UCR Project Concept Note & Monitoring Report (PCNMR)

Project Name : Rainwater Harvesting Recharge Kadusonnapanahalli, Karnataka, India



UCR RoU Scope:RoU Scope 2

Monitoring Period: 01/01/2015- 31/12/2021

Crediting Period 1: 2015-2021

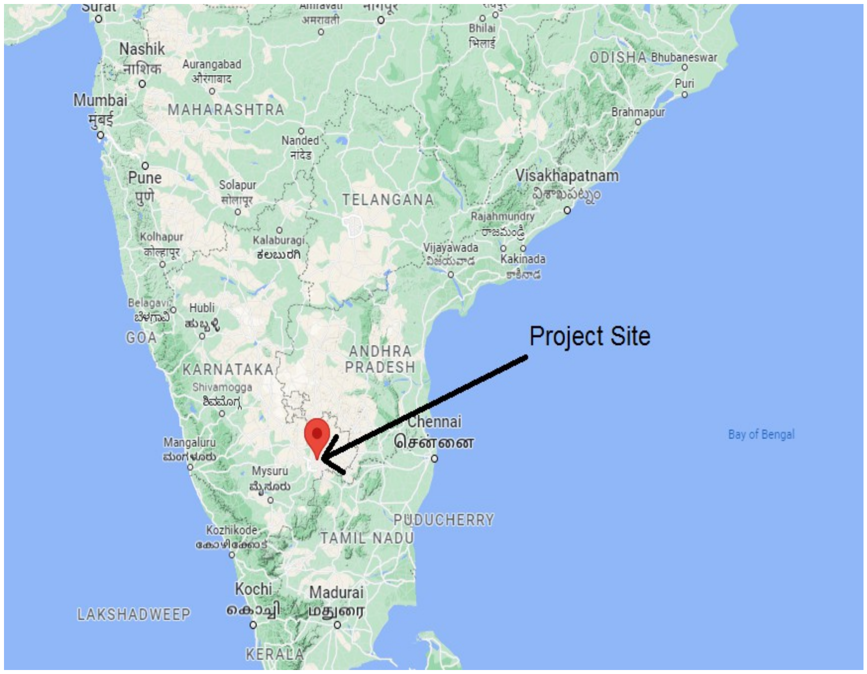
UNDP Human Development Indicator: 0.645 (India)

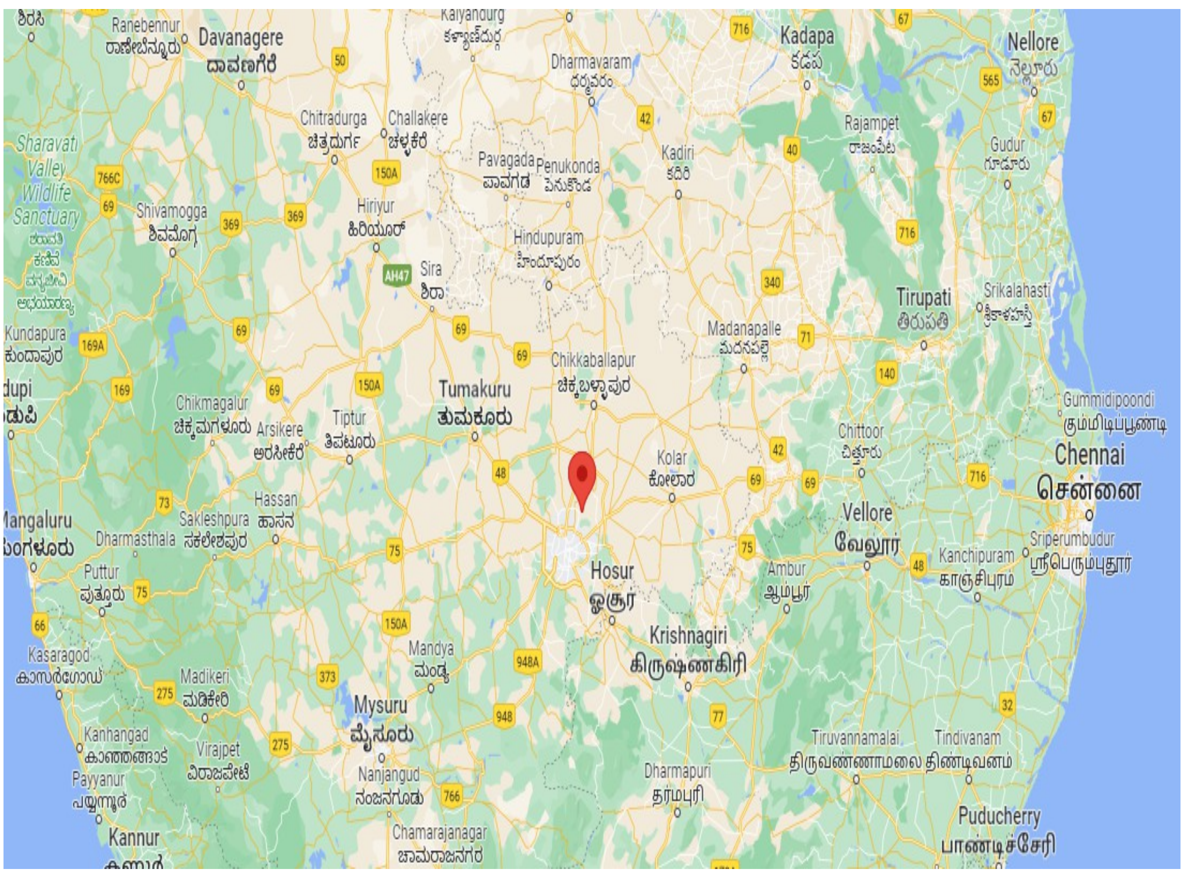
National Water Security Index: 2 (India)

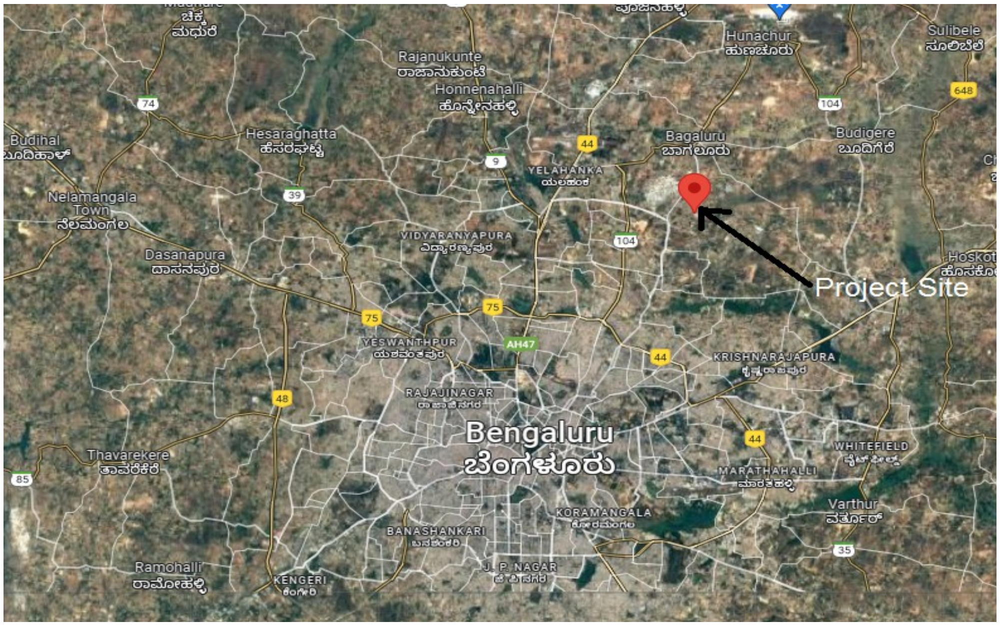
RoUs Generated During 1st Crediting Period: 52575 RoUs

A.1 Location of Project Activity

Address of Project Activity	Township: Nagaragiri, Village: Kadusonnapanahalli Map Description: Bengaluru Urban
State	Karnataka
District	Bengaluru Urban
Block Basin/Sub Basin/Watershed	East Flowing Rivers (4) / Between Krishna and Cauvery (4C) / Ponnaiyar (4C2)
Latitude. & Longitude	Catchment Area 1 13° 5' 58.0884" N 77° 39' 58.8341" E
	Catchment Area 2 13° 5' 53.286" N 77° 39' 58.2437" E
	Catchment Area 3 13° 5' 58.0376" N 77° 40' 4.084" E
Area Extent	Catchment Area 1 (Area = 6081.19 m^2) Catchment Area 2 (Area = 48.39 m^2) Catchment Area 3 (Area = 8588.53 m^2)
Total Catchment Area	14718.11 m^2
No. of Villages/Towns	1 Village, Kadusonnapanahalli, Bengaluru Urban, Karnataka
Major physiographic units	Rocky upland Plateau and Flat topped hills
Predominant Geological Formations	Granite Gneiss

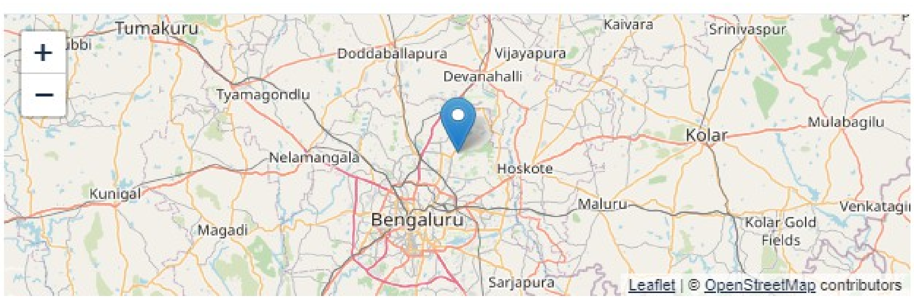

Nashik
Aurangabad
Mumbai
MAHARASHTRA
Nanded
Pune
Solapur
TELANGANA
Visakhapatnam
Rajahmundry
Kolhapur
Kalaburagi
Vijayawada
Kakinada
ODISHA
Bhubaneswar
Puri
Brahmapur
Bhilai
Belagavi
Hubli
GOA
Project Site
ANDHRA PRADESH
KARNATAKA
Shivamogga
Chennai
Mangaluru
Bay of Bengal
Mysuru
Kozhikode
PUDUCHERRY
TAMIL NADU
Kochi
Madurai
LAKSHADWEEP
KERALA


Ranebennur
Davanagere
Kadapa
Nellore
Dharmavaram
Chitradurga
Challakere
Rajampet
Sharavati Valley Wildlife Sanctuary
Pavagada
Penukonda
Kadiri
Gudur
Hiriyur
Shivamogga
Hindupuram
Sira
Tirupati
Srikalahasti
Kundapura
Madanapalle
Chikkaballapur
Udupi
Tumakuru
Chikmagalur
Arsikere
Tiptur
Gummidipoondi
Chittoor
Chennai
Kolar
Hassan
Vellore
Mangaluru
Sakleshpura
Dharmasthala
Sriperumbudur
Kanchipuram
Hosur
Ambur
Puttur
Krishnagiri
Mandya
Kasaragod
Madikeri
Mysuru
Kanhangad
Virajpet
Tiruvannamalai
Tindivanam
Nanjangud
Dharmapuri
Payyanur
Puducherry
Kannur
Chamarajanagar



Area	**1.8 km²**
Population (2020)	**2768**
Population Density	**2071 people per km²**
Male Population	**1350**
Female Population	**1418**
Nearest airport & distance	**Kempegowda International Airport, 8.89 km**
Nearest Railway Station & Distance	**Thanisandra, 4.35 km**

The village Kadusonnappanahalli falls in Bengaluru Urban district situated in Karnataka state, with a population 2768. The male and female populations are 1350 and 1418 respectively. The size of the area is about 1.8 square kilometer.



