UWR Rainwater Offset Unit Standard

(UWR RoU Standard)

Concept & Design: Universal Water Registry

www.uwaterregistry.io

Project Concept Note & Monitoring Report

(PCNMR)

Project Name: Good Earth Melange, Kochi

UWR RoU Scope: 3

Monitoring Period: 01/04/2020 – 31/12/2023

Crediting Period: 2020-2023

UNDP Human Development Indicator: 0.645 (India)

A.1 Location of Project Activity

State	Kerala
District	Ernakulum, Kochi
Block Basin/Sub Basin/Watershed	5A1c8a5 (https://slusi.dacnet.nic.in/dmwai/Kerala/district/ernakulam.html)
Lat. & Longitude	10.016983542675318,^{0} N latitudes 76.29823053535574^0 E longitudes
Area Extent	3035.25 m^2
No. of Villages/Towns	It is a residential complex in Kochi.

Good Earth Melange Owners' Association (GEMOA) is the owner's association of the residential units located in Good Earth Melange - a residential complex situated in Kochi, in the state of Kerala, in India.

Good Earth Melange is a tropical high rise apartment building, a green alternative which responds to and takes advantages of the climate and location. The design of the complex minimizes the common walls between apartments. The units are designed as homes that open up to the verandahs and sky gardens. The cavity walls capture the hot air which is expelled using air vents on the roof, keeping the indoors cool. The lobby also has been designed as an extension of the landscape with sky gardens. The design attempts to break away from the typical apartment plan to bring in elements of a home in space planning.

Apart from the facilities and amenities within Good Earth Melange, the complex taken series of innovative measures for sustainable living. They have rainwater harvesting system which captures the rainwater and instead of allowing it to run off to the local riverine system, it is fed to the local aquifer thereby reducing the depletion of ground water resources.

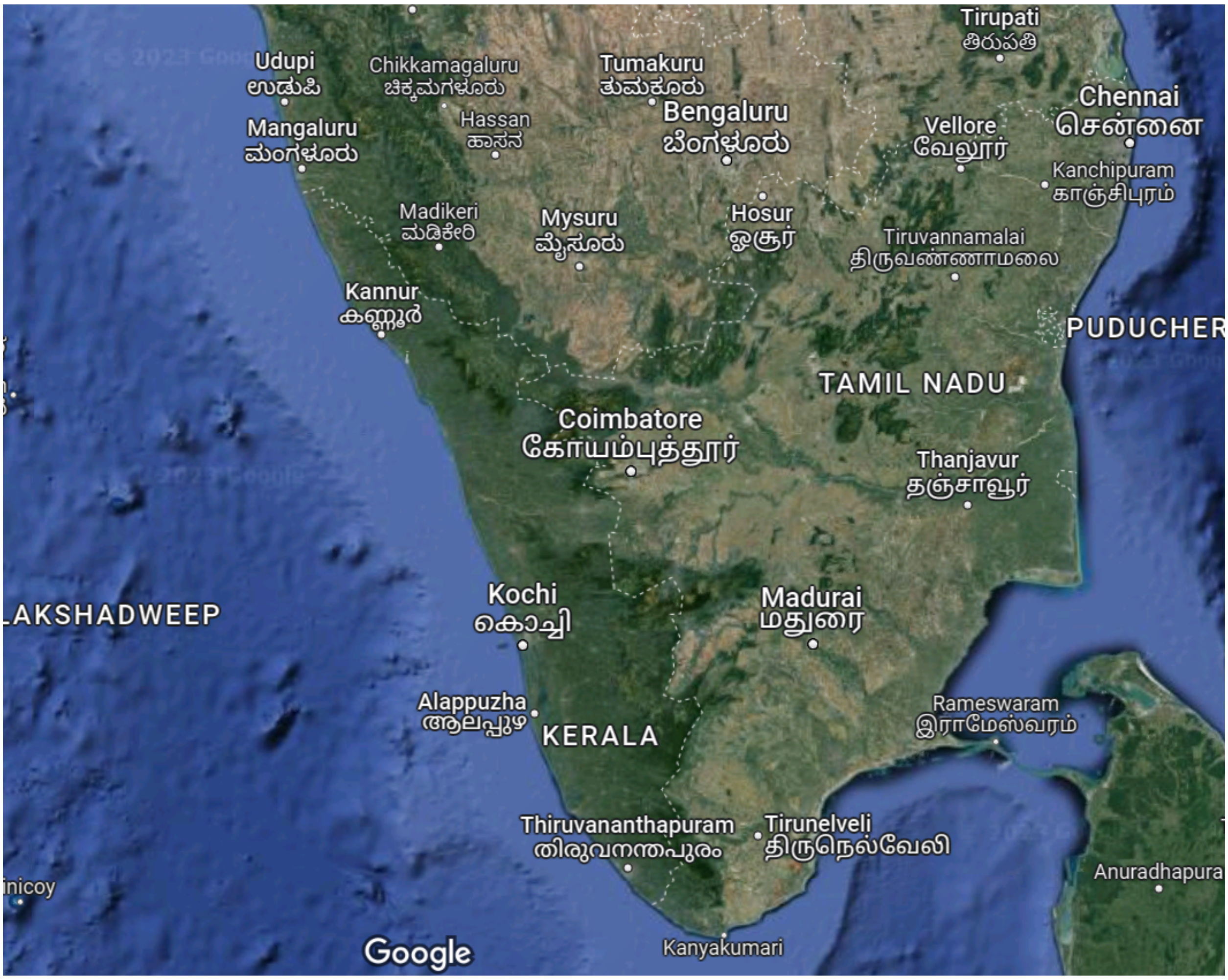

Fig: 1 Location of Kerala in India.

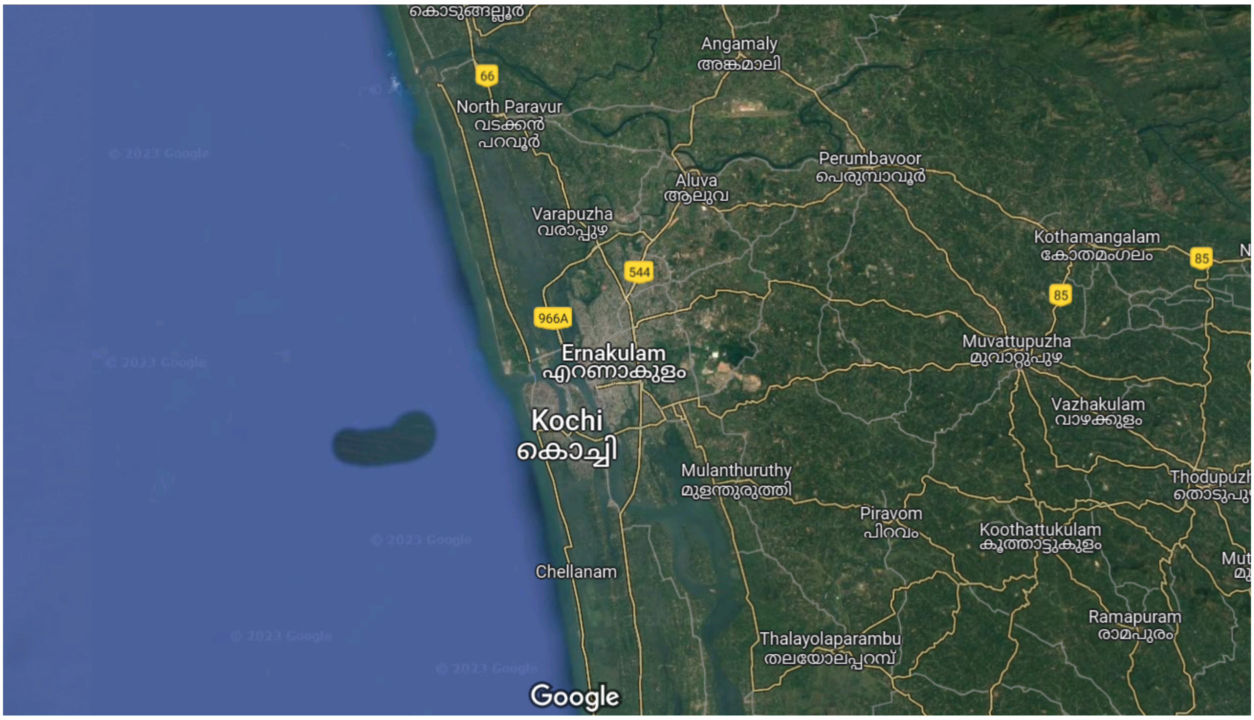

Fig: 2 Location of Kochi in Kerala

Fig 3: Location of Project in Kochi

A.2. Project owner information, key roles and responsibilities

Project Proponent and Owner (PP):	Good Earth Melange Owners' Association
Address:	Menon Parambu Rd, Edappally, Kochi, Ernakulam, Kerala 682024
Date PCNMR Prepared	**3rd January, 2024**

Project Proponent (PP) maintains the Rain Water Harvesting System (RWHS) during the rains and ensures that the flow valves are operated accordingly. PP is responsible for well cleaning, ensuring potable supply to surrounding users including uniform flow of rainwater during the monsoon period. PP maintains all the necessary permits and ownership documents for the recharge installations. The process of RWHS in this project activity is the most basic of systems that involves the installation of a harvesting system, which connects the main outlet of the building's terrace with a common pipe, leading to an open well, to store water and recharge the groundwater aquifer.

Roles & responsibilities:

The premises are operated by the owners' association (GEMOA) and they are responsible to operate the RWHS and all other sub-systems related to it. The cost of operation and maintenance of this system is part of the maintenance charges to the residential owners of the apartments.

A.2.1 Project RoU Scope

PROJECT NAME	Good Earth Melange
UWR Scope:	RoU Scope 3
Date PCNMR Prepared	3rd January, 2024
Catchment Area (Terrace of apartment complex)	924.611 m^2
Type of Well & Number	Open Dug Well & Two numbers
Diameter/Size of Well (mts)	1) 3 m 2) 1.5 m
Depth of Well (mts)	1) 4 m 2) 3.6 m
Month and Year of Construction	September 2017
Month and Year of Commissioning RWHs	April 2020
Device Used for Lifting Groundwater	Open well submersible pumps
Horse Power (Pump) HP	1 HP

The project activity **RWH for Well #N3406 Recharge at Good Earth Melange Owners' Association, Menon Parambu Rd, Edappally, Kochi, Ernakulam, Kerala 682024, India** is a rooftop RWHS for groundwater recharge via dilution to an open well located at:
Good Earth Melange Owners' Association,
Menon Parambu Rd, Edappally,
District: Ernakulam,
State: Kerala,
Country: India.
It is the one of the many residential complexes in the area involved in capturing rainwater.

