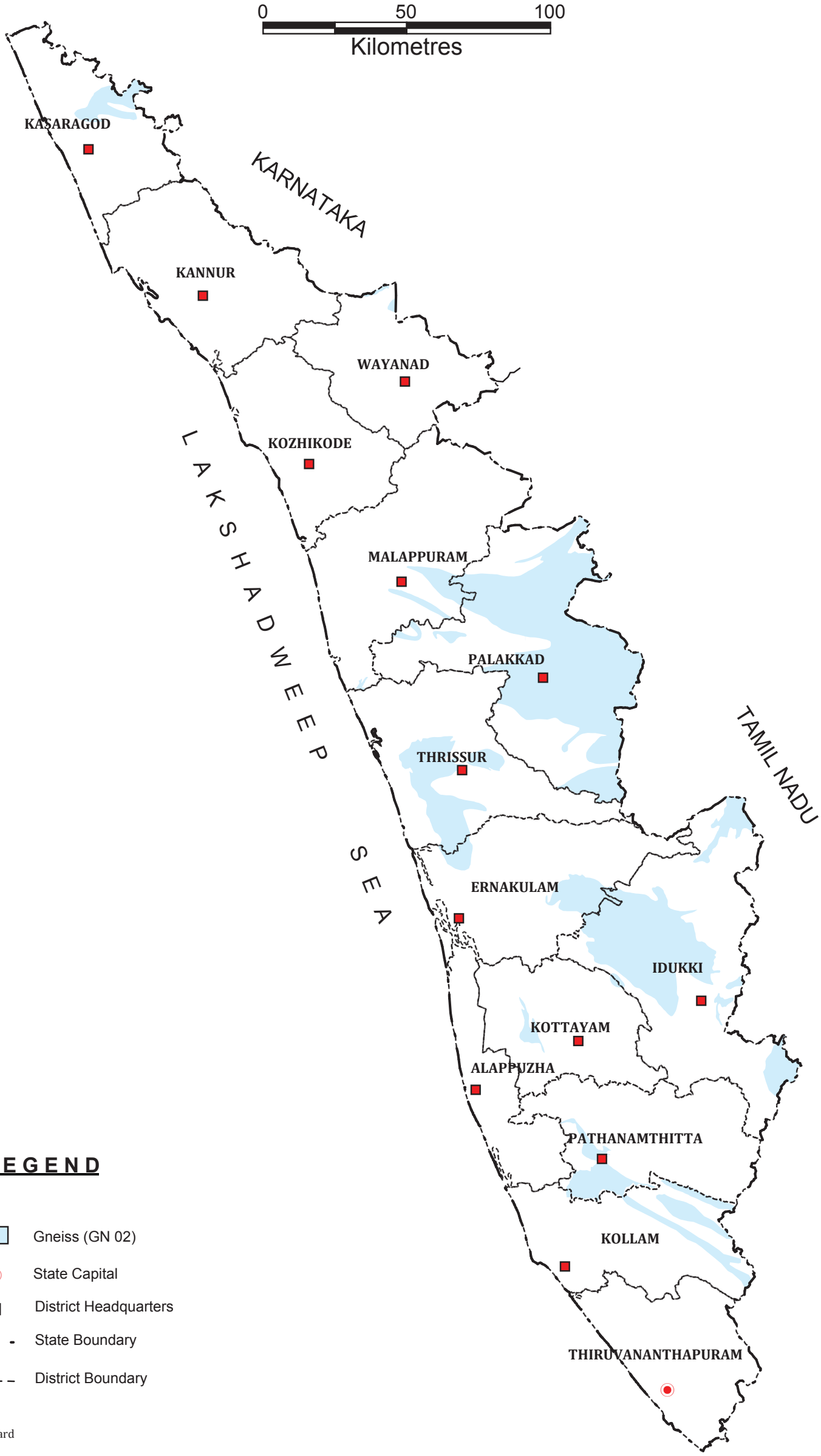

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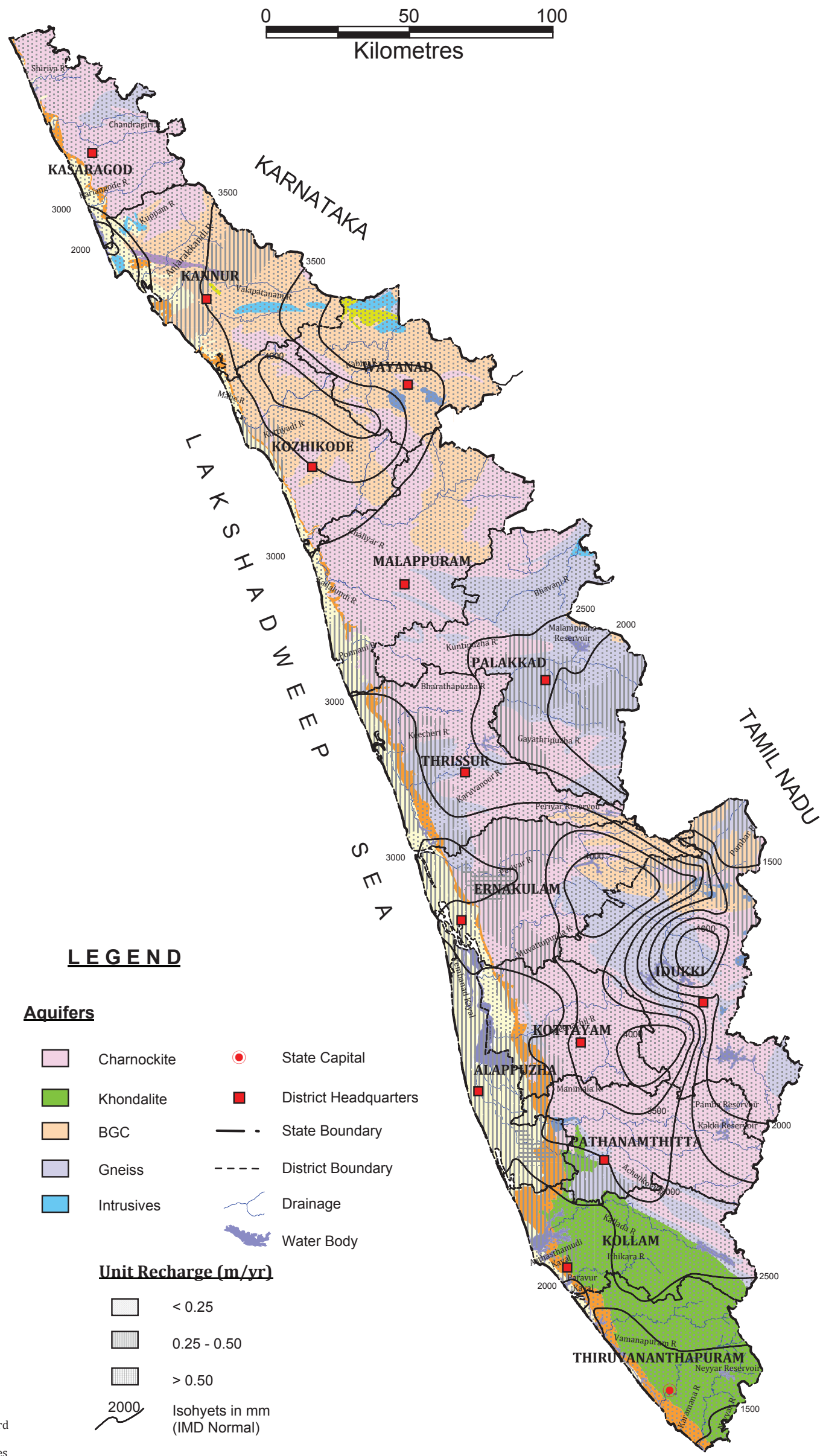
Table 27 : District wise and Aquifer wise Annual Replenishable Recharge in Kerala

Sl. No	Name of the District	Alluvium		Laterite		Granite		Schist		Quartzite		Charnockite		Khondalite		B G C		Gneiss		Intrusives	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Alappuzha	0.26	0.36	0.14	0.26	0.02	0.02					0.10	0.11								
2	Ernakulam	0.27	0.41	0.16	0.27							0.22	0.58			0.15	0.22	0.20	0.24		
3	Idukki					0.11	0.15									0.25	0.28	0.10	0.23		
4	Kannur	0.25	0.33	0.18	0.28			0.15	0.18	0.15	0.21					0.20	0.22				
5	Kasargod	0.21	0.28	0.21	0.35							0.21	0.23					0.13	0.23		
6	Kollam	0.26	0.31	0.16	0.30							0.13	0.15	0.16	0.27			0.13	0.15		
7	Kottayam	0.24	0.28	0.25	0.26							0.15	0.22					0.16	0.20		
8	Kozhikode	0.25	0.41	0.17	0.25							0.15	0.22			0.17	0.22				
9	Malappuram	0.24	0.37	0.18	0.20							0.19	0.24			0.17	0.21				
10	Palakkad											0.17	0.21	0.12	0.15			0.17	0.47		
11	Pathanamthitta	0.25	0.31	0.19	0.20							0.19	0.20								
12	Thiruvananthapuram	0.15	0.35	0.15	0.21									0.12	0.15						
13	Thrissur	0.25	0.37	0.26	0.35							0.19	0.25					0.19	0.43		
14	Wayanad					0.03	0.05	0.15	0.18							0.21	0.21	0.17	0.17		