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

Project Proponent (PP):	Oasis International School Survey No 90/2, Kadusonapannahalli Bidarahalli (Off Hennur Rd), Kannur Post, Bangalore
UCR Project Aggregator	Progressive Management Consultants
Contact Information:	info@progressive-iso.com
Date PCNMR Prepared	14/05/2022
External Media Links	https://www.indiawaterportal.org/articles/be-wise-water-wise-students-get-mission-combat-water-crisis

Project owner (PP) maintains and operates the Rainwater Harvesting Recharge systems (RWHs) during the monsoons and ensures that the rainwater runoff is harvested and flows into the linked recharge/soak pits that recharge the groundwater aquifer and also provide potable water supply via recharged bore-wells to the local villagers post monsoons. PP is responsible for maintaining the catchment area, ensuring potable water supply to nearby households (including R.O system filtration) and also ensuring the smooth flow of rainwater during the monsoon period in the recharge soak pits. PP maintains all the necessary permits and ownership documents for the water harvesting and conservation activity.

A.2.1 Project UCR RoU Scope & Details

UCR RoU Scope 2	Measures for conservation and storage of unutilized water for future requirements.

The project activity **Rainwater Harvesting Recharge Kadusonnapanahalli, Karnataka, India** involves three (3) distinct RWHs as below:

- A pond type catchment system with associated recharge/soak pits to capture rainfall runoff during the monsoons, constructed in 2015, by increasing the depth of a naturally occuring depression with high terrain on all four sides to collect rainwater (**Catchment Area 1**). The project activtiy in Catchment Area 1 hence creates potable drinking water from previously untapped water resources.
- A circular manmade catchment area with stones and concrete (**Catchment Area 2**) with associated recharge wells and borewells constructed in 2015. The project activtiy in Catchment Area 2 creates potable drinking water from previously untapped water resources.
- The irregular Catchment Area 3 is an abandoned quarry that has been cleaned by the PP and harvested for rainwater since 2016. The water collected and resused (from **Catchment Area 3**) is not fit for drinking purposes, hence the water is pumped and used by the local villagers for agricultural purposes only. In doing so, the PP has saved the groundwater from being over exploited.

In addition to the above, the PP has developed and constructed soak pits along the storm water drains to ensure that the catchment areas receives clean storm water run off. The project activity is the harvesting of rainfall during the monsoon season, which involves the conservation and storage of unutilized water for future and current potable water requirements, agricultural purposes and also recharge of the groundwater aquifer. Along with the increase in per household water consumption, the project activity helps replenish the ground water table. The overall goal of this project is to promote sustainable water development in the village of Kadusonnapanahalli and prevent over exploitation of groundwater resources. Hence the project activity ensures the water security of India and attains **SDGs 6, 11, 12 and 13**.

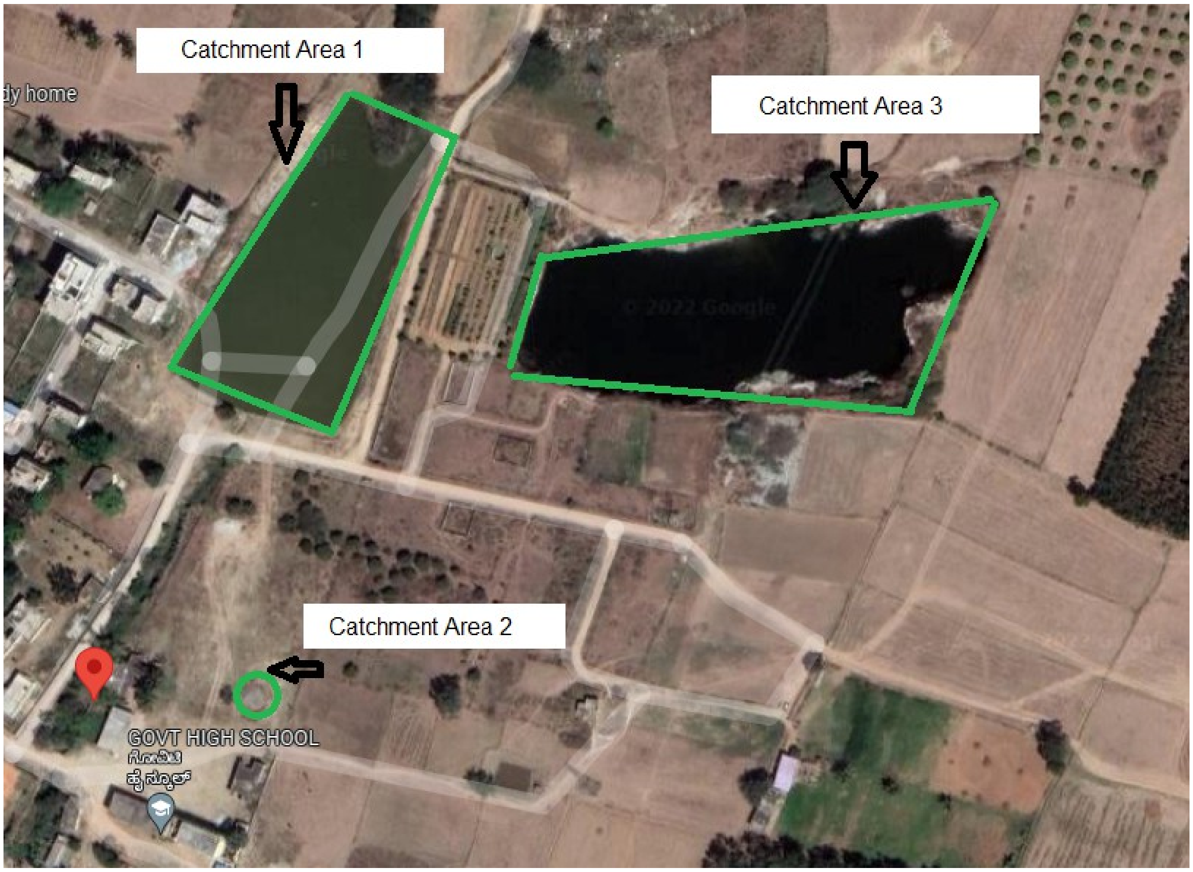
PROJECT NAME	Rainwater Harvesting Recharge Kadusonnapanahalli, Karnataka, India
UCR Scope:	RoU Scope 2 Measures for conservation and storage of unutilized water for future requirements.
Date PCNMR Prepared	10/05/2022
Catchment Area (Total)	14718.11 m^2
Number of RWHs and associated structures	3
Year of Construction	Catchment 1 &2: 2015 Catchment 3: 2016
Device Used for Lifting/Storing Groundwater Features Associated with the RWHs	Centrifugal Pumps, Soak Pits, Recharge wells and Bore Wells

The catchment areas serve as surface water reservoirs that

- collect and store rainwater,
- help to recharge groundwater and
- reduce exploitation of groundwater aquifers.

The rainfall runoff flows into recharge wells and soak pits that are then connected to nearby borewells for potable water supply to villagers. These rainwater harvesting catchment areas have improved the community's access to water immensely. It is used for irrigation, domestic purposes and acts as a water recharging unit, increasing the level of ground water.

Project Boundary



A.3. Land use and Drainage Pattern

(i) Land Use: Rural

The state of Karnataka has a geographical area of 1, 91, 761 sq. km. and is situated between N. Latitudes 11°31" and 18°45' and E. Longitudes 74 °12' and 78°40'. For administrative purposes, the state is divided into 30 districts and 176 taluks.

PHYSIOGRAPHY

The state of Karnataka is divided into four physiographic units as below;

a) The narrow Coastal plain along the west coast running to about 300 km from Karwar in the north to Mangalore in south. The tract is generally very narrow reaching maximum width of about 40 km at places. The general elevation of the ground varies between 0 to 200 m above mean sea level. The rivers draining the area have a westerly course.

b) The Malnad region with steep mountain ranges and valleys lying immediately east of the former. The general elevation of the area varies from 200m above mean sea level along the boundary with the coastal plain to 1872m above mean sea level at Kudremukh. Its width varies from 50 to 100km. Several rivers like Cauvery and Tungabhadra originate from this region.

c) The Northern part of the State comprises a tableland and its general elevation ranges from 300 to 350 m above mean sea level.

d) The Eastern districts towards south form a plateau, which is characterized by rolling topography with sporadic hills. The general elevation in this track varies from 600 to 1000 m above mean sea level.

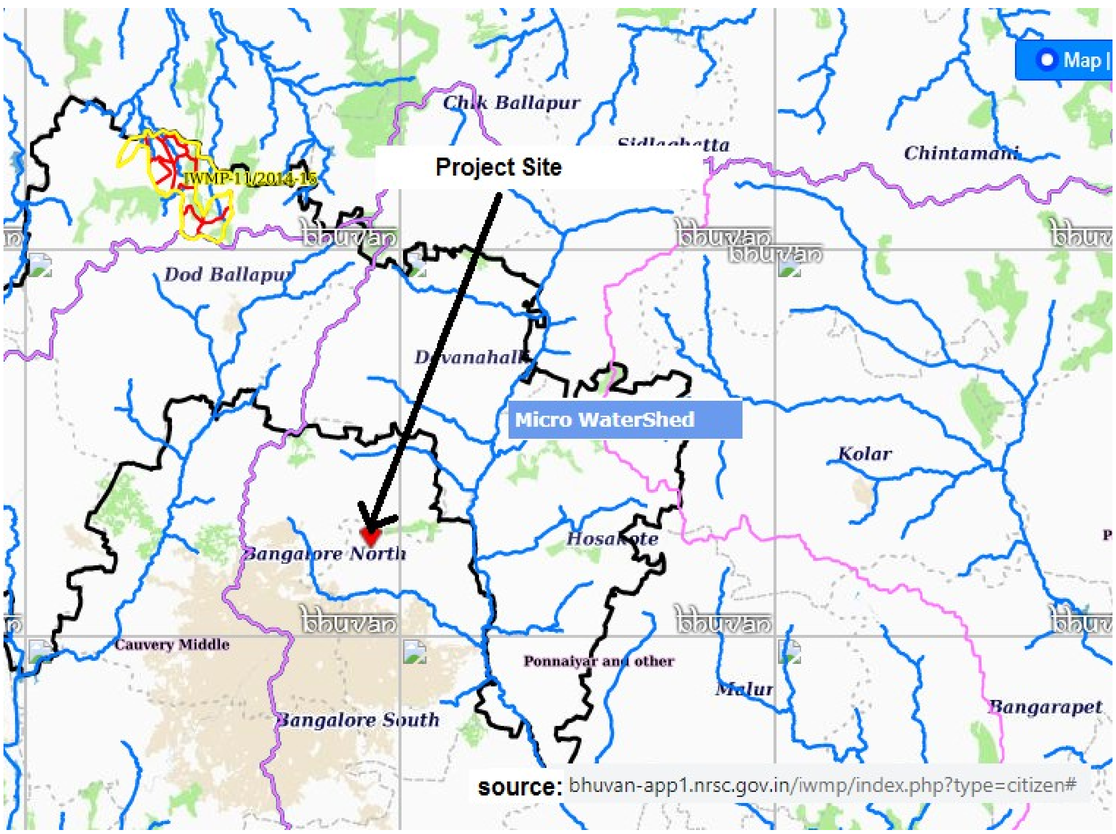
DRAINAGE

The State of Karnataka is drained by the rivers Krishna, Cauvery, Godavari, West flowing minor rivers, Palar, Pennar and Ponnaiyar. The river Krishna with its major tributaries viz. Bhima, Malaprabha, Ghataprabha, Tungabhadra, Upper Krishna and Vedavathi drains nearly 60% of the state area. Cauvery and its tributaries viz. Arkavathi, Hemavathi, Kabini, Shimsha, Suvarnavathi and Upper Cauvery drain about 18% of the State area. Palar, Pennar and Ponnaiyar, which originate from the Nandi hills in the southern part of the State drain about 7% of the area. About 2% of the area in the northern district of Bidar is drained by the Godavari river system. The remaining area is drained by the west flowing rivers such as Kalinadi, Netravathi, Sharavathi, Sita and Swarna etc. The details of the drainage basins and sub basins are given in Table 2. And shown in Plate I.