In urban residential areas, the roof top rainwater can be conserved and used for recharge of groundwater. This approach requires connecting the outlet pipe from rooftop to divert the water to existing wells, as is the case in this project activity. The RWHS is located on the north side of the single dwelling residential unit which collects rainwater runoff from the sloping roof and diverts it directly to the open well within the project boundary. In doing so, it improves the quality of existing ground water through dilution with rainwater runoff, else which would have remained unutilized and wasted to sea due to rainwater runoff. Hence this is a good initiative for the conservation of the rainwater resources and groundwater recharge.

The rainfall runoff flowing from the roads and open grounds is substantial during the monsoon. This water often creates the water logging and the drainage system is put under stress in the urban agglomerates. This water ultimately flows out of the city and remain unutilised.

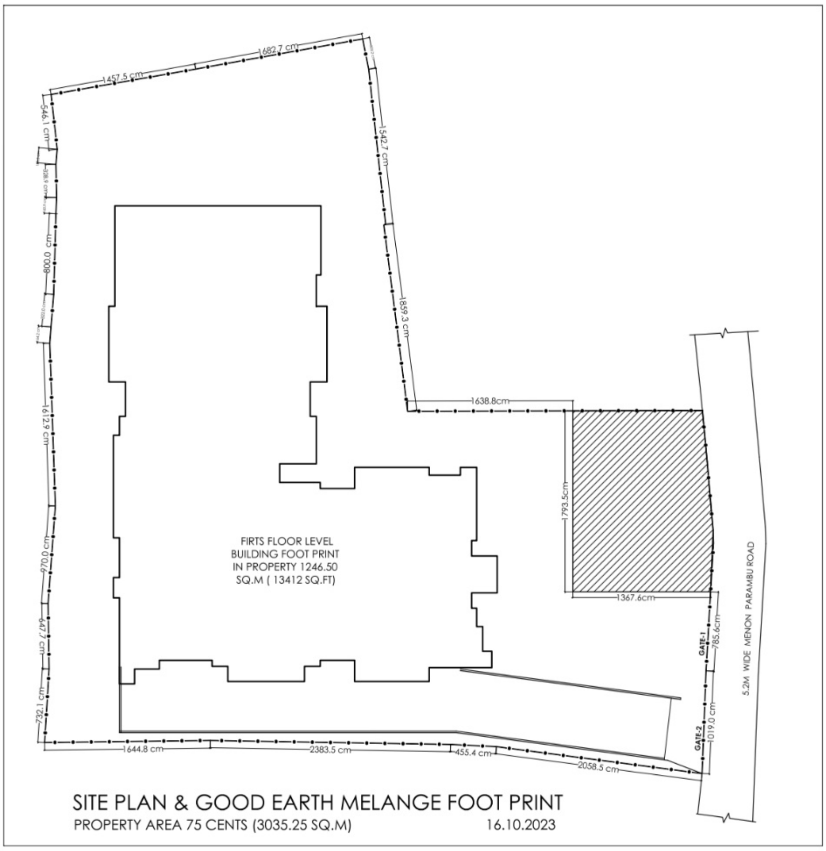

Fig 4: Project Boundary

A.3. Land use and Drainage Pattern

(i) Urban and Residential

Sr. No.	Basin	Place of Origin of Main River	Catchment Area (km^2)		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 Tamilnadu	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, Tamilnadu	2879
Total			**135735**	**38863**		**37**		**38863**

Kerala, a state on India's tropical Malabar Coast (10.1632° N latitudes and 76.6413° E longitudes), has nearly 600km of Arabian Sea shoreline. It is spread over 38,863 km^2 and it is divided into 14 districts. This state is known for its palm-lined beaches and backwaters, a network of canals, the Western Ghats, mountains and rich in tea, coffee and spice plantations, as well as unique wildlife.

Kerala has a wet and maritime tropical climate influenced by the seasonal heavy rains of the south-west summer monsoon and north-east winter monsoon. Around 65% of the rainfall occurs from June to August corresponding to the south-west monsoon, and the rest from September to December corresponding to north-east monsoon, with around 120–140 rainy days per year.

The state is situated between Arabian Sea to the west and western ghats mountain ranges to the east. The state's coastline extends for 595 Km, around 11 lakh population of the state is dependent on the fishery industry, which contributes 3% to the state's income. Named as one of the ten paradises of the world by National Geographic Traveler, Kerala is one of the prominent tourist destinations of India, with coconut-lined sandy beaches, backwaters, hill stations, Ayurvedic tourism and tropical greenery as its major attractions.

Hydrology

The traditional homestead type of habitation in Kerala is generally characterised by a well in each compound to tap groundwater. Therefore, it is estimated that the state has around 65 to 70 lakh nos. of wells. The well density in Kerala is very high, which is of the order of 200/km2 in the coastal areas, 150/ km2 in the midland areas, and 70/km2 in the highland regions (CWRDM, 1995), which increases to above 400 wells/km2 in certain stretches of coastal areas (CESS, 1995). This must have increased significantly by now. 65% of the rural households and 59% of the urban households depend on wells for the purpose of their drinking water needs (Census, 2011). In addition, 50% of the irrigation requirement is dependent on groundwater (KSPB, 2012). However, the occurrence and availability of groundwater in the state varies considerably across regions.

River Basins

Out of total 44 rivers in the state of Kerala, 41 flow westwards and the rest towards east. The basin area of major rivers is located within the western ghats, a global biodiversity hotspot, while some other northern rivers originate in laterite hills.

The country's longest lake Vembanad, dominates the backwaters, it lies between Alappuzha and Kochi and is about 200 km^2 in area. Around 8%of India's waterways are found in Kerala. Kerala's 44 rivers include the Periyar 244 km., Bharathapuzha 209 km., Pamba 176 km., Chaliyar 169 km., Kadalundipuzha 130 km., Chalakudipuzha 130 km., Valapattanam 129 km. and the Achankovil River 128 km. The average length of the rivers is 64 km. Many of the rivers are small and entirely fed by monsoon rain. As Kerala's rivers are small and lacking in delta, they are more prone to environmental effects. The rivers face problems such as sand mining and pollution. The state experiences several natural hazards like landslides, floods and droughts. The state was also affected by the 2004 Indian Ocean tsunami, and in 2018 received the worst flooding in nearly a century.

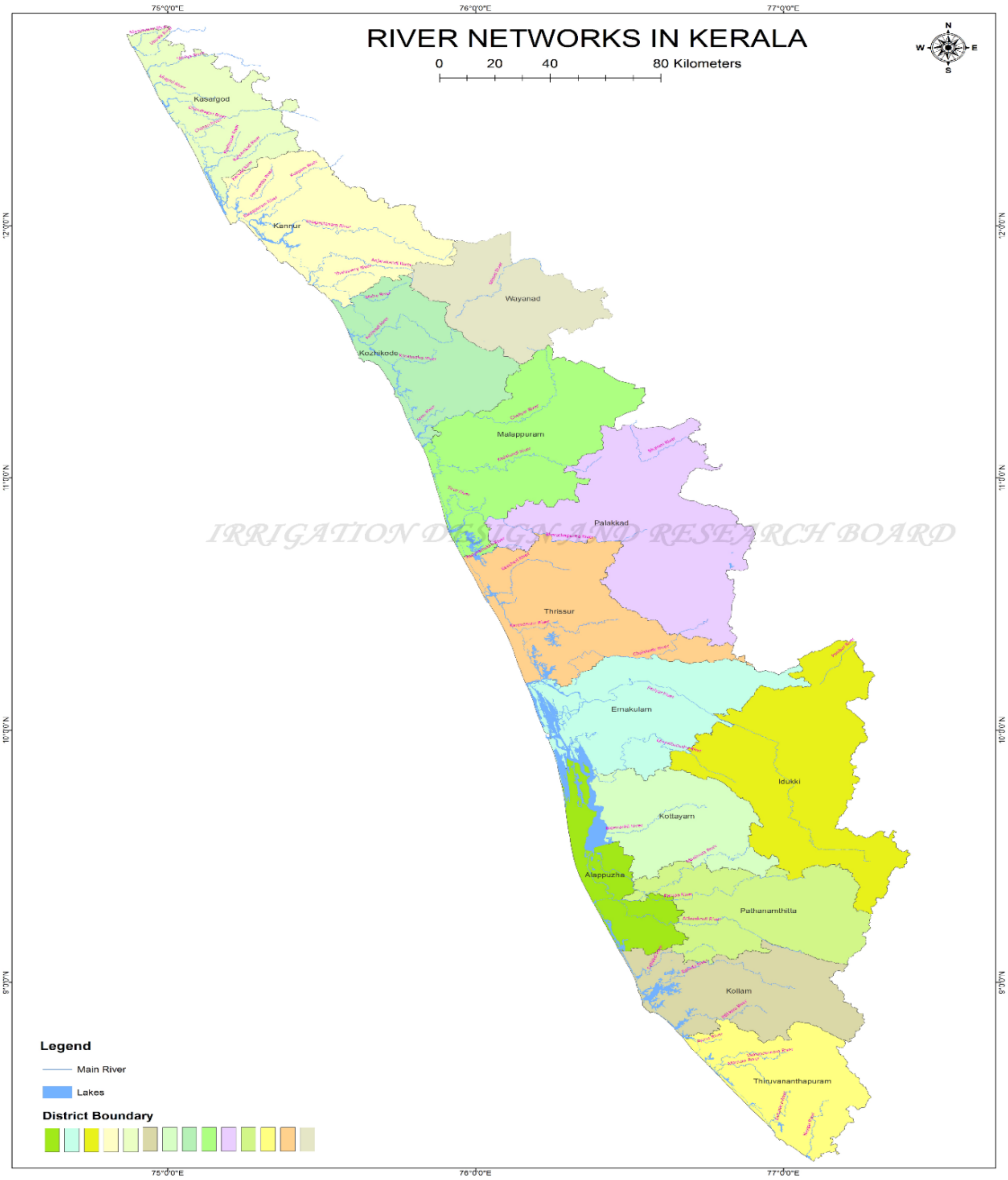

Fig 5: Rivers in Kerala

A.4. Climate

Climate type: Tropical Monsoon

With around 120–140 rainy days per year, Kerala has a wet and maritime tropical climate influenced by the seasonal heavy rains of the south-west summer monsoon and north-east winter monsoon. The moisture-laden winds of the south-west monsoon, on reaching the southernmost point of the Indian peninsula, because of its topography, divides into two branches: the "Arabian Sea Branch" and the "Bay of Bengal Branch". The Arabian Sea Branch of the south-west monsoon first hits the Western ghats, making Kerala the first state in India to receive rain from the south-west monsoon. The distribution of pressure patterns is reversed in the north-east monsoon, during this season the cold winds from north India pick up moisture from the Bay of Bengal and precipitate it on the east coast of India. The influence of the north-east monsoon is seen in southern districts only. During the summer, the state is prone to gale-force winds, storm surges, cyclone-related torrential downpours, occasional droughts, and rise in sea level. The mean daily temperature ranges from 19.8 °C to 36.7 °C and mean annual temperatures range from 25.0 to 27.5 °C in the coastal lowlands to 20.0–22.5 °C in the eastern highlands.