Unit : m/yr

ANNUAL REPLENISHABLE RECHARGE



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives

- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

Unit Recharge (m/yr)

- < 0.25
- 0.25 - 0.50
- > 0.50
- 2000 Isohyets in mm (IMD Normal)

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Ministry of Water Resources
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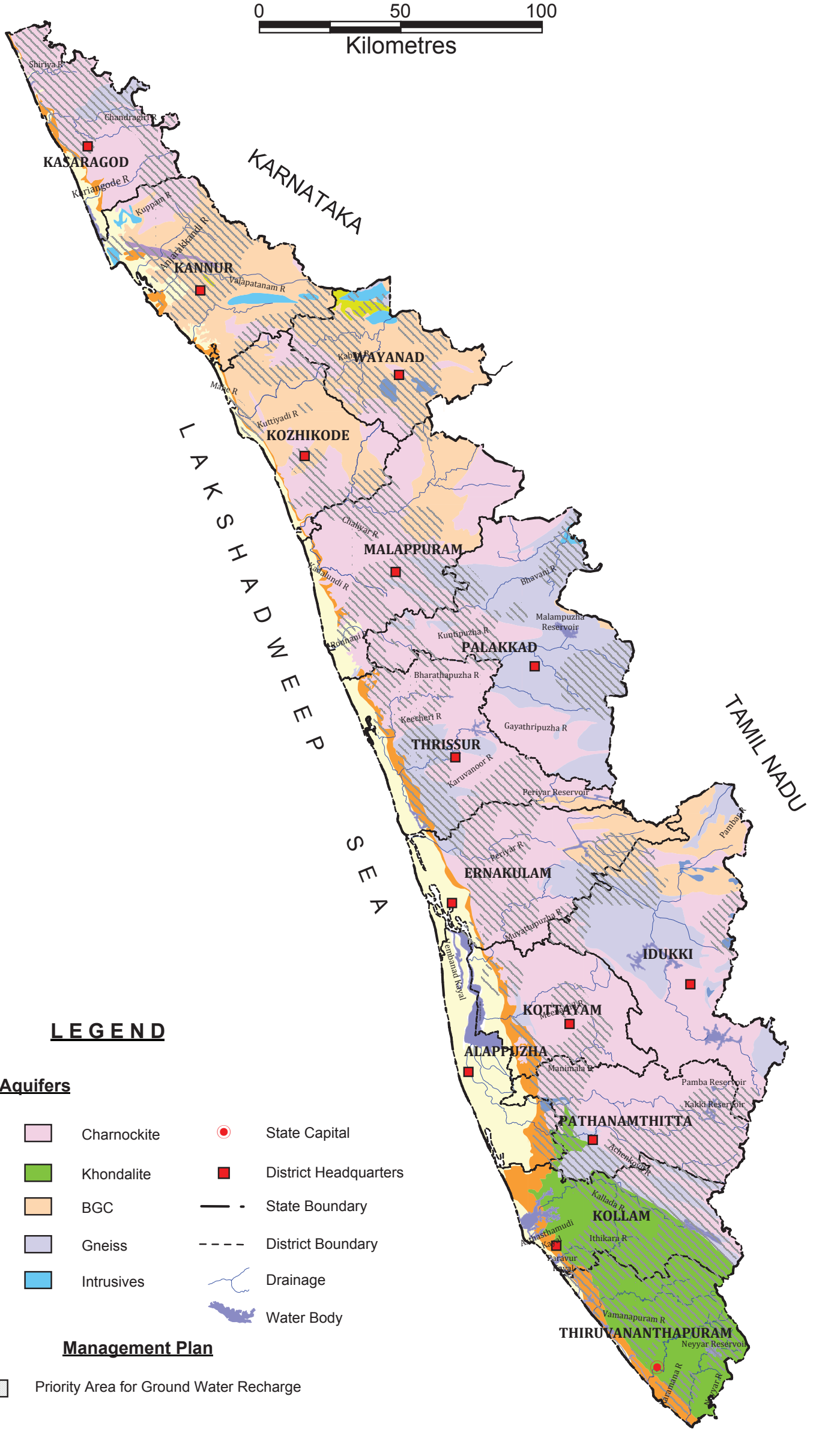
Source: Isohyets - IMD (Normal)