The Arkavathi sub-watershed has an aerial spread of 861.57 km2 and covers the districts of Bangalore urban and Bangalore rural in the state of Karnataka, India shown in figures below. The sub-watershed has been rapidly urbanizing and occupying almost one-third of the area. Four small towns and over 1000 villages along with Banglore come under this sub-watershed. Geographically it lies between latitude and longitude of 13°2′28.51″ N 77°20′35.07″ E and 12°35′53.77″N 77°35′39.97″E. The Arkavathi River a tributary of the river Cauvery flows across the watershed and hence the watershed is named after the river. Topographically the elevation varies from 890 m to 740 m above mean sea level (msl) and is sloping towards south. The minimum and maximum temperatures are 19°C and 39°C respectively with the average temperature being 25°C.

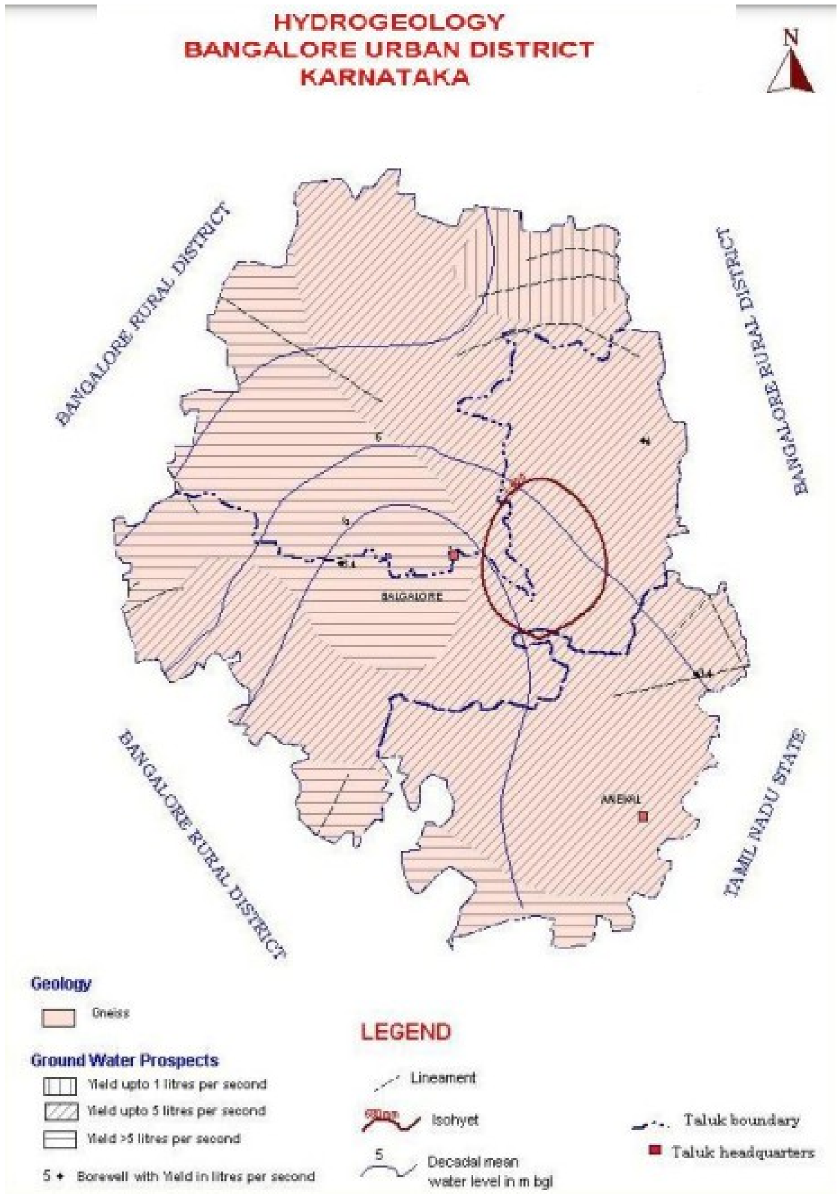
Table 2: Basins, Sub-Basins and Drainage Area

Drainage		Area		District
Basin	**Sub Basin**	**Sq.Km**	**%**	
Godavari	***Karanja***	4405	2	***Bidar***
Krishna	Bhima	19345	10	Bidar, Bijapur,
	Malaprabha	19233	10	Belgaum, Bijapur,
	Tungabhadra	37786	20	Bellary, Shimoga,
	Upper	17685	9	Belgaum, Bijapur,
	Vedavati	19222	10	Bellary, Hassan,
Cauvery	Arkavati	4500	2	Bangalore Urban,
	Hemavati	5006	3	Hassan, Chikmagalur
	Kabini	5160	3	Kodagu, Mysore
	Shimsa	7810	4	Bangalore, Mandya,
	Suvarnavati	4050	2	Mysore
	Upper	7747	4	Kodagu, Mandya,
West Flowing Rivers	Kalinadi	9291	5	Belgaum, Dharwar,
	Netravati	7057	4	Kodagu, Hassan,
	Sharavati	5540	3	Uttara Kannada,
	Sita Swarna	4344	2	Dakshina Kannada,
Palar		2826	1	Kolar
Pennar		7146	4	Bangalore Rural,
Ponnaiyar		2638	2	Bangalore Urban,



Basin/Sub-Basin

East Flowing Rivers (4) / Between Krishna and Cauvery (4C) / Ponnaiyar (4C2)



HYDROGEOLOGY

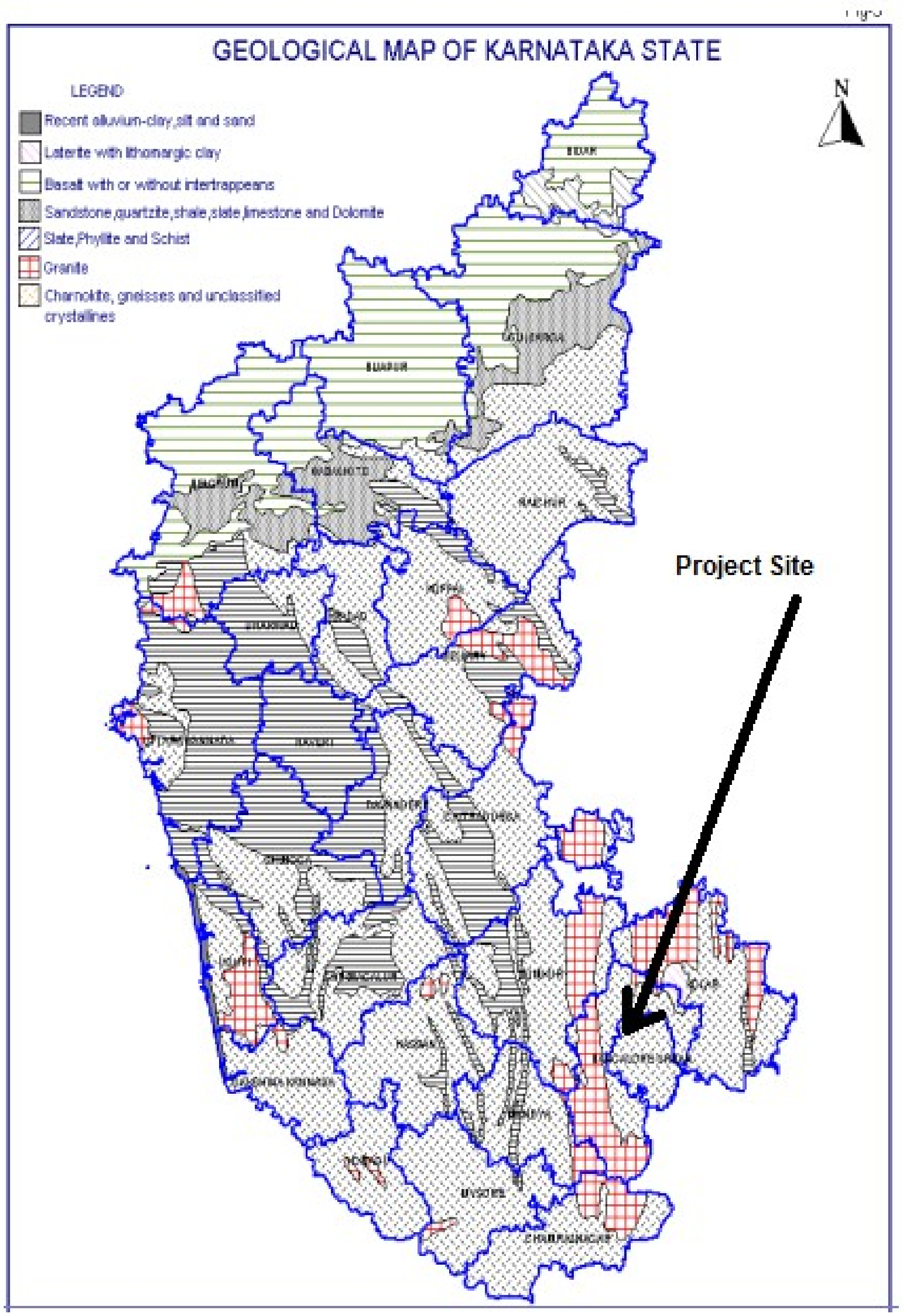
The state of Karnataka is underlain by geological formations ranging in age from Archaean to Recent. Major portion of the State is covered by Peninsular Gneisses, Granites and Dharwarian Schists of Archaean age. Substantial area in the northern part of Karnataka is underlain by basalts, which form a continuation of the Deccan Traps occurring in Maharashtra. The sedimentaries comprising Bhima and Kaladgis occupy a small area in the northern districts (Plate II) The recent alluvium is restricted to a narrow belt in the coastal area and along stream courses. The geological succession in the

State is presented in Table 3. Majority of the stations are located in Granitic Gniessic region. Except for the alluvium, which occurs in a limited area, the State is occupied mainly by crystalline rocks and consolidated sedimentaries, which do not possess primary porosity except for the Basalts, which have a limited primary porosity in the form of vesicular zones. Secondary porosity introduced in them through weathering, fracturing and jointing produces the void spaces to hold and transmit ground water. Solution cavities in the limestones, when sufficiently large can form good aquifers.