A.5. Rainfall

Around 65% of the rainfall occurs during the months of June to August corresponding to the south-west monsoon, and the rest from September to December corresponding to north-east monsoon. Kerala's rainfall averages 2,923 mm annually. Some of Kerala's drier lowland regions average only 1,250 mm; the mountains of the eastern Idukki district receive more than 5,000 mm of orographic precipitation: the highest in the state. In eastern Kerala, a drier tropical wet and dry climate prevails.

Year	Rainfall (mm) Ernakulam	Data/ value applied
2016	2326	Conservative data selected as per operation data map below, vs district rainfall figures. Customized Rainfall Information System (CRIS), Hydromet Division India, Meteorological department, Ministry of Earth Sciences.
2017	2991	
2018	3874	
2019	3380	
2020	3503	
2021	3949	
2022	3345	
2023	3623	

A.6. Ground Water

ERNAKULAM DISTRICT AT A GLANCE

Sr. No.	Items	Statistics
1.	**GENERAL INFORMATION**	
	i) Geographical area, sq km	3068.
	ii) Administrative Divisions Number of Taluks Number of Blocks Number of Municipalities Number of Gram Panchayats Population (as per 2011 census)	 7 14 11 88 32,79,860
2.	**GEOMORPHOLOGY**	
	Major physiographic units	Coastal Plain, Midland and High land
	Major Drainages	Periyar and Muvattupuzha rivers and their tributaries
3.	**LAND USE (AS ON 31-3-2021)**	
	a) Forest area (ha)	70619
	b) Total cropped area(ha)	175552
4.	**MAJOR SOIL TYPES** Parur, Kochi and Kunnathunad taluks Parts of Aluva and Kunnathunad taluks Muvattupuzha, Kothamangalam and parts of Aluva andKunnathunad taluks	Coastal Alluvium Riverine alluvium Brown hydromorphic soilLateritic soil
5.	**PRINCIPAL CROPS**	Paddy Coconut Fruits Spices Rubber
6.	**IRRIGATION BY DIFFERENT SOURCES, Area inha (AS ON 31-3-2021)**	
	Wells	6936
	Tanks	1967
	Canals	11250
	Tube well	461

	Minor Irrigation	3592
	Other Sources	2233
	Net Irrigated area	26825
7.	**NUMBER OF GROUNDWATER MONITORING WELLSOF CGWB (AS ON 31-3-2021)** No. of Dug wells No. of Piezometers	44 19
8	**PREDOMINANT GEOLOGICAL FORMATIONS**	Archaean Crystalline formation (Charnockite group& migmatite group), Tertiary sedimentary formation, Sub-Recent lateriteand Recent alluvium.
9.	**HYDROGEOLOGY** Major Water bearing formation	Weathered, fractured crystalline formations; semi consolidated Tertiary formations, laterites and Recent alluvium.
	Average depth to water level (Pre-monsoon, 2012-21)	0.75 to 12.05 mbgl.
	Average depth to water level (Post-monsoon, 2012-21)	0.54 to 10.42 mbgl.
	Long term water level trend in 10 years cm/yr.	No conspicuous trend except Vytilla block showing declining trend of 23.72 cm/yr. in pre-monsoon and 17.52 cm/yr. in post-monsoon
10.	**GROUND WATER EXPLORATION BY CGWB (As on 31-03-2021)**	
	No. of wells drilled (EW, OW, PZ, SH, Total)	EW – 34 OW-3, PZ –21, Total – 58
	Depth Range (m)	54 – 295.6
	Discharge (litres per minute)	6 – 1320
	Transmissivity (m^2/day)	4.72 -818
11.	**GROUND WATER QUALITY**	
	Presence of chemical constituents more than permissible limits	Quality is good in general. Major chemical constituents lie within the permissible limits.
12.	**DYNAMIC GROUNDWATER RESOURCES (2019) – in ha.m**	
	Annual Replenishable Ground Water Resources	61572.06

	Gross Annual Groundwater Draft	23975.68
	Projected demand for Domestic and Industrial Uses up to 2025	15254.34
	Stage of Ground Water Development, %	43.02
13.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	• Saline water ingress is observed in the shallowalluvial aquifer in the western part of the district which is inhydraulic connection with the back water. • Water logging along the western border of the district bordering the back water lagoons during the rainy season. • Brackish quality of groundwater alongtidal inlets. • Anthropogenic pollution.

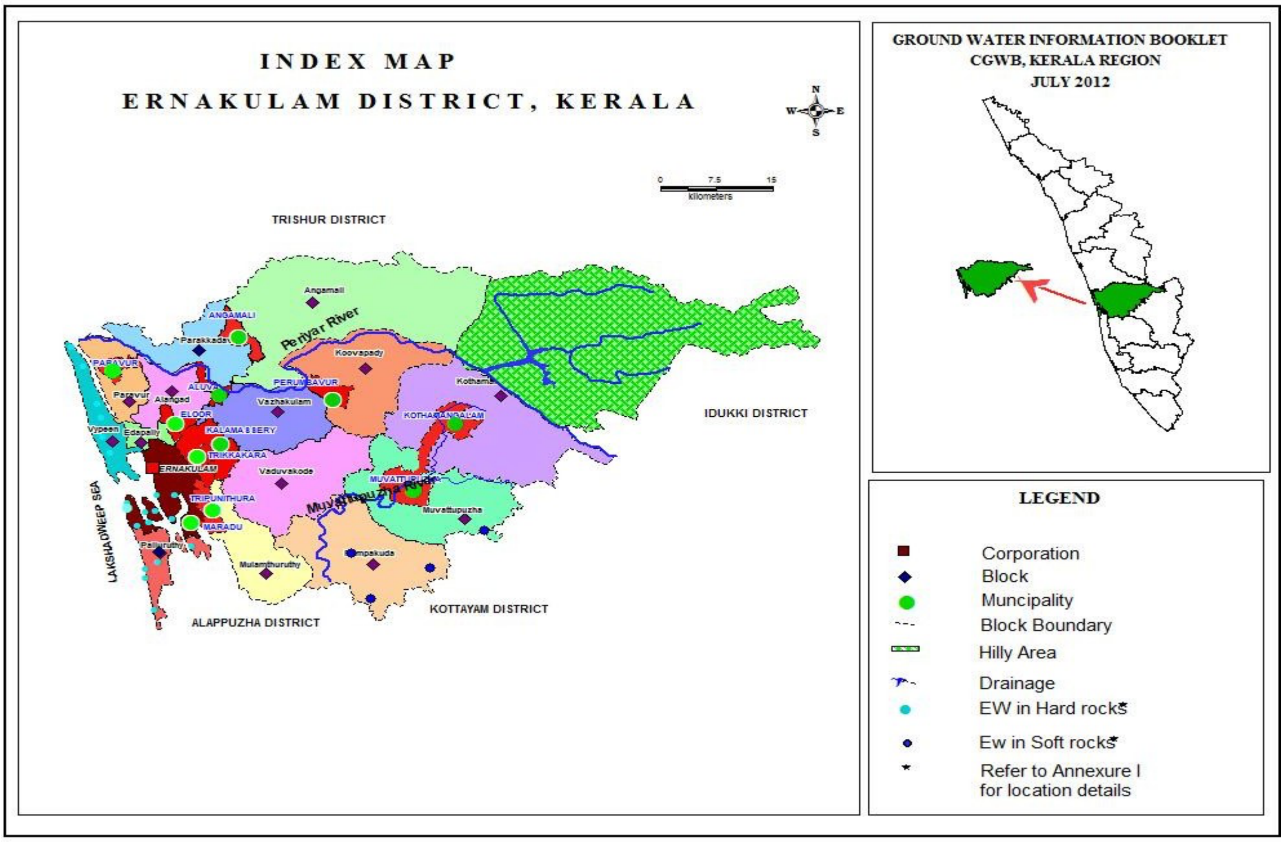

Fig 6: Index map of Ernakulam, Kerala

A. Drainage and Irrigation

The district is drained by the Periyar and its tributaries in the north and Muvattupuzha River in the south. Periyar, the longest river in the state with a total length of 244 km originates from the cardamom hills of the Western Ghats flows in a Northerly direction initially and then in North-west direction as it flows through Idukki district before entering Ernakulam district at Neriamangalam. In the district the river takes almost a straight line course roughly in a North Western direction and at near Bhuthathankettu dam, it is joined by major tributaries Cheruthoni and Idamalayar. Further downstream at Aluva, the river bifurcates into two: the Marthandavarma and the Mangalapuzha branches. The Mangalapuzha branch joins Chalakkudy river and empties into the Lakshadweep Sea at Munambam, and the Marthandavarma branch flows southwards, through the Udhyogamandal areaand joins the Cochin backwater system (part of Vembanad Lake) at Varapuzha. The Periyar is a perennial river and is source of drinking water for several major towns. The Idukki dam across the Periyar generates a significant proportion of Kerala's electrical power.