Table 28 : District wise and Aquifer wise Area Prioritized for Artificial Recharge

Sl. No	Name of the District	District Area	Alluvium	Laterite	Granite	Schist	Quartzite	Charnockite	Khondalite	B G C	Gneiss	Intrusives	Total	
													Area	%
1	Alappuzha	1414		80.4	15.9			29.3	23.4				**149.0**	**10.5**
2	Ernakulam	3068	13	5.7				902.1		177.7	75.3		**1173.8**	**38.3**
3	Idukki	4358			7.6			348.2		140.6	294		**790.4**	**18.1**
4	Kannur	2966	114.1	14.3		7.52	63.57	173.8		995.6			**1368.8**	**46.2**
5	Kasargod	1992	19	31.5				962.0			150		**1162.5**	**58.4**
6	Kollam	2491	6	21				28.0	1074		303		**1432.0**	**57.5**
7	Kottayam	2208	204.3	86.7				472.4			15.4		**778.8**	**35.3**
8	Kozhikode	2344	26.4	12				327.8		370.8			**737.0**	**31.4**
9	Malappuram	3550	5.74	8.9				1019.0		183.9	161		**1378.5**	**38.8**
10	Palakkad	4480						452.7			920.4	20.3	**1393.4**	**31.1**
11	Pathanamthitta	2637			11.41			1243.0	103		208.3		**1565.7**	**59.4**
12	Thiruvananthapuram	2192	10	149.7					1259				**1418.7**	**64.7**
13	Thrissur	3032	7.3	114.94				82.4			309.9		**514.5**	**17.0**
14	Wayanad	2131			62.3	42.5		98.2		866.7		18.74	**1088.4**	**51.1**
Total		**38863**	**405.8**	**525.1**	**97.2**	**50.0**	**63.6**	**6138.9**	**2459.4**	**2735.3**	**2437.3**	**39.0**	**14951.6**	**38.5**

ARTIFICIAL RECHARGE - PRIORITY AREA

AQUIFER MANAGEMENT PLAN



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives

- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

Management Plan

- Priority Area for Ground Water Recharge

Central Ground Water Board
Kerala Region
Ministry of Water Resources
Government of India