Table 3. The geological succession in Karnataka state

Age	Series/System	Formation
Recent	Soil & Alluvium	Sand and Clay
Pliestocene	Laterite	Laterite
Tertiary to Mesozoic	Deccan Trap Basalt	Hard massive & vesicular Basalts
~~ UNCONFORMITY		
Lower Paleozoic to upper Precambrian	Bhima Series	Quartzites, Sandstone, Limestone, Shale and Conglomerates
~~ UNCONFORMITY		
Upper Precambrian	Kaladgi Series	Quartzites, Sandstones, Limestones, Shale and Conglomerates
~~ UNCONFORMITY		
Lower Precambrian	Dharwar system volcanics Greenstone, metasediments	Dharwar Schists meta sediments Greenstone formations
~~ UNCONFORMITY		
Archaean	Peninsular Gneissic complex	Gneisses, Granites, Charnockites, Khondalites

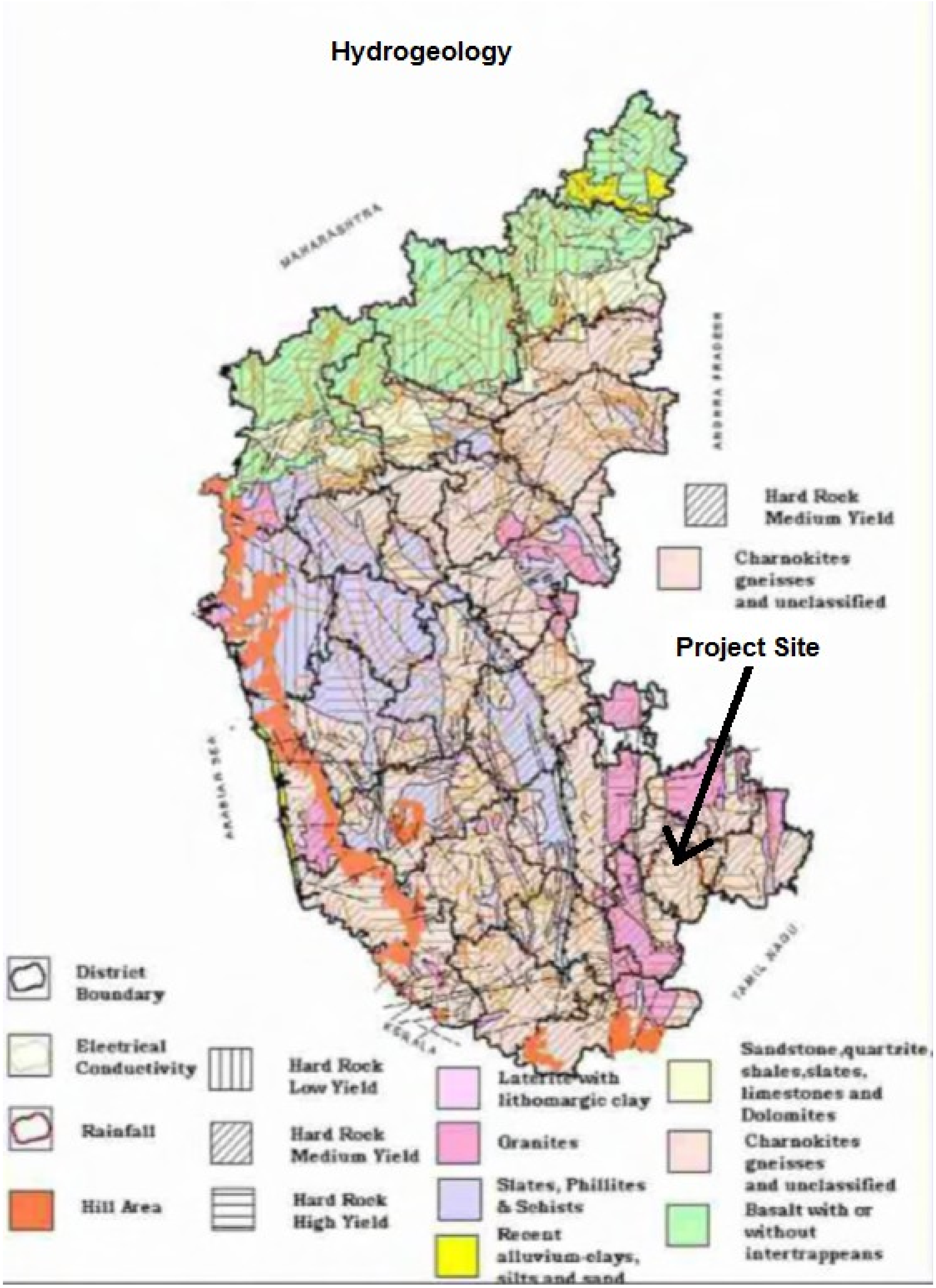
Plate-II


GEOLOGICAL MAP OF KARNATAKA STATE
LEGEND
Recent alluvium-clay,silt and sand
Laterite with lithomargic clay
Basalt with or without intertrappeans
Sandstone,quartzite,shale,slate,limestone and Dolomite
Slate,Phyllite and Schist
Granite
Charnokite, gneisses and unclassified crystallines
N
Project Site

The total geographical area of village is 170.97 hectares. Kadusonnappanahalli has a total population of 2,498 peoples, out of which male population is 1,218 while female population is 1,280. There are about 487 houses in Kadusonnappanahalli village. Pincode of kadusonnappanahalli village locality is 562149.

Karnataka State can be considered as having three major hydrogeological provinces. They are the Hard Rock province, Deccan Trap province and Metamorphosed sedimentary province as described below. Groundwater occurs in these provinces under unconfined to semi-confined conditions and under confined conditions in depth. The rock units of provinces do not have the primary porosity, therefore the occurrence and movement of groundwater is through secondary porosity developed through weathering, fracturing and tectonic formation under gone by the rocks. The main source recharge to the aquifers is by precipitation and also by applied irrigation. In addition to these along the coast a thin band of alluvium is encountered (Figure: Hydrogeology).

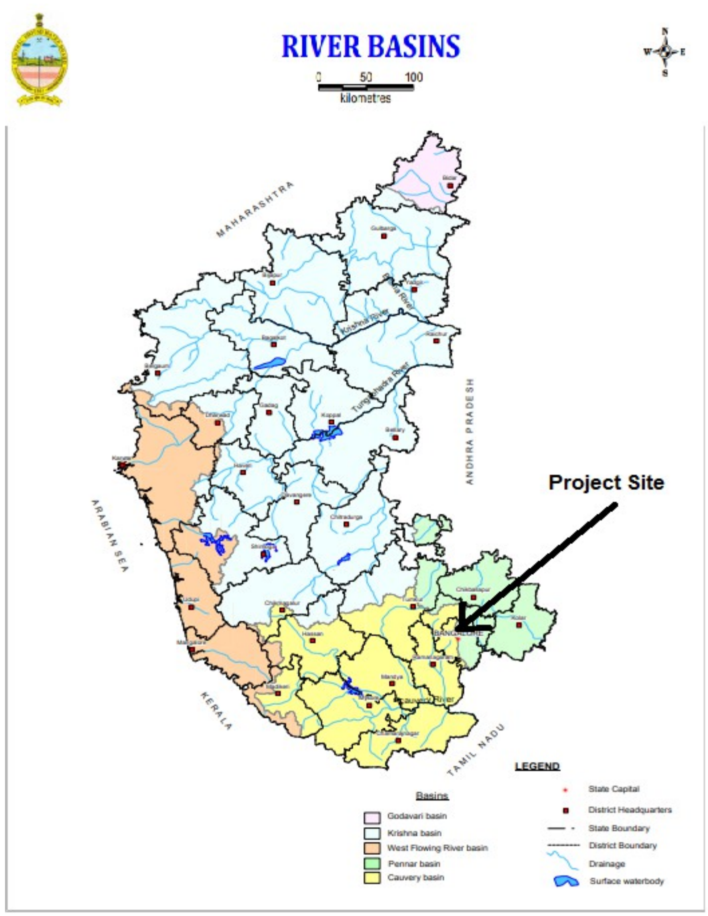
The Archaean Crystalline Hard Rock Province: Archaean crystalline hard rocks are represented by the gneisses, schists, granites and khondalites, which occupy up to 79% of the area of the state. The availability of groundwater in the phreatic zones in these formations is controlled by the degree of weathering and lithological unit of the area. The schists and khondalites are more susceptible to weathering and hence are having better yield in the phreatic zones compared to Granites. Generally the depth of weathering goes down to 30 min this formation sand they sustain dug wells. In contrast, the yield of bore wells is controlled by the tectonic history of the area and the lithology encountered. Thus equi-granular rocks when subjected to differential stress tend to develop open(tensile) joints in the direction of stress sand shear joints at about 23° to the direction of stress, whereas rocks having linear mineral stand to absorb the stress and the linear minerals reorient along the stress direction. Thus Granites, Pegmatite sand Charnockites yield better compared to Schists, Phyllites and Gneisses. Further, the analysis of the results of groundwater exploration in the state indicated that the tectonic story has an important bearing on the yield of bore wells. Thus all the lineaments are not equally potential. The NE-SW lineaments are the most potential followed by E-W, NNW-SSE and NW-SE in the order of preference even though the NW- SE lineament is the most commonly occurring one. The yield of bore well in the province is as high as 30lps with a transmissivity of upto 2000 m2/day in ideal conditions tapping tensile joints in granites/ pegmatite’s and other equi- granular rocks.


Hydrogeology
Project Site
Hard Rock
Medium Yield
Charnokites
gneisses
and unclassified
District
Boundary
Electrical
Conductivity
Rainfall
Hill Area
Hard Rock
Low Yield
Hard Rock
Medium Yield
Hard Rock
High Yield
Laterite with
lithomargic clay
Granites
Slates, Phillites
& Schists
Recent
alluvium-clays,
silts and sand
Sandstone,quartzite,
shales,slates,
limestones and
Dolomites
Charnokites
gneisses
and unclassified
Basalt with or
without
intertrappeans

River Basins

There are seven river systems in Karnataka which with their tributaries, drain the state. The names of these river systems and area drained by them are given below.

River System	Drainage Area	
	1000 Sq. km	Percentage
Godavari	4.41	2.31
Krishna	113.29	59.48
Cauvery	34.27	17.99
North Pennar	6.94	3.64
South Pennar	4.37	2.29
Palar	2.97	1.56
West Flowing Rivers	24.25	12.73
Total	**190.50**	**100**



Basin/Sub-Basin

East Flowing Rivers (4) / Between Krishna and Cauvery (4C) / Ponnaiyar (4C2)

Ponnaiyar Basin

The Ponnaiyar Basin is the second largest interstate East flowing river basin among the 12 basins lying between the Pennar and Cauvery basins. It covers a large area in the state of Tamil Nadu besides the areas covered in the states of Karnataka and Andhra Pradesh. It lies between East longitude 77° 33' to 79° 47' and North latitude 11° 45' to 13° 30' The Basin is bounded on the North -West and South by various ranges of the Eastern Ghats like the Velikonda Range, the Nagari hills, the Javadu hills, the Shevaroy hills, the Chitteri hills and the Kalrayan hills and in the East by the Bay of Bengal.

The Ponnaiyar drains an area of 16,019 Sq Kms out of which nearly 77 percent lies in Tamil Nadu. The State wise distribution of the drainage area is as follows:

Name of State	Drainage Area(Sq.Kms)	Percentage of Total
Karnataka	3,530	22.0
Andhra Pradesh	210	1.3
Tamil Nadu	12,279	76.7
Total	16,019	100.0

The Ponniyar or the Dakshina Pinakini river rises near Hongashenhalli village at an elevation of about 900 m above m.s.l at North latitude 13º 25' and East longitude 77º 58' in the Kolar district of Karnataka state. From its origin, the river Ponniyar generally flows in the Southern direction for a length of 79 km. through Kolar and Bangalore districts of Karnataka before entering the Dharmapuri district of Tamil Nadu. The river flows another 247 Kms generally in the South-Easterly direction in the districts of Dharmapuri, Vellore, Tiruvannamalai, Cuddalore and Villupuram.