The Muvattupuzha River is formed by the confluence of Thodupuzha River, Kaliyar River and Kothamangalam River at Muvattupuzha. These rivers originate from the Thodupuzha reserve forest. The Muvattupuzha River takes a rough east-west course up to Ramamangalam and thereafter it flows towards south leaving the districts south of Pazhur. In the upstream areas the drainage pattern in both Periyar and Muvattupuzha basin are trellis to sub-trellis. In the lower reaches dendritic pattern of drainage is observed.

Vembanad Lake; Ernakulam district is bordered to south-west by Vembanad Lake which is the largest lake in Kerala. Besides Ernakulam, the lake is bordered by Alappuzha and Kottayam districts. The lake is separated from the Lakshadweep Sea by a narrow barrier island and opens to the sea at Cochin. And at Munambam further north. The port of Kochi (Cochin) is located at the lake's southern outlet to the Sea. The stretch from *Kochi Azhi* to *Munambam Azhi*, is popularly known as Varapuzha. Canals link the lake to other coastal lakes to the north and south. The portion of the Vembanad Lake located in and around the Kochi mainland is known as Kochi kayal. The lake bears many an islands and in Ernakulum district itself it hosts island like Vypin, Mulavukad, Vallarpadam, Willingdon Island etc. The lake is a part of Vembanad-Kol wetland system which extends from Alappuzha in the south to Azheekkode in the north, making it by far, India's longest lake at just over 96.5 km in length. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely the Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar. The total area drained by the lake is 15,770 km², which accounts for 40% of the area of Kerala. Its annual surface runoff of 21,900 mm accounts for almost 30% of the total surface water resource of the state.

The lake has become a major tourist location due to its scenic beauty. The Vembanad Wetland system is the largest of the three Ramsar Sites in the state of Kerala. But Vembanad Lake has been heavily reclaimed over the course of the past century with the water spread area reduction. The lake faces a major ecological crisis and has reduced to 37 per cent of its original area, as a result of land reclamation.

Land Use, Irrigation and cropping pattern

About 83% of the total area of the district is cultivable land, 10% is under forest cover including reserve forest and plantations; water bodies constitute 5.3% and built up area constitutes nearly 2% ofthe total area. The land use pattern of the district is given in **Table 1** below

Table 1: Land use pattern of Ernakulam district as on 2019-21

Sl. No.	Head of classification	Area In hectares
1	Total Geographical area	305826
2	Forests	70617
3	Land put in non-agricultural use	30750
4	Barren and uncultivable land	1193
5	Permanent pastures and other grazing land	7
6	Land under miscellaneous tree crops (not included in net area sown	133
7	Cultivable waste	9938
8	Fallow land other than current fallow	7150
9	Social Forestry	10876
10	Net area sown	158763
11	Area sown more than once	16789
12	Total cropped area	175552

An area of 26,825 hectares is under irrigation (net area) in the district. Periyar valley irrigation project with a barrage at Bootathankettu which uses the tail race water of Sengulam, Panniyur and Pallivasal Hydro-electric projects and Chalakudy diversion project are source for canal irrigation in the district. Area irrigated by different source of Irrigation is given in **Table 2.**

Table 2: Area irrigated by different source of Irrigation (2019-21)

Canal	Tank	Wells	Minor Irrigation	Tube wells	other	Total
11250	1967	6936	3592	461	2233	26825

The major crops under irrigation in the district are paddy, coconut, rubber, banana and arecanut. Paddy is cultivated in more than one season. The crop wise area under irrigation is presented in **Table 3**

Table 3: Crop wise area under irrigation (2019-21)

Crop	Paddy	Coconut	Fresh Fruits	Rubber	Spices	Others	Total
Area in	10787	44475	25891	58729	17303	18367	175552

hectares							

(Source: Report on Agricultural Statistics by Dept. of Economics and Statistics)

Rubber is the major crop in the district followed by Coconut, Paddy, and Banana. Spices, Areca nut,oil seeds and vegetables are also cultivated in the district.

RAINFALL AND CLIMATE

Rainfall

Ernakulam district has wet monsoon type of climate. The district experiences heavy rainfall during southwest monsoon season followed by northeast monsoon. During the other months the rainfall is considerably less. March, April and May are the hottest months. December to February are the coldest months

The district receives on an average 3359.2 mm (based on 1901-2000 data) of rainfall annually. The annual rainfall ranges from 3233 to 3456 mm at different places of the district.

The rainfall is less in the western part of the district and gradually increase towards the east.Maximum rainfall is received around Neriamangalam area in the eastern part where the normal annual rainfall is found to be 5883 mm. While Kochi, which is in the western part receives around 3233 mm rainfall annually. The annual average rainfall of Ernakulam district from 2017 to 2021 is given in **Table 4**

South-west monsoon season contributes nearly 67.4% of total rainfall of the year, followed by the north-east monsoon which contributes nearly 16.6% and the balance of 16% is received during the month of January to May as summer showers. The Average monthly rainfall distribution for Ernakulam district (2017 to 2021) is given in **Table 4.**

Table 4: Average Monthly Rainfall (mm) of Ernakulam District (2017 -2021)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2017	1.9	1.4	9.2	146.5	193.5	815	1133	480.1	667.3	522	66.1	9.8	2883.9
2018	3	30.8	329.6	129.1	137.7	455.1	539	326.2	555.1	304	37.4	36.9	4045.8
2019	10.4	0	45.8	89.5	315.7	615.1	839	312.2	497.4	177	290	70.1	3262.2
2020	9.8	0	30.5	233.8	239.9	849.9	691	356.5	456.9	625	517.5	63.2	4074
2021	26	98	37	201	187	896	619	593	528	161	120	34	3500

Maximum rainfall is received in the month of June or July with July 2017 recording the maximummonthly rainfall of 1133mm. Minimum rainfall is received in the month of January or February.

Meteorological Parameters

Temperature

The mean monthly maximum temperature ranges from 28.1 to 31.4°C and the minimum ranges from 23.2 to 26 °C. The maximum temperature occurs during March and April months and the minimumtemperature occurs during December and January months.

Relative Humidity

The humidity ranges from 68 to 89% during morning hours and 64 to 87% during evening hours.The maximum humidity is observed during May to October months.

Evaporation

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

Sunshine Hours

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

Wind

The wind speed ranges from 6.7 to 10.9 km/hour with mean speed of 9.1 km/hour. The wind speed is high during the period from March to September.

Potential Evapotranspiration (PET)

The PET ranges from 94.5 to 159.2 mm. The maximum PET occurs during March and minimum occurs during June. The PET is less than the rainfall from May to November indicating water surplusfor recharge into ground water regime.

GEOMORPHOLOGY AND SOIL

The district can be broadly divided into three physiographical units viz. (1) the Coastal plains (low lands) (2) the mid lands and (3) the high lands. The general elevation of the coast is less than 8.0m. amsl and that of the midlands is between 8.0 and 76 m. amsl. The highlands are having the general elevation above 76 m with the maximum of around 504 m. amsl. The entire taluks of Kochi and Parur and major parts of Kanayannur fall under the coastal plain. The municipalities of Paravur and Tripunithura the township of Kalamasseri and the corporation of Kochi are located in the coastal plains. All the other taluks except the north-eastern parts of Kunnathunad taluk fall under the mid land area. The high land belt of the district is the Malayattoor reserve forest in Koovappady block, which covers about 9% of the area of the district.

The Coastal belt is dotted with a host of islands ranging from largest Vypin islands of length 27 km to, smaller islands like Mulavukad, Vallarpadam, and Willingdon Island etc.

The western coast of Vypin has the longest beach in Kochi namely, the Cherai Beach. The northern tip of Vypin (Munambam) has the largest fishing harbour in Kochi namely, the Munambam Fishing Harbour. Vypin is home for harbour related industrial establishments like, the SPM project of the Kochi Refineries, and the Puthuvyp LNG Terminal.

Pedology

On the basis of morphological features and physico-chemical properties, the soils of the district are classified as Lateritic, Hydromorphic saline, Brown hydromorphic, Riverine alluvium and Coastal alluvium.
Lateritic soil is the most predominant soil type of the district. In Muvattupuzha, Kothamangalam, Kunnathunadu and parts of Aluva taluks lateritic soil is encountered. These soils are well drained, lowin organic matter and plant nutrients. The major crops grown are coconut, tapioca, rubber, arecanut, pepper, cashew and spices. Small patches of hydromorphic saline soil are encountered in the coastal tracts of the district in Kanayannur and Cochin taluk. The tidal backwaters contribute to the salinity of the soil. Coconut is grown in these soils.

Brown hydromorphic soil is the second most prevalent soil type of the district and they are encountered in valley bottoms. The soil is enriched in clay content and plant nutrients. The soil is suited for paddy cultivation.

Riverine alluvium is restricted to the banks of rivers and their tributaries. They are composed of sandy to clayey loam and are enriched in plant nutrients. It is suited for a large variety of crops like coconut, paddy arecanut, pepper, vegetables etc. In Cochin taluk and the western parts of Paravur and Aluva taluk coastal alluvium is encountered and is composed of sand and clay. Coconut is the major crop in these soils.

GROUND WATER SCENARIO

Hydrogeology

Groundwater generally occurs under phreatic conditions in weathered and fractured crystalline rocks, laterites and unconsolidated coastal sediments. It occurs under semi-confined to confined conditionsin the deep seated fractured aquifer of the crystalline rocks and Tertiary sediments. The weathered zone in the crystalline below acts as good storage for groundwater.

Based on nature of formation, the aquifer can be classified into hard rock aquifers and sedimentary aquifers.

Hard Crystalline Formation

Groundwater occurs under phreatic conditions in the shallow weathered portions whereas it occurs under semi confined to confined condition in the deep-seated fractures of the crystalline formation. The hard rock formations in general lack primary porosity. The water is stored in the secondary poresdeveloped as a consequence of weathering in fractures, fissures and joints etc. The movement of groundwater is controlled by the extent of the interconnection of the fractures.

In the shallow phreatic zone, the depth of dug wells varies from 3.4 to 14.8 mbgl. The depth to water level in the wells ranges from 1.82 to 12.05 mbgl.

The Central ground water board has drilled 7 exploratory wells in the hard rock areas of the district asa part of its exploration programme to explore the deeper confined aquifer. The depth of the wells ranged from 131 to 201 mbgl. Most of these wells were drilled in the Charnockitic area. The details of wells drilled in Hard rock area of the district is presented in Appendix – I. Fracture zones were encountered at depth ranging from 5 – 194 mbgl with yield ranging from 1 to 22 lps. The studies have indicated that the wells located at intersections of lineaments are most potential. Among the lineaments the E-W, NNE – SSW and NE – SW lineaments are potential whereas the NNW – SSW are least potential lineaments. The deep fractured rock has transmissivity ranging from 15.64 to 319 m^2 /day.