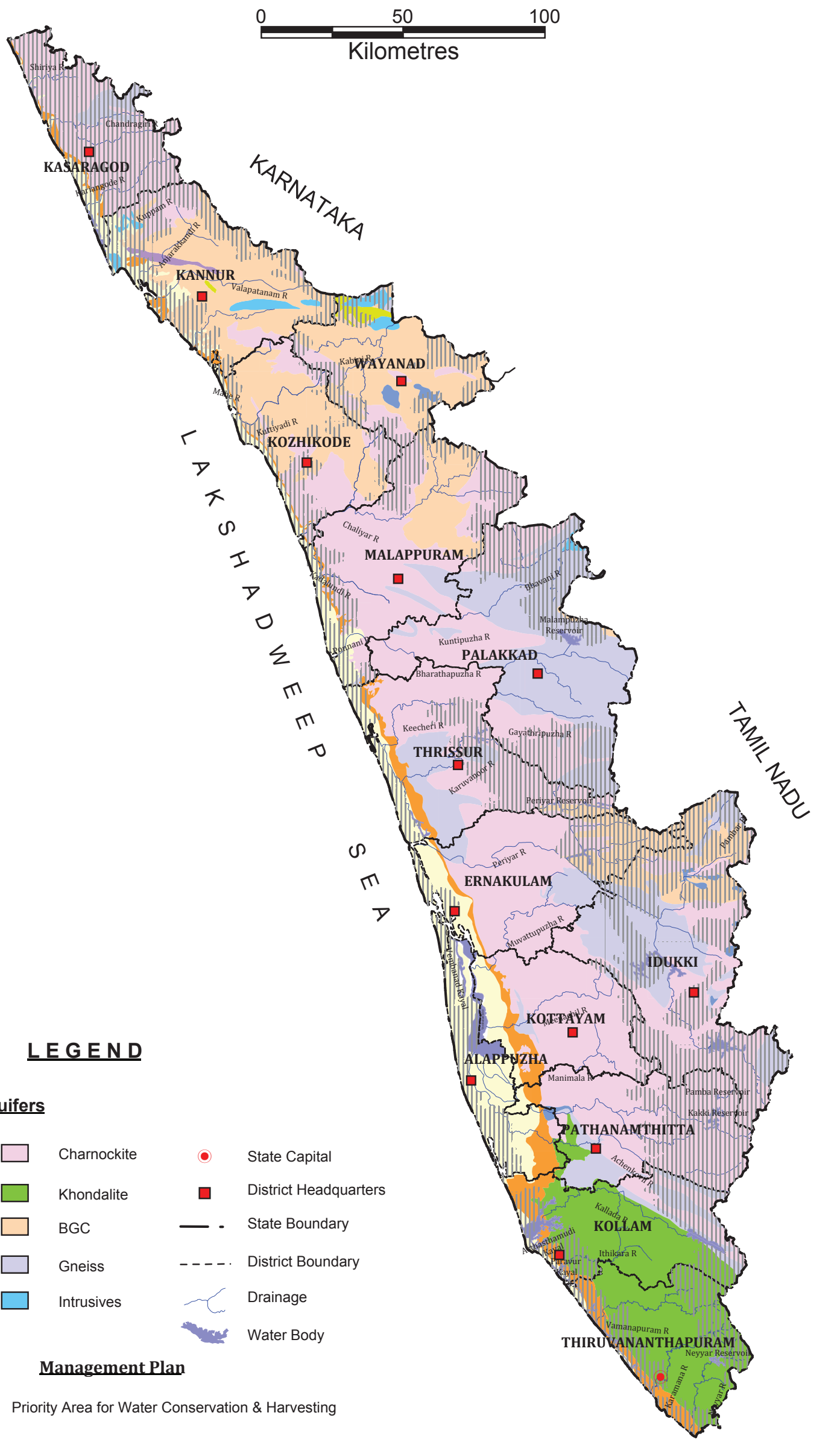
Table 29 : District wise and Aquifer wise Area Delineated for Rainwater Harvesting and Water Conservation in Kerala

Sl. No	Name of the District	District Area	Alluvium	Laterite	Granite	Schist	Quartzite	Charnockite	Khondalite	B G C	Gneiss	Intrusives	Total	
													Area	%
1	Alappuzha	1414	544										**544**	**38.5**
2	Ernakulam	3068	168					171		474			**813**	**26.5**
3	Idukki	4358			30			1405		634	763		**2832**	**65.0**
4	Kannur	2966	281	40			13	244		680		46	**1304**	**44.0**
5	Kasargod	1992	169	86				1557		179	32		**2023**	**101.6**
6	Kollam	2491	157	145				241	194		259		**996**	**40.0**
7	Kottayam	2208						132			4		**136**	**6.2**
8	Kozhikode	2344	136	41				342		185			**704**	**30.0**
9	Malappuram	3550	283	53				684		142	8.5		**1170.5**	**33.0**
10	Palakkad	4480						397			295		**692**	**15.4**
11	Pathanamthitta	2637						1236					**1236**	**46.9**
12	Thiruvananthapuram	2192	31	265					782				**1078**	**49.2**
13	Thrissur	3032	252	20				781		127	64		**1244**	**41.0**
14	Wayanad	2131			22	59		368		262	17	54	**782**	**36.7**
Total		**38863**	**2021**	**650**	**52**	**59**	**13**	**7558**	**976**	**2683**	**1443**	**100**	**15555**	**40.0**

Area in Sq.Km.

WATER CONSERVATION AND HARVESTING - PRIORITY AREA

AQUIFER MANAGEMENT PLAN



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives

- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

Management Plan

- Priority Area for Water Conservation & Harvesting

Central Ground Water Board
Kerala Region
Ministry of Water Resources
Government of India