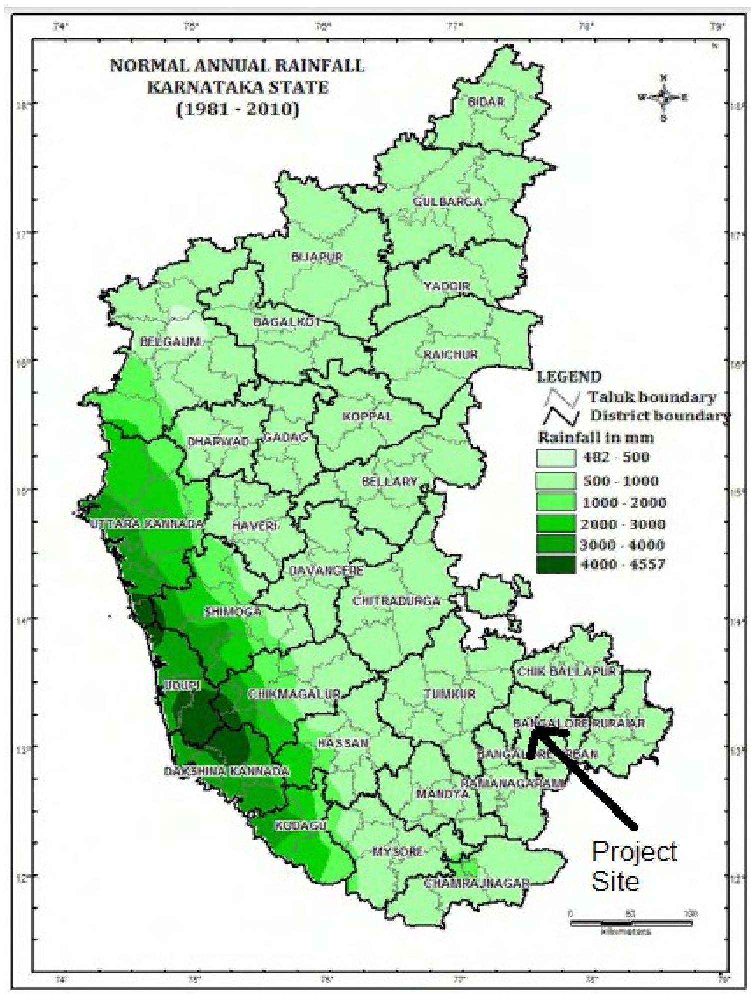
The river then flows in Easterly direction below the Tirukoyilur anicut for another 70 Kms before finding its way into Bay of Bengal. The river Ponnaiyar branches into two, the Gadilam and the Ponnaiyar below the Tirukoyilur anicut. The Gadilam joins the Bay of Bengal near Cuddalore and the Ponnaiyar near the Union Territory of Pondicherry. On its way, the river receives a number of small streams and rivulets.

The Ponnaiyar basin is covered by the Archaean rocks such as Pyroxene granulites, Quartzite, Ferruginous Quartzite, Amphibolites, Gneiss and Hornblende biotite gneiss with younger intrusive of Pegmatite and Dolerite in the central and western parts . The eastern part is covered by the cretaceous formation of argillaceous, calcareous sandstone with clay and limestone. The tertiary formation is of Cuddalore sandstones and the recent formation of river alluvium and coastal alluvium.

A.4. Climate

CLIMATE AND RAINFALL

In Karnataka typical monsoon is experienced. Bulk of the annual rainfall is received during the south-west (June to September) and north-east (October-December) monsoons. Pre-monsoon thunder storms also contribute significant to considerable rainfall. Humid to semi arid climatic conditions prevail in the state. In general rainfall varies from around 400 mm in the eastern fringe of the state to more than 4000 mm in the west (map below).



The state can be broadly classified into four distinct climatic zones. These are:

Narrow Coastal Zone along the West Coast: The whole of Dakshina Kannada, Udupi and western parts of Uttara Kannada district come under this zone. The rainfall generally increases from the coast towards the mountains on the east and from north to south. Average rainfall is around 4000 mm and bulk of this rainfall occurs during the south west monsoon period lasting from June to September. July is the wettest month.

The Mountain (Malnad) Zone: Parts of Belagavi, Uttara Kannada, Shimoga, Chikamagalur, Hassan, Kodagu and Mysuru districts fall under this zone. The area is composed of series of mountain and dense tropical forests. Rainfall is over 5000 mm on hill tops and around 2000mm in the adjoining forest areas. However, Agumbe in Shimoga district records a rainfall over 7000mm annually on an average. The south west monsoon yields the bulk of the rainfall and July is the wettest month. The rainfall decreases from west to east.

The Northern Plains: Eastern part of Belagavi and whole of Bidar, Vijayapura, Bagalkote, Bellary, Kalaburagi, Dharwad, Gadag, Haveri, Raichur and Koppal fall in this zone. Bulk of the rainfall occurs in the winter months. The rain fall decreases from the west to east. On an average about 700mm rainfall is received annually. September is usually the month of peak rainfall.

The Southern Plains: Parts of Shimoga, Chikamagalur, Hassan, Mysuru and whole of Mandya, Tumkur, Bangalore and Kolar districts fall in this zone. In these parts, rainfall ranges from 1000mm to around 400mm. Considerable rainfall occurs during the pre-monsoon months due to thunder storms. Both the monsoons are active giving copious amounts of rainfall. The peak rainfall is found to occur in September/October with a secondary peak occurring in May. The average rain fall in these parts is around 700 mm.

A.5. Rainfall

The monsoon season in Karnataka is from June, July, August and September. Daily rainfall data from 1989 to 2018 is considered for the analysis of rainfall trend, variability and mean rainfall patterns (*source: Observed Rainfall Variability and Changes Over Karnataka State, 2020, Met Monograph No.: ESSO/IMD/HS/Rainfall Variability/13(2020)/37 by Climate Research Division/ Climate Application & User Interface Group/ Hydrometeorology*).

The mean rainfall (mm) and coefficient (%) of variation for the state of Karnataka for monsoon months, southwest (SW) monsoon season and annual for the period 1989-2018 is reported in the table below:

	June	July	August	September	JJAS	Annual
Mean	205.5	269.6	221.2	150.5	846.8	1146.9
CV	22.0	27.7	23.1	35.3	14.5	12.7

Mean rainfall (mm) and coefficient of variation of the state for the monsoon months, southwest monsoon season and annual

Contribution of July month to SW monsoon seasonal total rainfall is highest (32%) followed by August (26%), June (24%) and September (18%). On an average 74 % of the annual rainfall is received in SW monsoon season. The variability for monsoon and annual rainfall is 14.5 % and 12.7 % respectively

DISTRICT	JUNE		JULY		AUGUST		SEPTEMBER		MONSOON		ANNUAL	
	MEAN	CV	MEAN	CV	MEAN	CV	MEAN	CV	MEAN	CV	MEAN	CV
BAGALKOTE	83.5	57	55.9	45	71.6	56	118.7	62	329.6	36	542.8	25
BENGALURU RURAL	71.7	63	89.9	57	116.4	51	151.7	54	429.6	28	796.5	27
BENGALURU URBAN	72.7	60	81.8	54	124.0	58	162.7	51	441.3	29	825.9	26

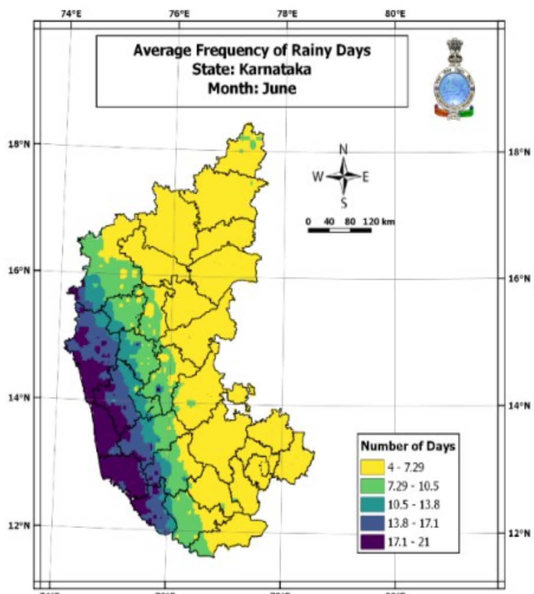
Rainfall statistics **(mm)** for the districts of Karnataka for the four monsoon months, southwest monsoon season and annual

As Karnataka receives maximum amount of rainfall during SW monsoon season, coastal and adjacent districts (Uttar Kannada, Shivamogga, Udupi, Dakshin Kannada and Kodagu) of the Karnataka state receive highest amount of rainfall ranging from 269-1124 mm in June, 583- 1378 mm in July, 442-1000 mm in August, 155-412 mm in September respectively. The average rainfall received for these districts during SW monsoon season and annual is in the range of 1739- 3914 mm and 2108-4474 mm respectively. Inland districts receive less amount of rainfall compared to coastal districts.

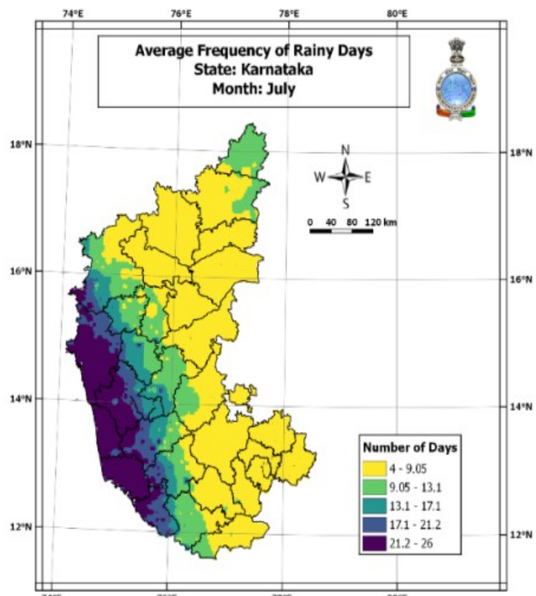
The mean rainfall received for inland districts of Karnataka during SW monsoon is in the range of 55-269 mm in June, 54-319 mm in July, 71-257 mm in August 90-155 in September 289-1014 in SW monsoon and 530-1319 for the annual respectively.

Average frequency of rainy days for the districts of the Karnataka state has been identified (see figures below). The East-West pattern in average frequency of rainy days has been observed. The coastal and adjacent western districts indicate the higher number of rainy days while interior eastern districts record comparatively lesser number of rainy days.

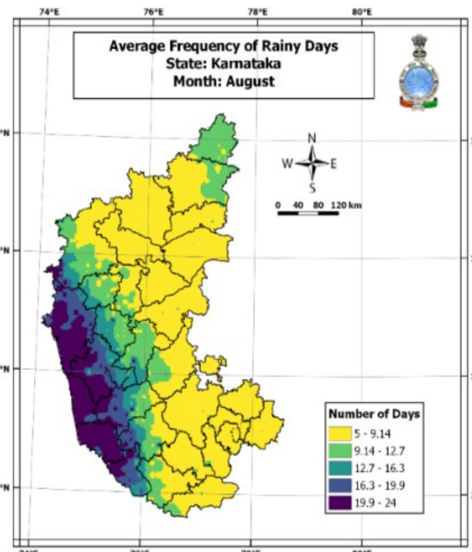
Karnataka state receives maximum rainfall in the month of July (32 % of SW monsoon rainfall) followed by August (26%), June (24%) and September (18%) and contribution of the SW monsoon rainfall to annual total is 74 %. The variability for monsoon and annual rainfall is 14.5 % and 12.7 % respectively.