Sedimentary formations

The sedimentary formations are confined to the coastal belt and the potential aquifers occurring at depth among are the Warkali and Vaikom beds.

Warkali Beds

The Warkali beds of the Tertiary formation are found to constitute aquifers of semi-confined to confined aquifers. In Ernakulam district, they are least extensive and are restricted to the southern coastal belt with thickness thinning out from South to North from 106.7m at chellanum in south to less than 13 m in north at Panangad. The Warkali aquifers are essentially composed of fine to medium grained sand. However, in the district the formation water is found to be of brackish nature and not worth to be tapped except along certain pockets in and around Kumbalangi area. The central ground Water Board has constructed an exploratory well at Kumbalangi which is tapping the warkalaiaquifer and also the Vaikom aquifer. The total dissolved constituents of the groundwater are found to be 1379 mg/l.

Vaikom Beds

The Vaikom beds are potential confined aquifers and are generally separated from the overlying potential Warkali formations by confining Quilon beds except in the northern portion of the district where the Vaikom beds are underlying the Coastal alluvium or Laterite. The Vaikom beds are composed of thick sequence of coarse to very coarse sand, gravel and pebble beds intercalated with ash, grey clay and carbonaceous clay. They extent North to South in the coastal belt with thickness increasing from 18 m at Panangad in north to 151 m at Chellanum in south. The wells tapping coarse sand and gravel aquifers of Vaikom formation with granular zones 6 to 14 m thick have yield ranging from 1.2 to 10.1 lps and transmissivity of aquifer ranges from 193.6 to 818 m^2/day. Some of the wells were flowing wells at the time of construction.

The beds are coarse grained in nature. The quality of groundwater from these beds is brackish in nature with EC varying from 4000 to 17,300 μ Siemens/cm at 25^0C. In small restricted pockets like Narakal, Subash Park, Naval base and Kumbalangi the water is fresh.

Laterite

The laterite are vastly occurring in the mid land areas of the district by weathering of the crystalline formation and also at depth in the sedimentary formation in the coastal belt. Along the coastal belt, they are discontinuous and are found to be eroded at places and generally they occur as a horizon between the Recent alluvium in top and Warkali beds or Vaikom beds below at depth ranging from20 to 56 mbgl.

The laterites are highly porous and permeable. It is extensively developed by dug wells in the mid land area for domestic and to a limited extent for irrigation. The depth of wells in laterite ranges from 3.4 to 14.8 mbgl and depth to water level ranges from 1.55 to 11.06 mbgl. Wells located on slopes and elevated areas go dry or have very small water column during summer season. The yield of well ranges from 0.5 to 6 m^3/day and sustain pumping for 3 to 4 hrs. a day.

Alluvial Formations

The alluvial formations occurring in the coastal belt are constituted by sand, silt, clay of the lagoonaland back water deposits, beach deposits and the river/flood plain deposits in mid land areas. The thickness ranges from less than 1m to 54 m at Kandakadavu in south. It forms potential phreatic aquifer extensively developed by dug wells and filter point wells. They are tapped to meet domestic and other needs. The dug wells range in depth from 2.14 to 13 m in general and depth to water level range from 0.35 to 7.03 mbgl. The dug wells have an average yield ranging from 15 to 20 m^3/day.

Filter point wells are common wherever the average saturated thickness of alluvial sand exceeds 5 m and have depth ranging from 5 to 15 mbgl. They have yield ranging from 12 to 18 m^3/day.

Water levels

The Central Ground Water Board is maintaining a total of 70 NHS in Ernakulam district. Of these 49are dug wells and 21 are piezometers. They are monitored 4 times a year i.e., during January, April, August and November. Water samples are collected annually during April (pre monsoon) foranalysis and analysed for major elements and other parameters.

Average depth to water level (2012-21)

The depth to water level in the district shows wide variation on account of the physiographical unitsin which the wells are located and undulating terrain in the mid land. Water level is shallower in western coastal part and is less than 2 mbgl in general although occasionally it is deeper at around 4to 4.5 mbgl except for a small pocket in and around Chengamanad where it is more than 11 mbgl. The average depth to water level for the different blocks in the district for the period 2012 to 2021 is given in table below.

Table 5 Block-wise decadal average depth to water level Ernakulam district (2012-21)

Sr. No	Block Name	Average Depth to Water Level (2012-21)	
		Pre-monsoon (April)	Post-monsoon (November)
1	Alangad	2.43	1.50
2	Angamaly	6.42	6.42
3	Edapally	3.87	3.40
4	Koovapady	6.63	5.46
5	Kothamangalam	4.15	3.41
6	Mulamthuruthy	6.16	4.35
7	Palluruthy	1.84	0.94
8	Pampakkuda	5.85	4.87
9	Muvattupuzha	6.58	4.45
10	Parakkadavu	6.93	5.10
11	Paravur	1.46	0.61
12	Vaduvakode	5.19	5.15
13	Vazhakulam	5.69	5.00
14	Vypeen	1.01	0.63

Figures 7 and 8 shows the average depth to water table of Ernakulam district for pre monsoon for the decade (April 2012-2021) and Post monsoon (November 2012-2021).

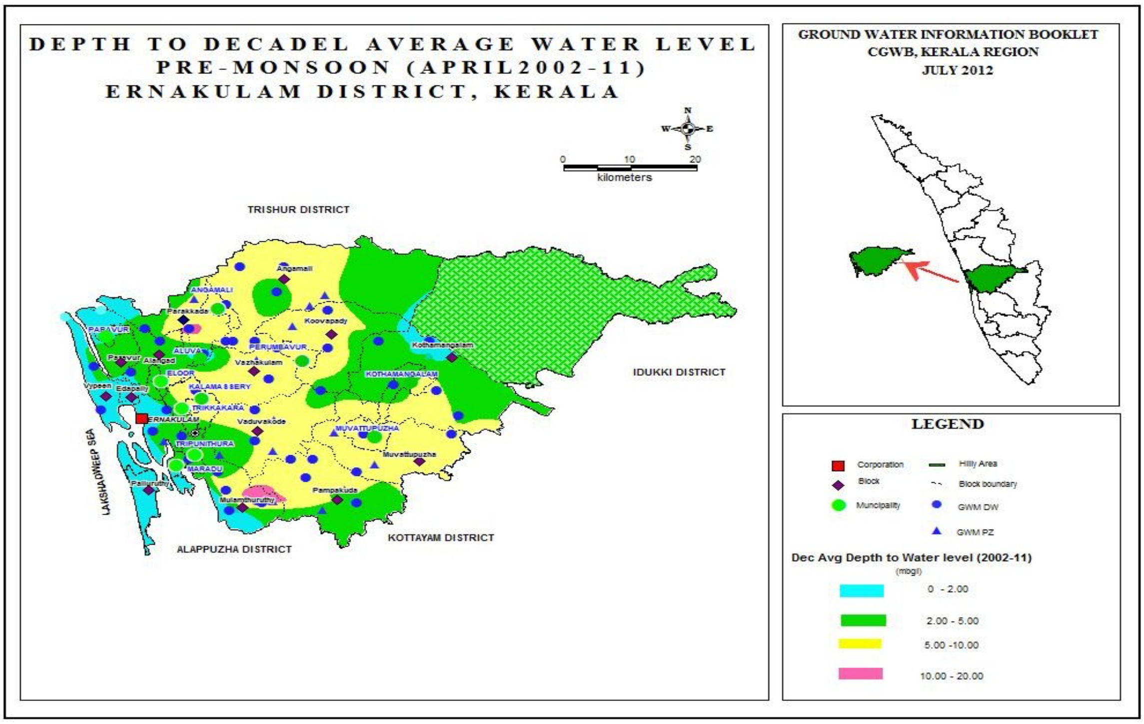

Fig 7: Pre-Monsoon average depth to water level of Ernakulam District April (2012-21)

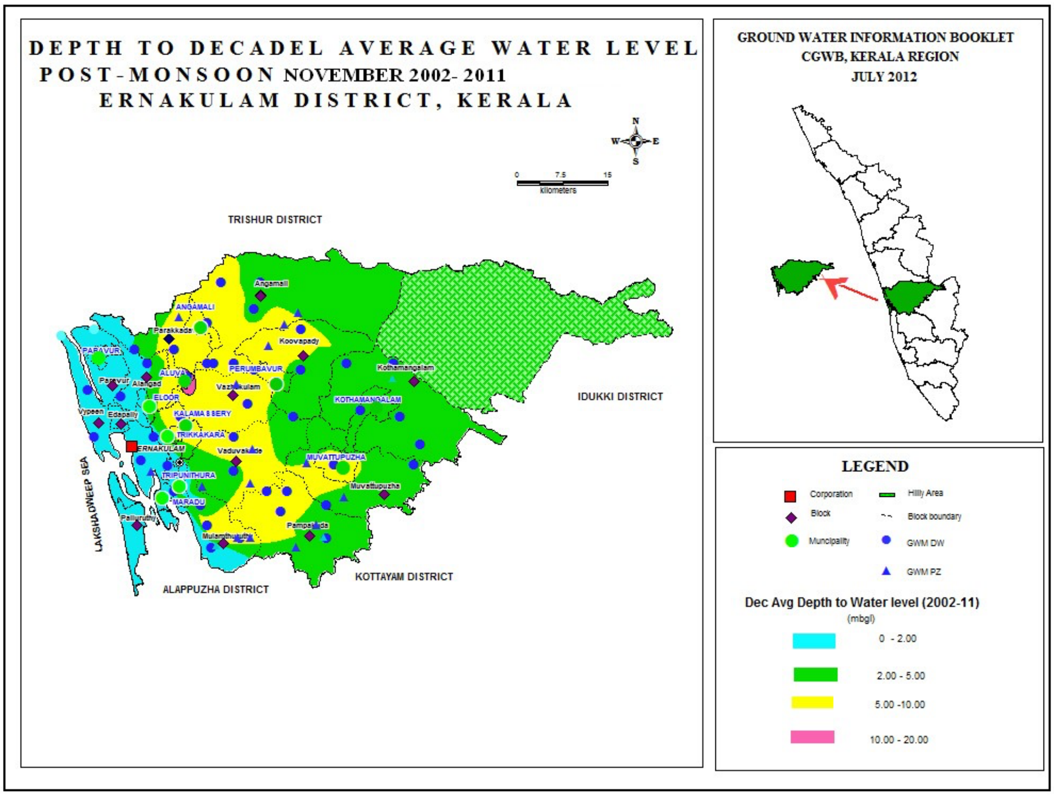

Fig 8: Post-Monsoon average depth to water level of Ernakulam District November (2012-2021)

In the Coastal Plains the water level is shallow and restricted to less than 2mbgl.