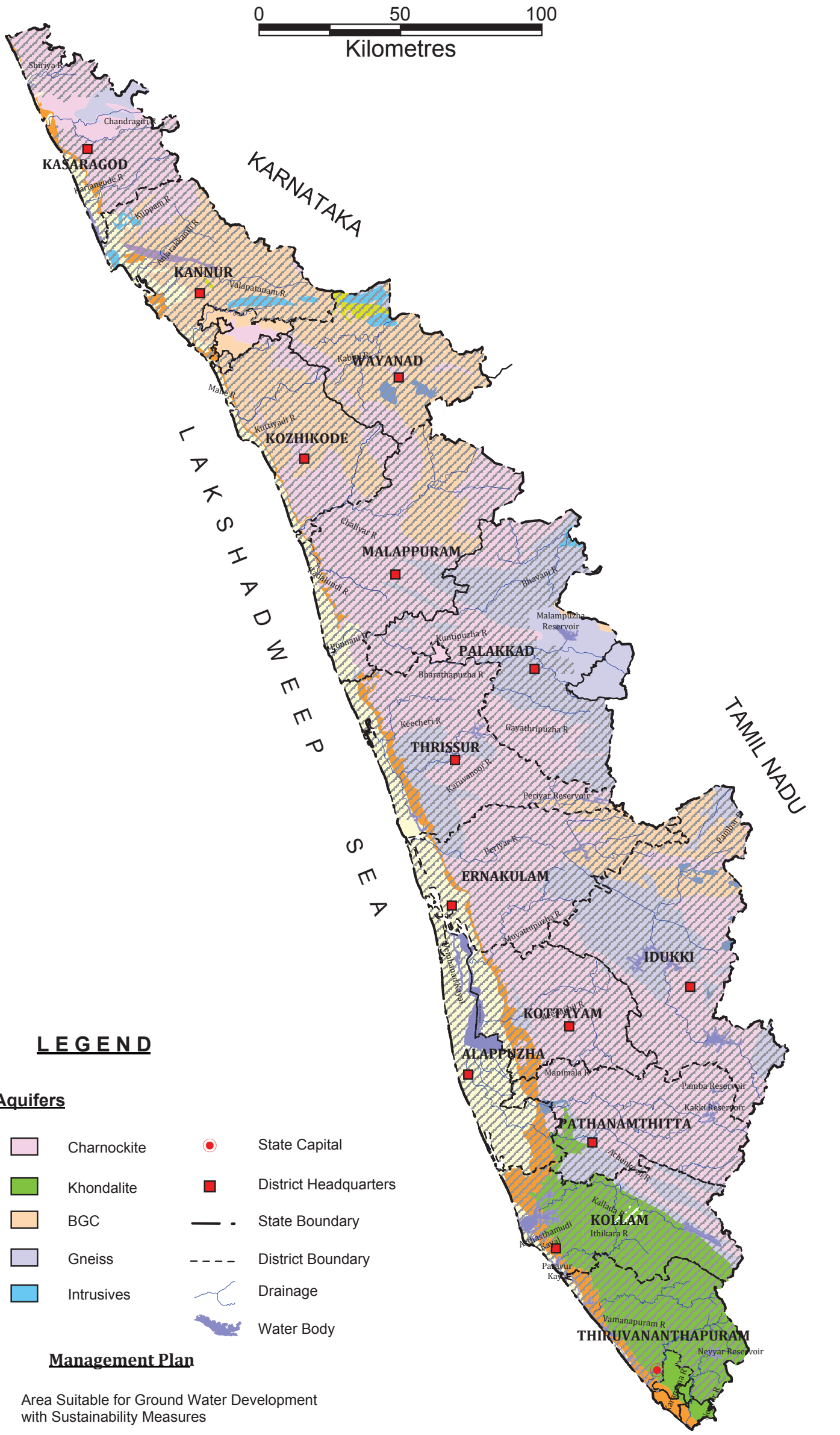
Table 30 : District wise and Aquifer wise Area Suitable for Ground Water Development in Kerala

Sl. No	Name of the District	Area	Alluvium	Laterite	Granite	Schist	Quartzite	Charnockite	Khondalite	B G C	Gneiss	Intrusives	Total	
													Area	%
1	Alappuzha	1414	1197	148	16			30	23		0		**1414**	**100.0**
2	Ernakulam	3068	378	55				1872		479	286		**3068**	**100.0**
3	Idukki	4358			63			2038		763	1495		**4358**	**100.0**
4	Kannur	2966	322	78		9	71	399		1959		129	**2966**	**100.0**
5	Kasargod	1992	162.6	58				1276			9		**1506**	**75.6**
6	Kollam	2491	107	262				330	1470		322		**2491**	**100.0**
7	Kottayam	2208	248	189				1710			61		**2208**	**100.0**
8	Kozhikode	2344	134	43				801		1366			**2344**	**100.0**
9	Malappuram	3550	285	53				2291		752	170		**3550**	**100.0**
10	Palakkad	4480						1787			1945	3	**3735**	**83.4**
11	Pathanamthitta	2637	45	43	11			2170	108		260		**2637**	**100.0**
12	Thiruvananthapuram	2192	36	284					1872				**2192.06**	**100.0**
13	Thrissur	3032	267	181				1842		98	593		**2980**	**98.3**
14	Wayanad	2131			63	92		335		1524	19	99	**2131.24**	**100.0**
Total		**38863**	**3180.27**	**1393.09**	**152.75**	**100.88**	**70.6**	**16879.45**	**3473.56**	**6939.55**	**5159**	**230.47**	**37579.5**	**96.7**

Area in Sq.Km.