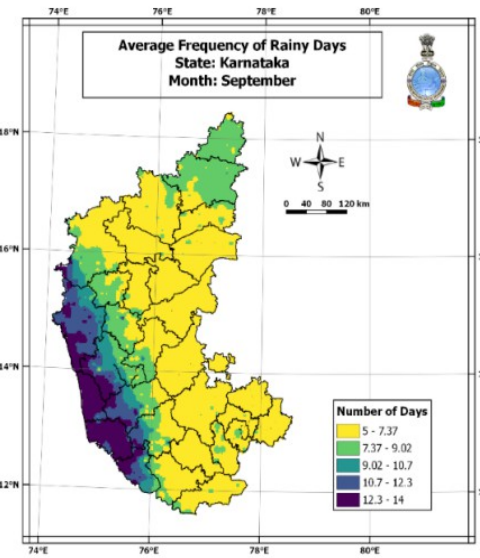
Average frequency of rainy days: June



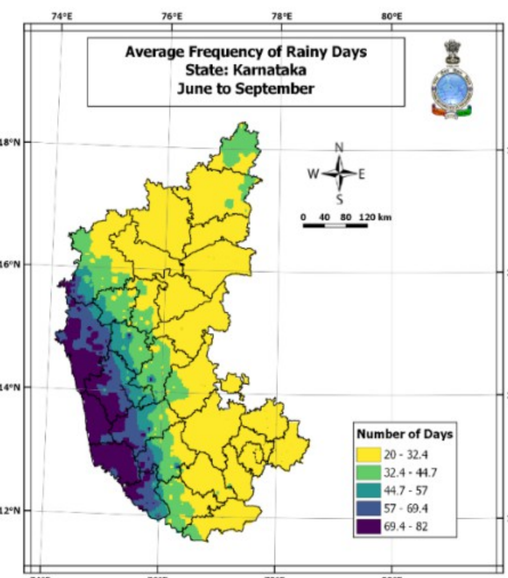
Average frequency of rainy days: July



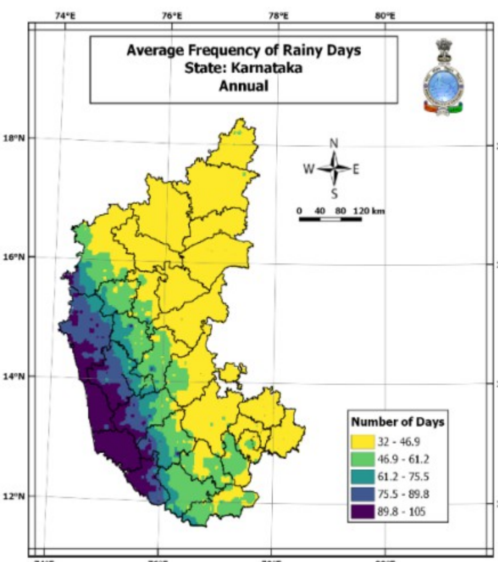
Average frequency of rainy days: August



Average frequency of rainy days: September



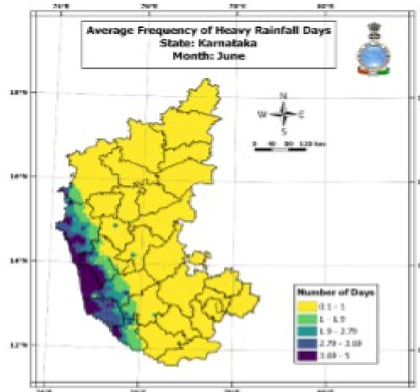
Average frequency of rainy days: JJAS



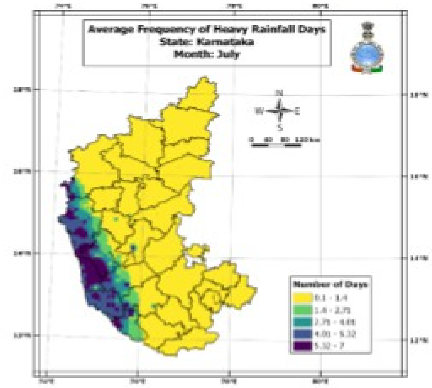
Average frequency of rainy days: Annual

Average frequency of rainy days

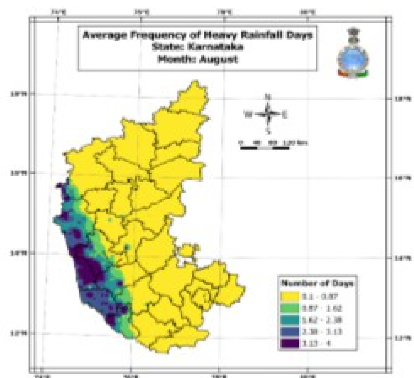
The average frequency of rainy days for the month of June for the coastal and adjacent western districts (interior eastern districts of Karnataka) is in the range of 45-82 (20-45) days for SW monsoon season and 61-105 (32-61) days for annual.



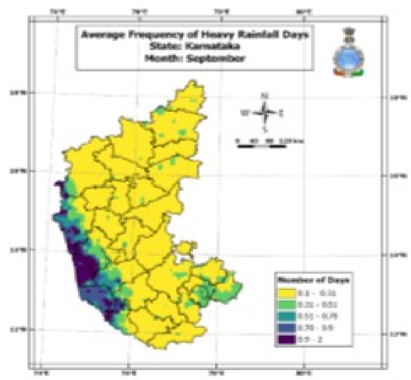
Average frequency of heavy rainfall days: June



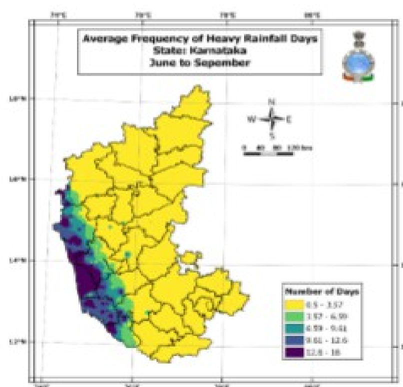
Average frequency of rainy days: July



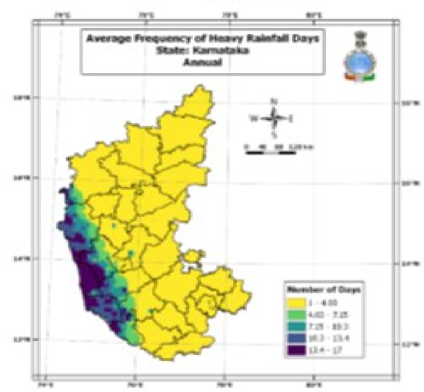
Average frequency of rainy days: August



Average frequency of rainy days: September



Average frequency of rainy days: JJAS



Average frequency of rainy days: Annual

14

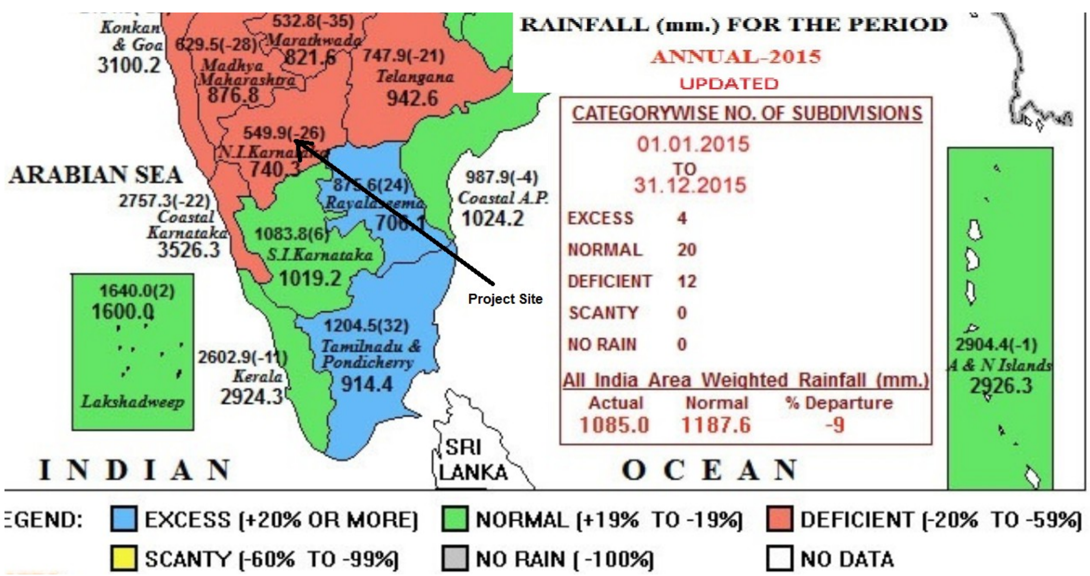
(*Source: GOVERNMENT OF INDIA MINISTRY OF EARTH SCIENCES INDIA METEOROLOGICAL DEPARTMENT)*

Year	Rainfall (mm) Bengaluru Urban	Data/Value Applied
2015	1083.8	Conservative data selected as per operation data map below vs district rainfall figures in Appendix 1. Customized Rainfall Information System (CRIS)Hydromet DivisionIndia Meteorological DepartmentMinistry Of Earth Sciences
2016	687.3	
2017	1061.7	
2018	771.7	
2019	956.2	
2020	1051.9	
2021	1430.1	

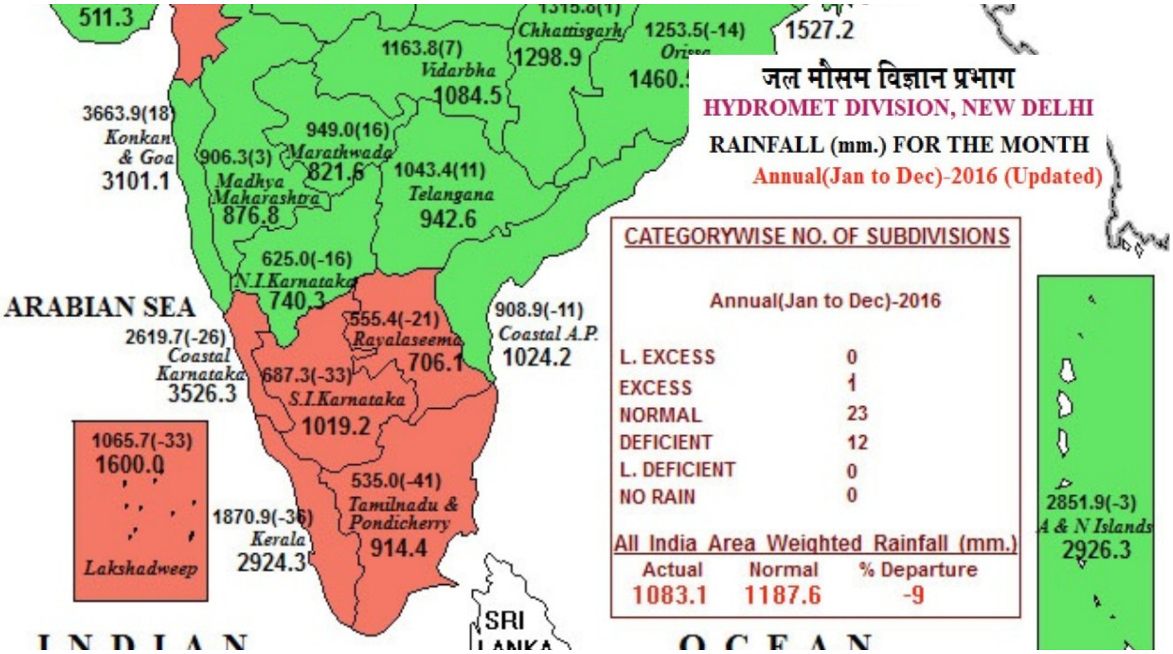
Source for district rainfall figures:Appendix 1

https://hydro.imd.gov.in/hydrometweb/(S(4h0svtznbxcwhue0qx353055))/DistrictRaifall.aspx