In the eastern part of the district also it is observed that the water level is shallow and is following the riverine alluvial belt of Periyar River. In the midland region the water table is between 5 and 10 mbgland at isolated pockets and is found to be deeper levels of more than 10 m depth.

Compared to the pre monsoon period, in the post monsoon period the water level has risen in general. In the coastal belt, the water level is very shallow and less than 2 mbgl throughout. Besides in most areas of the district the water level has risen and is at depth of less than 5 mbgl. However, in the isolated pockets in the northwestern segment of the district it is deeper than 10 m.

Long term trend analysis in water level

The long term behaviour of water level in dug wells is mainly controlled by the rainfall rechargereceived and also the return seepage due to canal flow and irrigation.

The pre-monsoon water level trend reflect the trend of groundwater development, the post monsoon water level trend brings out the actual rise or fall in the area. The change in water level is considered to be significant if there is a fall of more than 15 cm/year. The block-wise long term water level for pre-monsoon does not show any conspicuous change in water level except Vytila block. Six blocks show rising trend ranging from 4.99 cm/year for Palluruthy block to maximum 17.89 cm/year for Mulamthuruthy block and nine blocks show declining trend ranging from 0.98 cm/year for Vazhakulam block to 23.72 cm/year for Vytilla block. The hydrogeological map of Ernakulam district is shown in **Figure 9**.

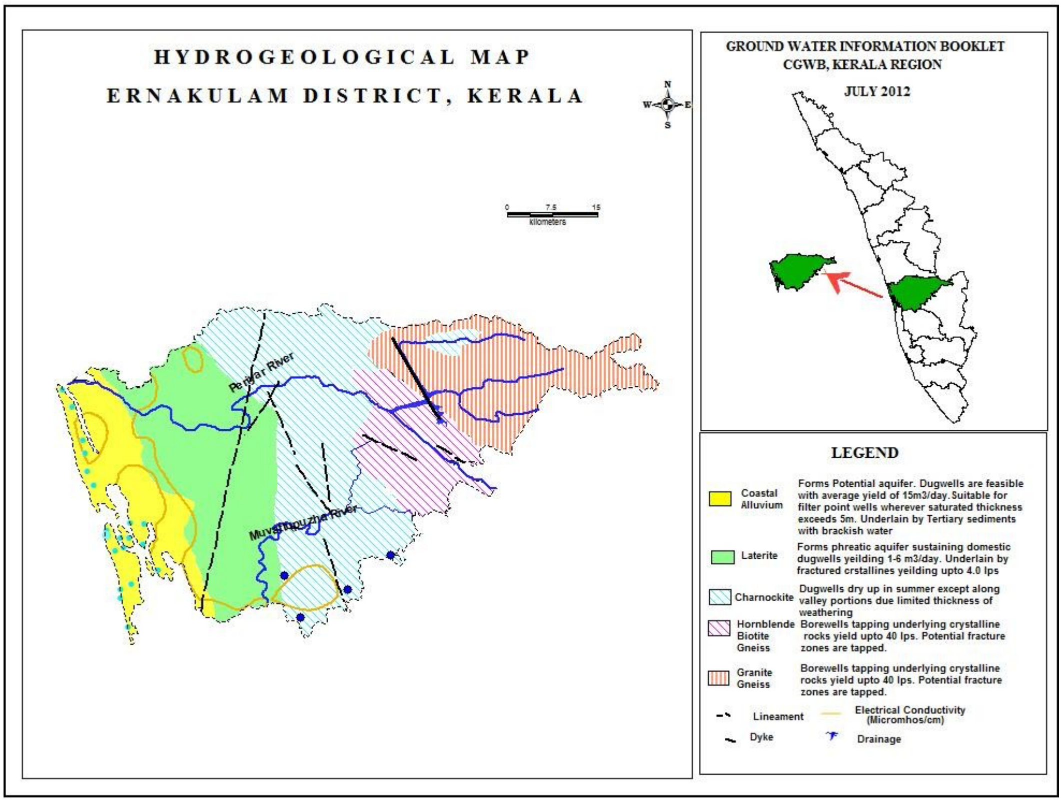

Figure 9: Hydrogeological map of Ernakulam district

Ground Water Resources

Ground water Recharge

The groundwater resource of the district was computed jointly by CGWB and State Ground Water Department as on March 2009, as per the guidelines of the Ground water estimation Methodology 1997. The total annual recharge of groundwater has been computed block- wise using average water level fluctuation in Ground Water Monitoring Wells and Specific yield of the respective aquifers for 2blocks and Rainfall Infiltration method for 13 blocks. The net annual groundwater availability is 557.35 MCM. The resources available varied from block to block depending on the geographical areaof the block and ranges from 14.07 to 57.45 MCM. The block wise details of total recharge and the net available recharge are presented in **Table 6.**

Table 6 Net Annual Ground Water Availability (MCM) as in March 2009

Sl. No	Block	Total Annual Recharge	Net Annual GW Availability	Existing gross GW draft for ...	Existing gross GW draft for domestic & ...	Existing gross groundwater draft for all uses	Stage of GW developme...	Categorization for future GW development
1	Alangadu	25.88	23.29	5.66	8.33	13.99	60.05	Safe
2	Angamaly	56.86	51.18	9.10	10.93	20.04	39.15	Safe
3	Edappali	32.36	29.12	1.81	8.28	10.10	34.67	Safe
4	Koovapady	83.50	75.14	10.61	8.24	18.85	25.09	Safe
5	Kothamangalam	62.09	55.88	9.04	10.68	19.72	35.29	Safe
6	Mulamthuruthy	22.51	20.26	4.88	7.46	12.34	60.91	Safe
7	Moovattupuzha	49.50	44.55	12.13	8.58	20.71	46.48	Safe
8	Palluruthy	34.77	31.29	0.36	19.38	19.75	63.10	Safe
9	Pampakuda	55.29	49.76	10.04	7.55	17.59	35.63	Safe
10	Parakadavu	24.39	21.95	10.48	6.52	17.00	77.47	Semi-Critical
11	Paravoor	22.26	20.04	8.84	8.42	17.25	86.10	Semi critical
12	Vaduvacode	63.83	57.45	6.44	7.19	13.63	23.73	Safe
13	Vazhakulam	53.2	47.93	11.63	9.72	21.35	45.68	Safe
14	Vypin	18.45	16.60	10.19	9.28	10.31	62.05	Safe
15	Vytilla	14.81	14.07	1.03	6.10	7.13	50.68	Semi-Critical
Total		**615.72**	**557.34**	**103.08**	**136.67**	**239.76**	**43.02**	

The withdrawal of ground water for irrigation has diminished and domestic draft has increased. The gross draft in the district was worked out to be about 239.76 MCM of which about 103.08 MCM is for irrigation. The block wise details of draft for irrigation, domestic and industrial purposes are givenin **Table 6**.

As per the methodology, the blocks are categorized as safe, semi critical, critical and over exploitedon the basis of the stage of development and long term groundwater trend of water level. The categorization based on stage of development and long term water level trend for the 15 blocks(old) of Ernakulam district as on March 2009 is given in **Table 6**. 12 blocks are categorised as safe and 3 as semi critical. There are no over-exploited blocks in the district. Among the three Semi-critical blocks, the long term water level trend in Parakadavu and Paravoor blocks do not show declining trend. But in Vytilla block, although the stage of development is less than 75 %, the long term trendof water level is showing significant declining trend due to which it is classified as semi-critical. As per 2004 assessment, 7 blocks are categorised as safe, 3 as semi critical and 4 as critical. The long term water level trend in these blocks are showing declining trend. Two blocks namely Koovapady and Vytilla are showing significant declining trend in water level due to which they were classified as semi-critical and critical. The categorization of blocks is represented in **Figure 10.**

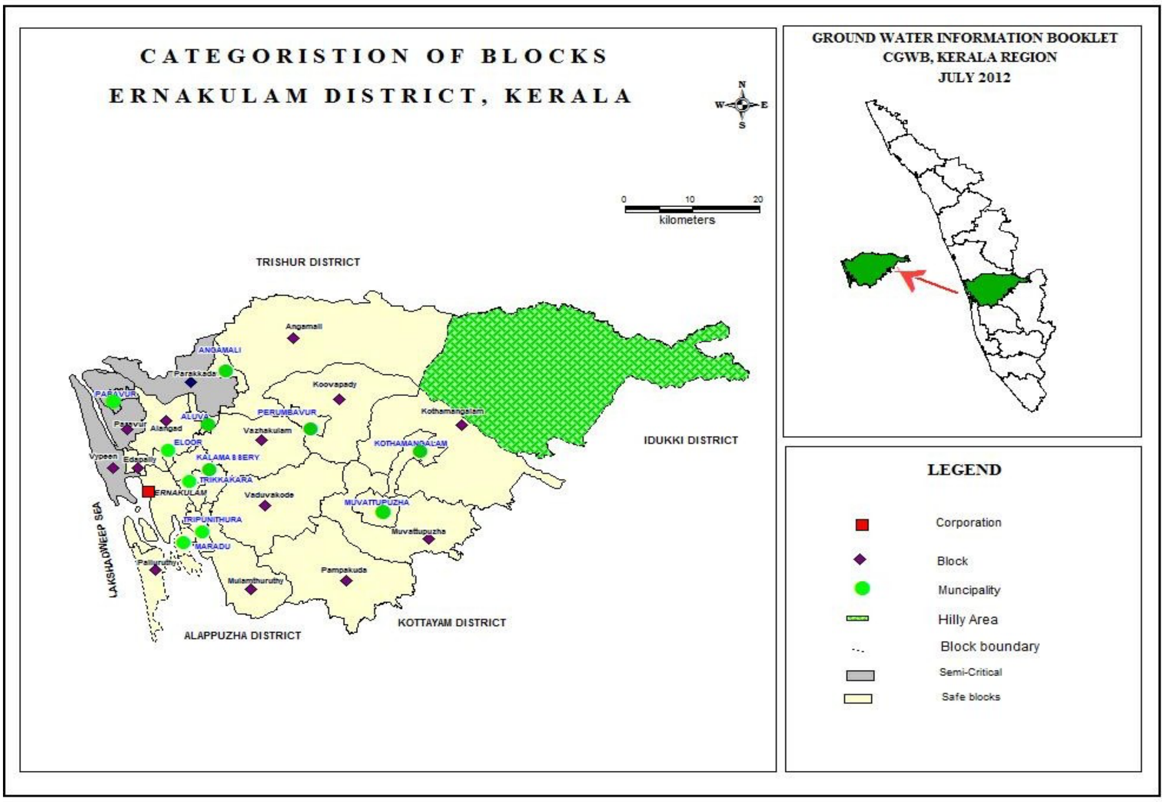

Figure 10: Groundwater Resources of Ernakulam district

Ground water Quality

Shallow aquifer

The ground water quality of the shallow aquifers of the district is generally very good. Samples collected during April 2019 from the groundwater monitoring stations are analysed. The range of chemical constituents (Major ions) is summarised in **Table 7**. Results of analysis are given in **Annexure – III.**