AREA SUITABLE FOR GROUND WATER DEVELOPMENT

AQUIFER MANAGEMENT PLAN



LEGEND

Aquifers

- Alluvium
- Laterite
- Granite
- Schist
- Quartzite
- Charnockite
- Khondalite
- BGC
- Gneiss
- Intrusives

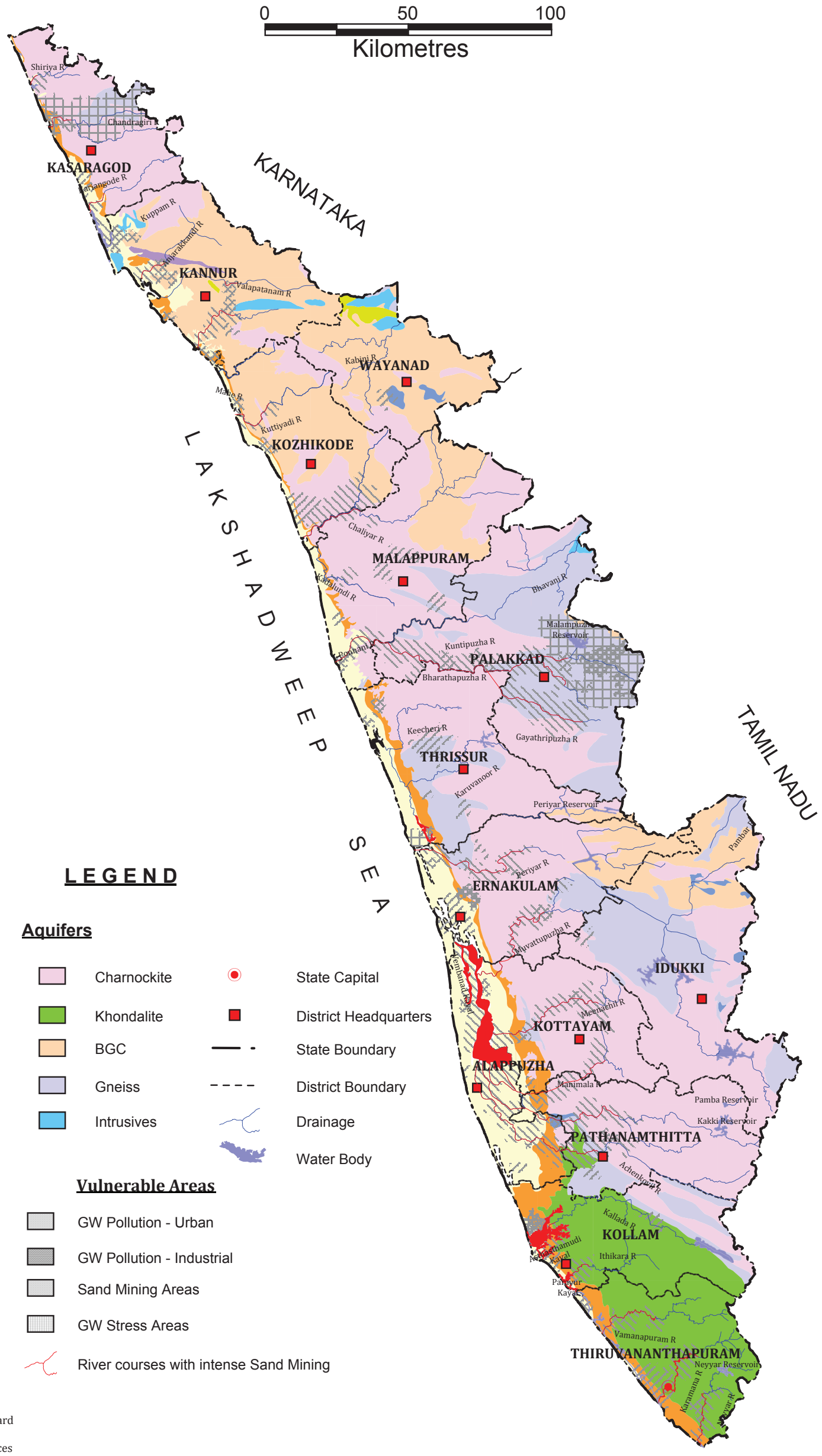
- State Capital
- District Headquarters
- State Boundary
- District Boundary
- Drainage
- Water Body