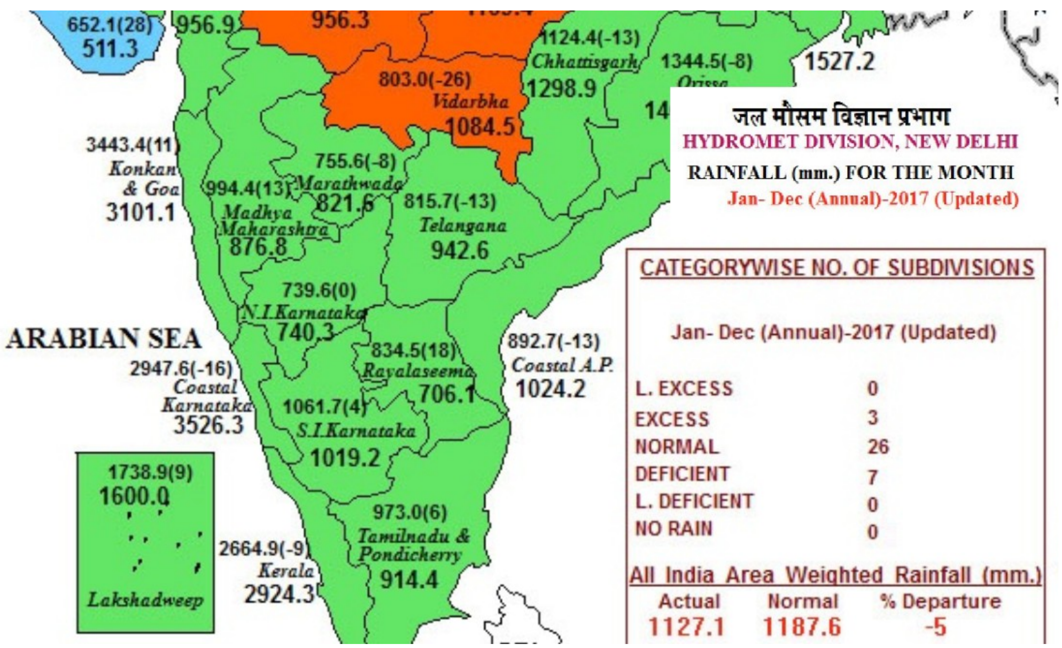
Operation Data



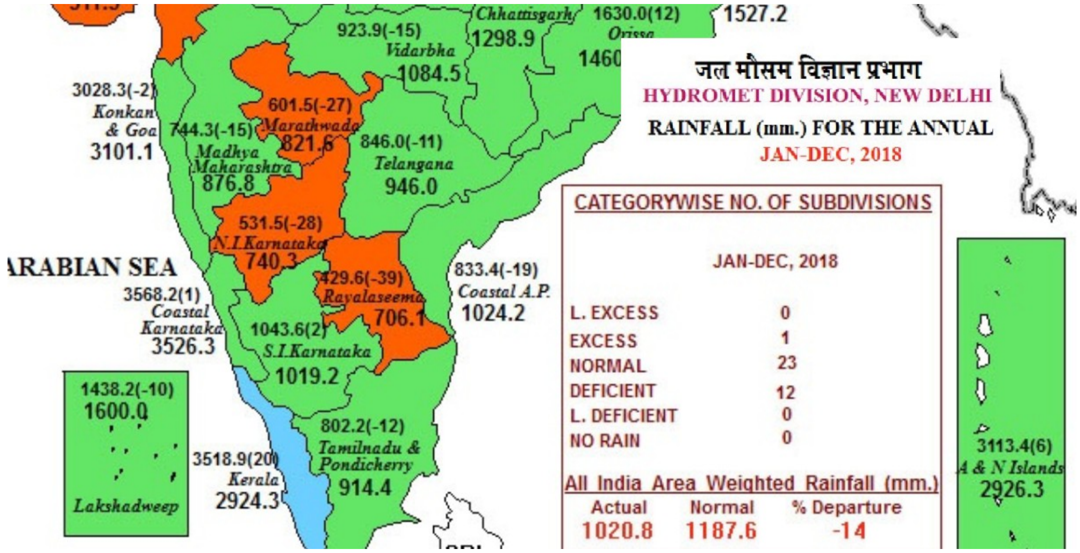
Year 2015 Rainfall: 1083.8mm



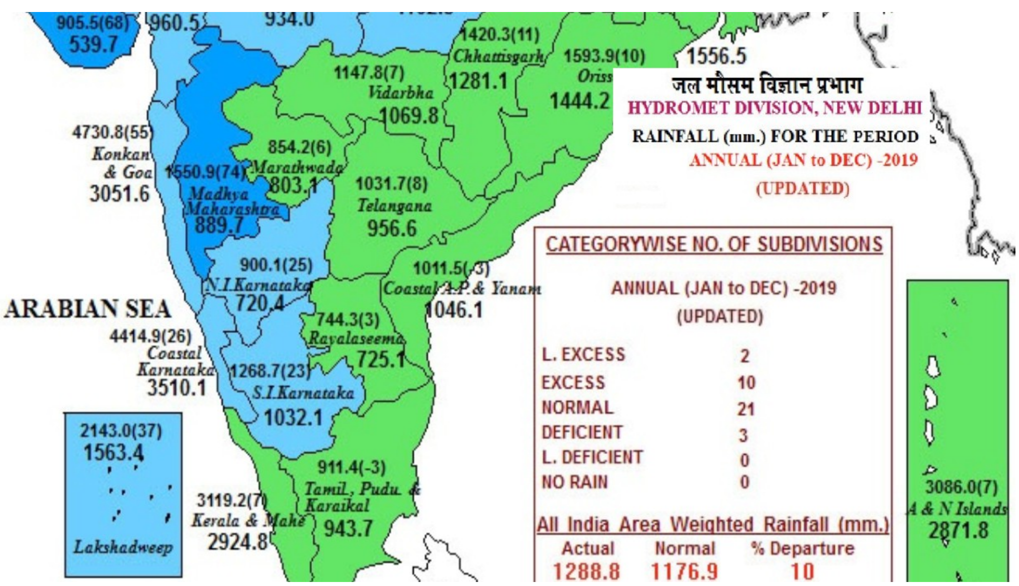
Year 2016 Rainfall: 687.3mm



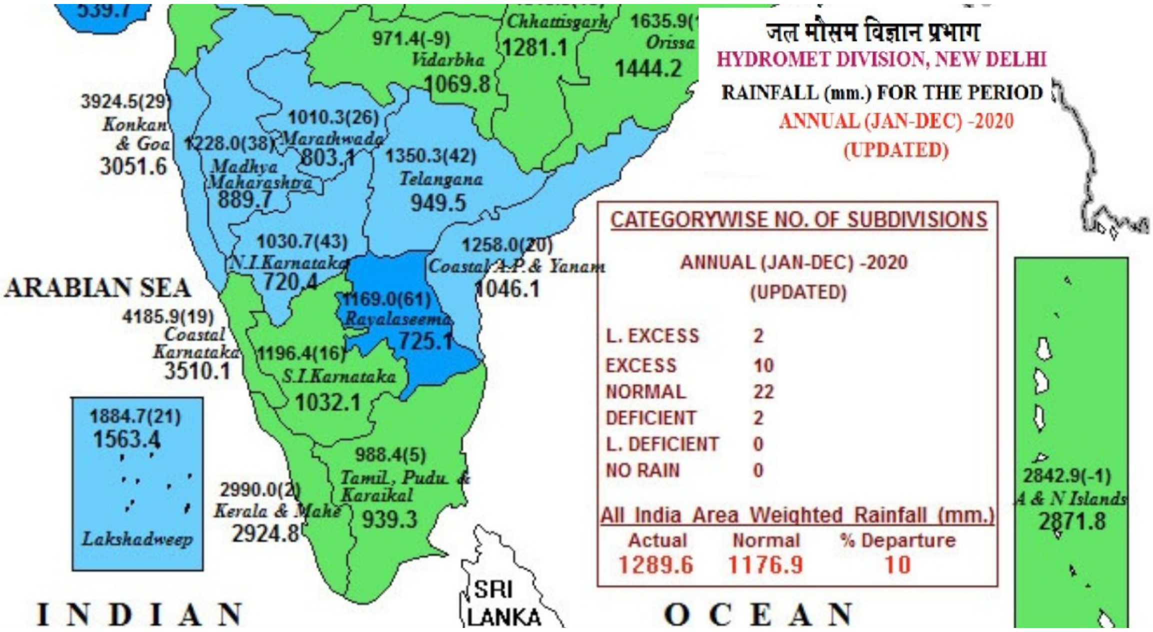
Year 2017 Rainfall: 1061.7mm



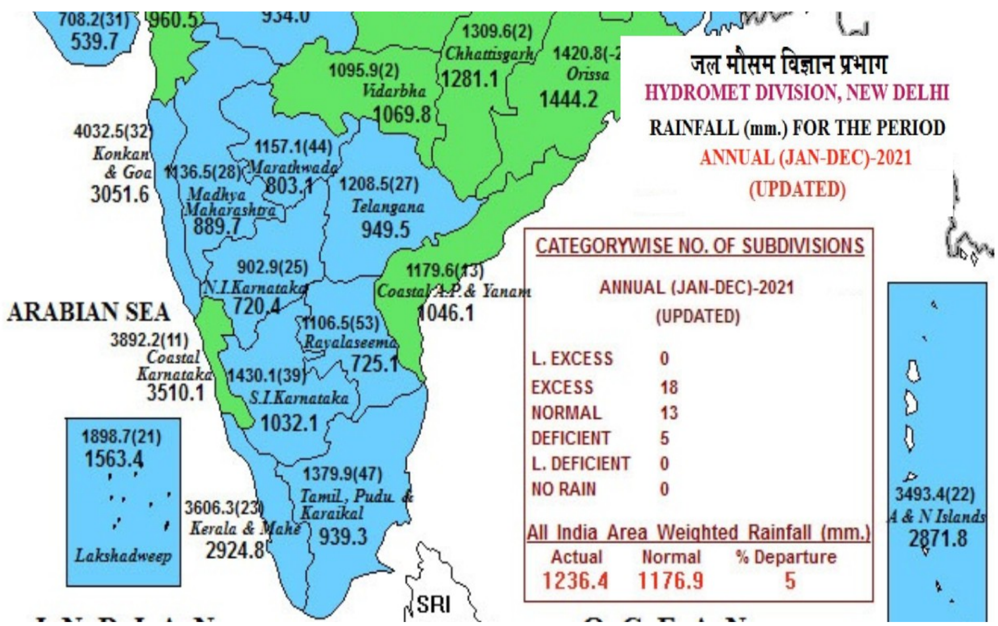
Year 2018 Rainfall: 1043.6mm