Table 7 Range of chemical constituents

Chemical constituent	Range in concentration	
	Minimum	Maximum
EC, μ Siemens / cm At 25^0C	37	5260
Total hardness, mg/l as Ca CO_3	6	675
Ca, mg/l	1.6	90
Mg, mg/l	0	109
Cl, mg/	5.7	1778
F, mg/l	0	0.39
NO_3	1.3	42

The data indicates that the ground water in the phreatic aquifers of the area is very low in mineralisation and is fit for all domestic, industrial and agricultural purposes in general. On the basis of USSL classification of groundwater, water samples from the study area have been classified into Good, Marginally saline and Saline. Majority of the samples (97.8 %) falls in the category of Good water. Marginally saline water is absent in the study area while the groundwater sample collectedfrom Chellanum is found to be saline. The quality of formation water of phreatic aquifer is generally good. The average Electrical Conductance is ranging from 150 to 250 μs/cm.

Groundwater quality in deeper aquifers

In general, the quality in deeper aquifers is good in most of the hard rock areas of the district. The exploratory drilling data has revealed the quality to be good. However, it has also revealed the presence of inland salinity in some areas namely Deshom and Sree Moolanagaram where the EC is found to be very high of the order of more than 17,000 micro siemens/cm at 25^0C.

In the coastal sedimentary aquifers, the quality of the water of Vaikom aquifers is saline in most part of the district except for small pockets like Narakal and Kumbalangi where it is fresh. The EC is found to range between 4000 micro siemens/cm to 17,300 micro siemens/cm at 250C. The Warkalai aquifer is completely saline in the district.

Table 7a: Range of chemical constituents

Chemical constituent	Range in concentration	
	Minimum	Maximum
EC, µ siemens / cm At 25^0C	27	9370
TDS		
Cl, mg/	5.7	3138
F, mg/l	0	0.47

5.0 Ground water Development

In the district groundwater is developed for irrigation mainly by marginal farmers from wells used forboth domestic and irrigation. The crops irrigated are chiefly coconut, plantain and vegetables. Groundwater is also developed for water supply schemes in rural areas by and to a limited extent in urban areas.

Though groundwater development for the district is observed to be only about 43 %, the groundwater development for two blocks viz. Parakadavu, Parur, are having a higher stage of development of above 75%. Besides the above, in the case of Vytilla block, although the stage of development is at lesser rate, the water levels are showing declining trend. Hence in this block also, further development of ground water should be done with caution and suitable conservation methods are tobe resorted.

In crystalline aquifers dug wells can be constructed wherever sufficient weathered thickness of the saturated zone is available. Existing low yielding wells can be revitalized by deepening such wells to tap the entire thickness of weathered zone. Dug wells located along lineaments and fracture directions can be revitalized by converting them into dug cum bore wells. Bore-wells are feasible in crystalline areas tapping deep fractures and are site specific.

Tube wells are feasible in coastal belt in freshwater pockets of Vaikom aquifer. Tube wells may be constructed tapping 15 to 20 m of aquifer material with slot size of 3.1 mm and gravel pack. In the Laterite terrain dug wells and dug cum bore wells are feasible with depth of 10 to 16 m and diameter of 2 to 4 m and in the valley areas dug wells of 6 to 8 m depth and 1.5 to 3.0 m diameter are feasible.

In the coastal alluvium dug-wells with depth of 4 to 7 m and diameter 1.5 to 2.0 m and filter point wells wherever saturated thickness of 5 m or more are feasible.

Water Conservation and Artificial recharge

The district is having ideal site for implementing ground water conservation structures and rainwater harvesting structures. The subsurface dam constructed at Odakkali in the premises of Aromatic and Medicinal Plant Research Station of the Kerala Agricultural University has improved the ground water conditions of the area and it ensures sustain water for irrigation for the farm area of the university. The structure was constructed during 1988 with a cost of Rs. 1.67 lakhs. The length of the dam is 80 m and the depth is about 6m.

Similar structures can be constructed along the narrow valleys of the district. In addition to this, gully plugging and check dams will also be of great use in improving the groundwater resources of the district. In the coastal area, roof top rainwater harvesting is to be given a thrust. The artificial recharge schemes recommended for different blocks are given in Figure 11.

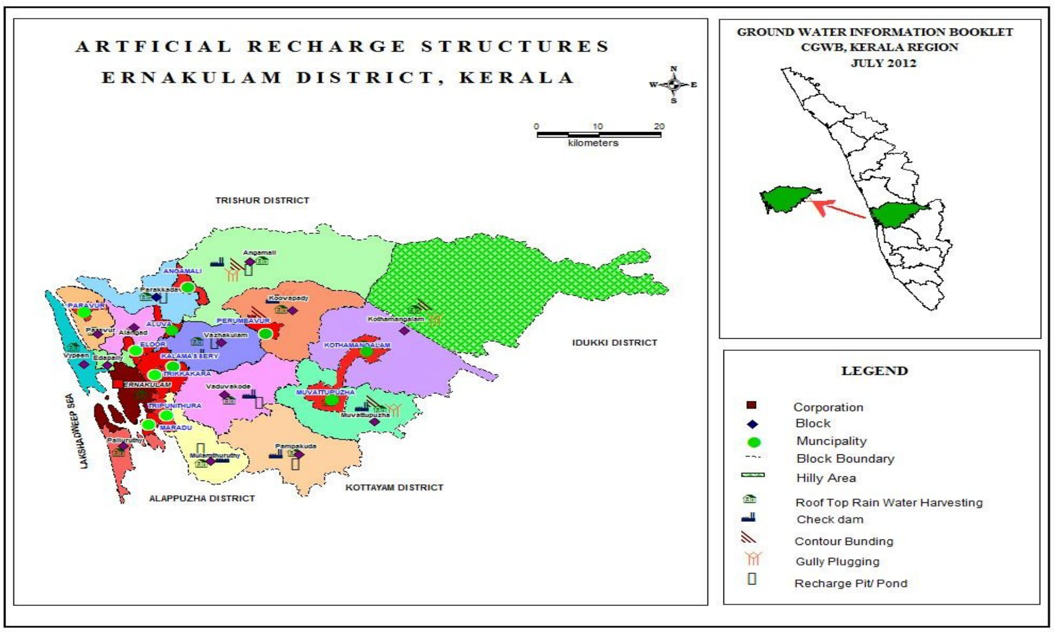

Fig 11: The artificial recharge schemes recommended for different blocks in Ernakulam District

A.8. Design Specifications

1. PVC pipe carrying rain water from aluminium roof gutter to storage tank. 110 mm PVC pipe connected to one side of 300x300 mm gutter. The length of pipe to storage tank is 50 meters.

2. The exit end of the 110 mm PVC pipe discharging rain water to ground storage tank 35000 ltrs.

3. PVC pipe carrying rain water from aluminium roof gutter to open well 1. 110 mm PVC pipe connected to one side of 300x300 mm gutter. The length of pipe to open well is 50 meters. The dia of open well is 150 cms.

4. The open well 150 cm dia receiving roof water. This open well has not overflown in the last 3 monsoon seasons, which means the rate of lateral seepage of the ground water in the well is more than the inflow from rainwater harvesting system.

5. 140 mm PVC pipe- 2 nos carrying rain water from aluminium roof gutter to open well 2. 140 mm PVC pipe connected to one side of 300x300 mm gutter. The length of pipe to open well 2 is 50 meters.

6. The 140 mm PVC pipe - 2 nos networked at first floor level and discharge to 360 cm dia open well 2 as 160mm PVC pipe.

7. 140 mm PVC pipe- 1 no carrying rain water from aluminium roof gutter to open well 2. 140 mm PVC pipe connected to one side of 300x300 mm gutter. The length of pipe to open well 2 is 80meters.

A.9. Implementation Benefits to Water Security

The artificial recharge to ground water by the project activity aims at the augmentation of ground water reservoir by modifying the natural movement of surface water utilizing suitable civil construction techniques, such as rooftop rainwater harvesting.

Such artificial recharge technique addresses the following issues -

(i) Serves as alternatives to enhance the sustainable yield in areas where over- development has depleted the aquifer.

(ii) Serves to conserve and store excess surface water for future requirements, since these requirements often change within a season or a period.

(iii) Serves as simple alternatives to improve the quality of existing ground water through dilution.

(iv) Avoids the flooding of roads.

(v) Raises the underground water table

(vi) Reduces groundwater pollution

(vii) Reduces soils erosion

(viii) Supplements domestic water needs

The basic purpose of artificial recharge of ground water is to restore supplies from aquifers, which has depleted due to excessive ground water development.

The availability of source water, one of the prime requisites for ground water recharge, is basically assessed in terms of non-committed surplus monsoon run off, which as per present water resource development scenario is going unutilised. This component can be assessed by analysing the monsoon rainfall pattern, its frequency, number of rainy days, maximum rainfall in a day and its variation in space and time. The variations in rainfall pattern in space and time, and its relevance in relation to the scope for artificial recharge to sub-surface reservoirs can be considered for assessing the surplus surface water availability.