Management Plan

- Area Suitable for Ground Water Development with Sustainability Measures

Central Ground Water Board
Kerala Region
Ministry of Water Resources
Government of India

GROUND WATER VULNERABLE AREAS



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WAY FORWARD

The document entitled 'Aquifer Systems of Kerala' is an effort of Central Ground Water Board to compile the available information on the important water-bearing formations in the State and to group them into a manageable number of categories based on their lithological, hydrological and hydrochemical characteristics. This has culminated in the grouping of ground water systems of Kerala into 10 major aquifer systems. This document will serve as the base for the National Aquifer Mapping Programme of CGWB during the XII and XIII Plans in the State, which aims at detailed and systematic mapping of the aquifers on scales of 1:50,000 or larger.

As a base document for the National Aquifer Mapping Programme, 'Aquifer Systems of Kerala' provides valuable information on the areal and vertical extents of major aquifers, the nature and behaviour of ground water contained in them as well as the hydrochemical characteristics of the formation waters. It also helps in the quantitative and qualitative assessment of ground water resources and also in understanding its vulnerability to various stresses on a regional scale.

However, considering the diversity of geomorphic and hydrogeologic settings and the hydrochemical variations in the aquifer systems in the State, this is to be considered as the first step in the challenging task of formulating strategies for ensuring long-term sustainability of our precious ground water resources which will contribute significantly in achieving water and food security of the State. This will involve a host of activities, the most important of which are listed below:

- ❖ Collection, compilation and synthesis of all available information on ground water resources of identified aquifer systems at scales of 1:50,000 in general and at larger scales for critical and vulnerable areas for the State as a whole.
- ❖ Identification of data gaps in terms of information on litho-stratigraphy of water bearing formations, ground water conditions, spatial and temporal variations of water levels, ground water development status and hydrochemical characteristics.
- ❖ Planning of cost-effective scientific investigations suited to various terrain conditions aimed at filling the data gaps.
- ❖ Micro-level hydrogeological investigations supplemented by hydrometeorological, hydrological, remote sensing, geophysical and hydrochemical studies on the status of ground water regime, its characteristics and linkages with rainfall, surface water resources, prevailing water use pattern, socio-economic conditions etc.
- ❖ Demarcation of vulnerable areas in terms of ground water depletion and contamination from natural or anthropogenic sources and quantitative assessment of the extent of vulnerability of each aquifer system. This will help formulate plans for addressing location-specific vulnerability concerns in the such as over-exploitation, water level decline and environmental degradation due to indiscriminate river sand mining, ground water contamination due to municipal, agricultural and industrial pollutants, seawater ingress into coastal freshwater aquifers etc.
- ❖ Quantitative assessment of the ground water resources in each aquifer, status of their utilization, scope for future development for various uses and sectoral allocation of the resources based on assigned priorities.
- ❖ Integration of the data collected on a suitable GIS platform and preparation of thematic layers at suitable scales, depicting important parameters having a direct or indirect impact on ground water resources.
- ❖ Integration of thematic maps to form comprehensive aquifer maps at sub-basin, watershed and micro-watershed scales.
- ❖ Development of calibrated ground water flow and solute transport models at appropriate scales to function as Decision Support Systems to help planners choose the best and scientifically defensible management interventions for aquifer management.
- ❖ Formulation of strategies for ensuring long-term sustainability of ground water resources in identified aquifers and for protecting their quality through a judicious mix of supply side and demand side strategies. This may involve various measures such as recharge augmentation, ground water regulation, water conservation, aquifer remediation, improvements in water use efficiency etc. depending on the characteristics of aquifers, status of ground water development and the vulnerability of the aquifer systems.

The aquifer mapping programme is aimed at the development of aquifer management plans and water security plans, ultimately at the village level. It will then be possible for us to move on to the implementation of management of ground water resources by the local communities, which is now proving to be the best strategy for ensuring the long-term sustainability and protection of ground water resources.

Water !
There is no alternative to it!
Save Every Drop!

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