A9.1 Objectives vs outcomes

The impact assessment or objectives of this RWH scheme can be enumerated as follows:

a) Conservation and harvesting of surplus monsoon runoff in ground water reservoir which otherwise was going un-utilised outside the watershed/ basin and to sea.

b) Rise in ground water levels due to additional recharge to ground water. In case where continuous decline of ground water level was taking place, the intensity of decline subsequently reduces. The energy consumption for lifting the water also reduces.

c) The ground water structures (wells) in the benefitted zone of artificial structures gains sustainability and the wells provides water in lean month when these were going dry.

d) The domestic wells will become sustainable and many of the areas become tanker free.

e) The quality of ground water would improve due to dilution.

f) Besides the direct measurable impacts, the artificial recharge scheme generates indirect benefit in terms of decease in soil erosion, improvement in fauna and flora, influx of migratory birds, etc.

A9.2 Interventions by Project Owner / Proponent

Although there are many wells in the residential complexes of Kochi, however, except for the project activity and few others, no other project owner or residential complex / society has undertaken or contemplated RWH for their wells. This is mainly due to the lack of incentives provided to project developers and enforcement in the State and Country. In 2020 itself, on the completion of the construction of the residential complex, the PP decided to install a simple RWHs to collect rainwater. It should also be noted that the PP has not availed of any subsidy for the RWHs.

There was apprehension on part of the locals that rooftop rainwater groundwater recharge was not important since the water table in the area was high, however, the PP was convinced that the harvested rainwater will be useful since the ground water is used for bathing, washing and even drinking.

In India, rainwater harvesting has been in practice for more than 4000 years. It is basically a simple process of accumulating and storing of rainwater. Rainwater harvesting systems, since ancient times, has been applied as a supply for drinking water, water for irrigation, and water for livestock.

The systems are easy to construct from locally sourced inexpensive materials, and it has proved to be a success in most areas. The prime advantage of rainwater is that the quality of water is usually good, and it does not necessitate any treatment before consumption. Household rainfall catchments can significantly contribute where the source of drinking water is contaminated and scarce.

A.10. Feasibility Evaluation

As stated in section A.7, there are no other viable options for recharging of groundwater using rainfall near residential constructions due to area being a residential area, hence RWHs was the most cost effective and logical option given the space and situational constraints.

A.11. Ecological Aspects

In the modern era, the age-old methodology of rainwater harvesting is greatly neglected. Years of negligence, and short-sighted water management policies that mostly rely on overexploitation of ground and river water, has once again brought rainwater harvesting to the fore because of its life-saving qualities.

Today, rainwater harvesting systems are acting as incredible support systems in many Indian cities, providing a superb alternative to the main water supply, especially during dry seasons. The advantages of storing rainwater are not only limited to a particular individual or a family, but it is coming off as a lifesaver for many urban communities as well. Widespread installation of such system is also revitalizing the natural properties of land, helping to improve the quality of groundwater, raising its level, and preventing wells and tube wells from drying up. Additionally, efficient deployment of rainwater harvesting systems is limiting surface runoff of water, reducing soil erosion, and increasing its fertility.

Ecological Issues addressed by the project activity in terms of	
Inundation of habitated land	The project is a RWHs and hence does not leadto inundation of residential land.
Creation of water logging and vector diseaseprevention mitigation	The catchment area, and bore wells are all inter-related and provide potable drinkingwater to the residences in the surrounding area.
Deterioration of quality of groundwater	Recharging water into the aquifers helps in improving the quality of existing groundwateraquifer due to deep percolation. Hence the quality is improved.

A.12. Recharge Aspects

The RWHS indirectly recharges the bore wells within the project boundary. The soak pits close to the catchment areas ensures that rainwater runoff is adequately filtered prior to entry into recharge zones. The bore-wells in the area are filled with water during the non-monsoon season, clearly indicating that the groundwater recharge is successful. The RoU verifier can interview the users of the well water during the verification process to confirm the same.

A.13. Quantification Tools

Baseline scenario

The baseline scenario is the situation where, in the absence of the project activity, unutilized water flows uncollected into drains and is not conserved and harvested into a well and hence remains unutilized. Baseline scenario, if not directly measurable, is calculated by using the following formula:

Harvested water or Volume of water utilized (m^3)	=	**Area of Catchment / Roof / Collection Zone (m^2)**	X	**Amount of rainfall (mm)**	X	**Runoff coefficient * Uncertainty Factor (1-0.36 = 0.64).**

Area of Roof: 924.611 m^2

As per UCR RoU Standard:

Different Surfaces	Runoff Coefficient (K)
Roof inclined (Sloping)	0.95

Calculation

Year	Rainfall (mm)	Roof Area (sqm)	Total Quantity of Water Collected (cum)	Quantity after uncertainty & run off co-efficients (cum)
2020	3503	924.611	3239	1969
2021	3949	924.611	3651	2220
2022	3345	924.611	3093	1880
2023	2769	924.611	2560	1556
		Total		**7625**

(Rainfall data from: https://www.visualcrossing.com/weather-history/kochi/metric)

Quantification

Year	RoUs (1000 litres) /yr.
2020	1969
2021	2220
2022	1880
2023	1556
Total	**7625**

All calculations of RoUs for **rooftop rainwater harvesting systems are rounded down.*

A.14. UWR Rainwater Offset Do No Net Harm Principles

According to the UCR RoU Standard principles, the project activity accomplishes the following:

1. **Increases the sustainable water yield in areas where over development has depleted the aquifer**

According to the data released by the Central Groundwater Board in 2021, the total amount of groundwater that can be utilised in India in a year is 398 billion cubic meters (BCM), of which, approximately 245 BCM is currently being utilised, which is about 62 per cent of the total. But the level of exploitation of groundwater is very high in states like Punjab, Rajasthan, Haryana, Delhi and Tamil Nadu. This project activity was commissioned in 2017, and the PP has showcased harvesting, recycling and safe reuse of rainwater run off within the industry from unutilized water resources. Revenue from the sale of UCR RoUs will enable scaling up of such project activities.

2. **Collect unutilized water or rainwater and preserve it for future use**

In India, at the district level, in 24 states/UTs, as many as 267 districts had stages of groundwater extraction more than 63 per cent, ranging from 64 per cent to 385 per cent (source: https://www.business-standard.com/article/current-affairs/from-58-to-63-india-pumped-more-groundwater-between-2004-and-2017-121122101377_1.html). This project activity serves as an example to recycle and reuse unutilized rainwater and encourages companies, especially large and transnational companies in the biotechnology and biopharmaceuticals sector, to adopt similar sustainable practices in regard to captive water requirements and groundwater management.

3. **Conserve and store excess water for future use**

The project activity decreases the dependence on groundwater, thereby preventing excessive depletion. From 2020 to 2023, the project activity has harvested **7625** kilolitres of rainwater successfully with gainful end use of the same. Rainwater harvesting helps conserve freshwater resources by reducing reliance on groundwater and surface water sources. Collecting and using rainwater lowers the water extracted from groundwater sources, which can help preserve them for future generations. It significantly reduces corporate water bills by providing a water source for non-potable uses such as irrigation, flushing toilets, and washing purposes. Also, it helps manage storm-water by reducing runoff and preventing flooding. By capturing rainwater on-site, the PP reduces the amount of water that flows into storm drains and reduce the risk of flooding. Rainwater is generally free from chemicals and contaminants. Rainwater harvesting is a sustainable practice that promotes environmental stewardship and reduces the industrial water footprint. By conserving water and reducing their reliance on traditional water sources, the PP has created a more sustainable future for India’s future generations.

A.15. Scaling Projects-Lessons Learned-Restarting Projects

It is staggering to note that in a country of more than 1.3 billion people, 29 states and 4100 towns and cities, only two cities- Thiruvananthapuram and Kota, get continuous, 24×7 water supply, and all those cities with a population greater than 1 million, get water for around 3-4 hours a day.

This is not due to lack of adequate infrastructure but due to mismanagement of the water distribution system in the districts. This results in a large section of the society, mostly the poor and downtrodden, consuming contaminated water for their basic sustenance, resulting in the spread of diseases.

More systematic infrastructures are needed. In some places, it exists but is not maintained. It is a difficult area of work. It is simpler in open areas, parks, low lying areas, flood plains to create RWH structure. There are many areas where it is not being tapped. Only about 30% to 40% of the potential is utilised. There is no proper distribution in the city of RWH structures. In some parts, groundwater level is already low, while in some it is better. The pace of work has been slower in the last two years due to the pandemic. Another factor affecting the pace is budget. RWHs require regular maintenance and technical skills for installation.

Further, if not installed properly, it may attract mosquitoes and lead to waterborne diseases. Finally, storage limitations are an additional drawback. The State cannot harvest rain; people have to be involved. RWHs has to be done in every house; every colony; every village; and for every catchment. Hence the UWR water credits program will serve as an initial spark to bring about change in rainwater management across India by providing an incentive to those who have already undertaken RWHS installation.

One hectare of land with just 100 mm of rain -- that's what even the most barren of Indian lands receive on an average -- is capable of harvesting one million litres of water. A family of five would not need more than 10-15 litres a day for drinking and cooking. This comes to 4,000-5,000 litres in a year. This means one hectare can harvest enough water to meet the needs of 200-300 families.

With countless predictions that most major cities around the world are on the brink of running out or exhausting their groundwater supplies in the near future, it is extremely important to look beyond the conventional sources of sustenance and look towards adopting and adapting the non-conventional, renewable sources, essential for our survival. Rainwater is a renewable source prevalent in areas with little to no rainfall, and such collected water can be put to uses like irrigation and other domestic chores like toilet flushing, washing, etc. It needs to be purified further in order to make it potable, since rainwater collected from rooftops may contain animal and bird feces, dust particles and other particulate matter, and gases like Nitric and Sulphur Oxide; which require elaborate purification setups, which are difficult to install, operate and maintain at the domestic level.

As for the regulatory enforcement of the rules and regulations for rainwater harvesting, all these rules and regulations aim towards one primary objective: to save water- which is the primary essence of life. Formulated by the respective local authorities in the districts, the major impediment in the effective implementation is the lack of information and mismanagement. Hence, focus on encouraging community rainwater harvesting can fulfill the objective to save water.

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