Year 2019 Rainfall: 1268.7mm



Year 2020 Rainfall: 1196.4mm

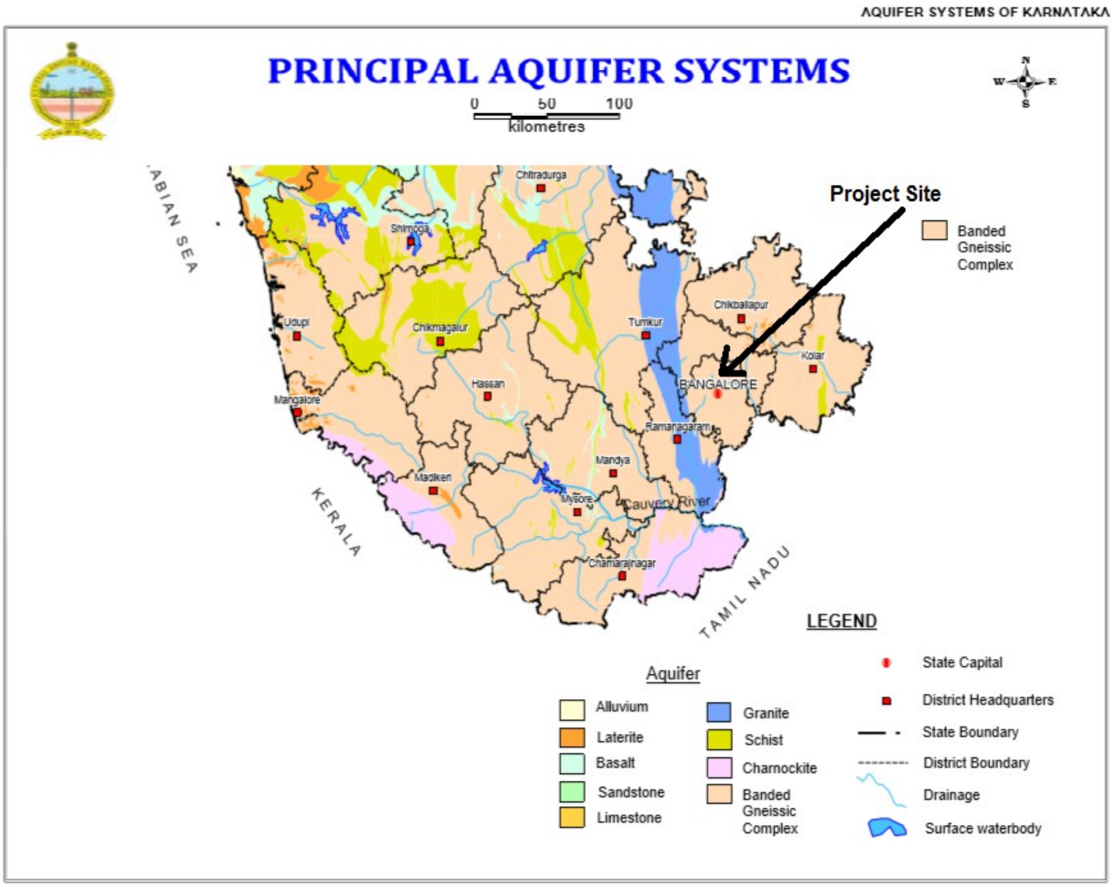


Year 2021 Rainfall: 1430.1mm

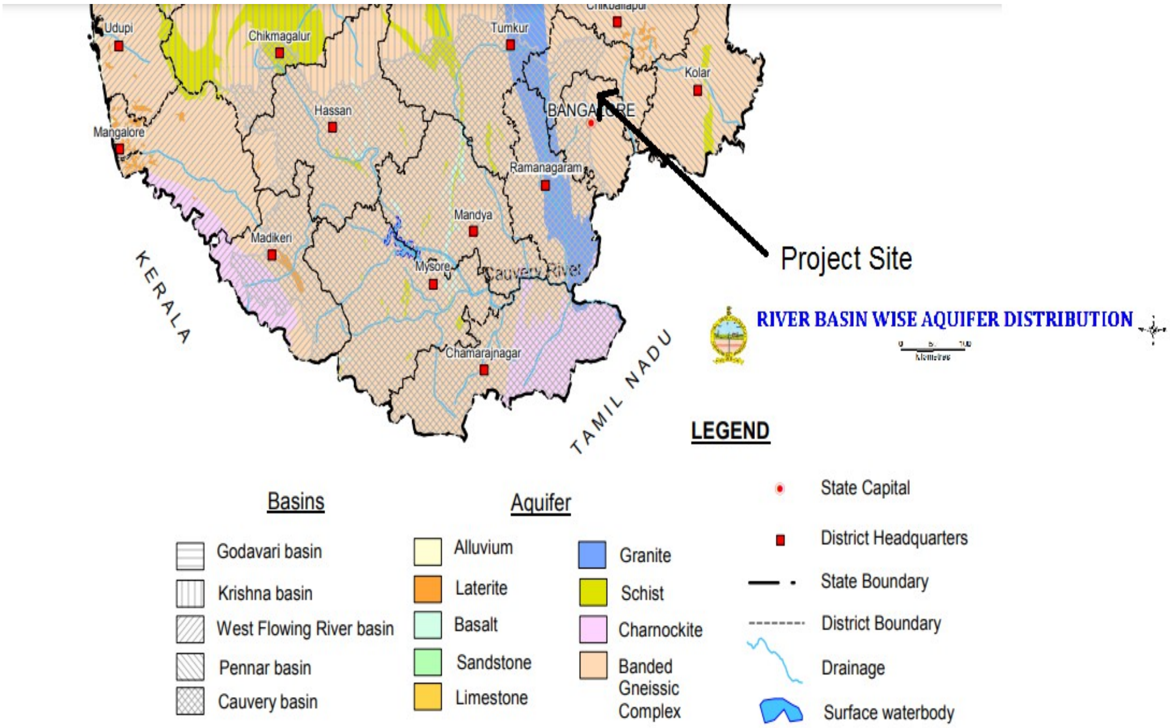
A.6. Ground Water

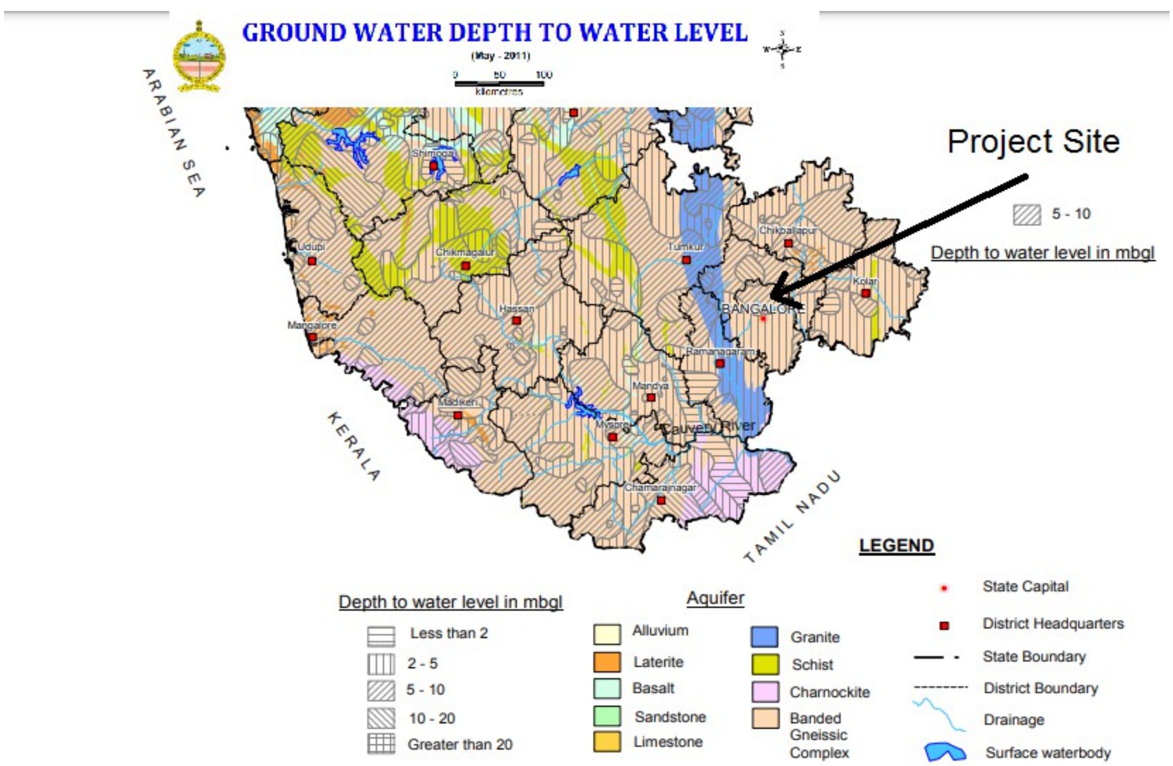
Description of aquifer: Banded Gneissic Complex (BGC) Aquifer System

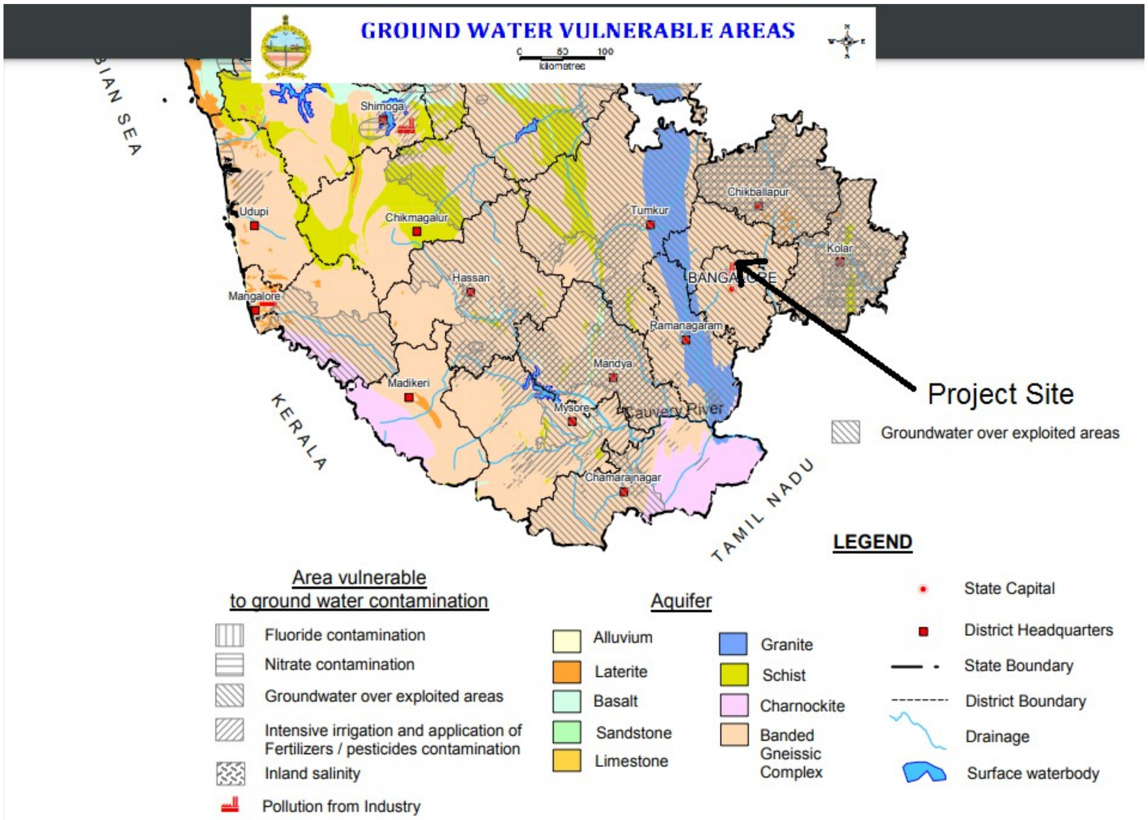
Type: Semi confined-confined

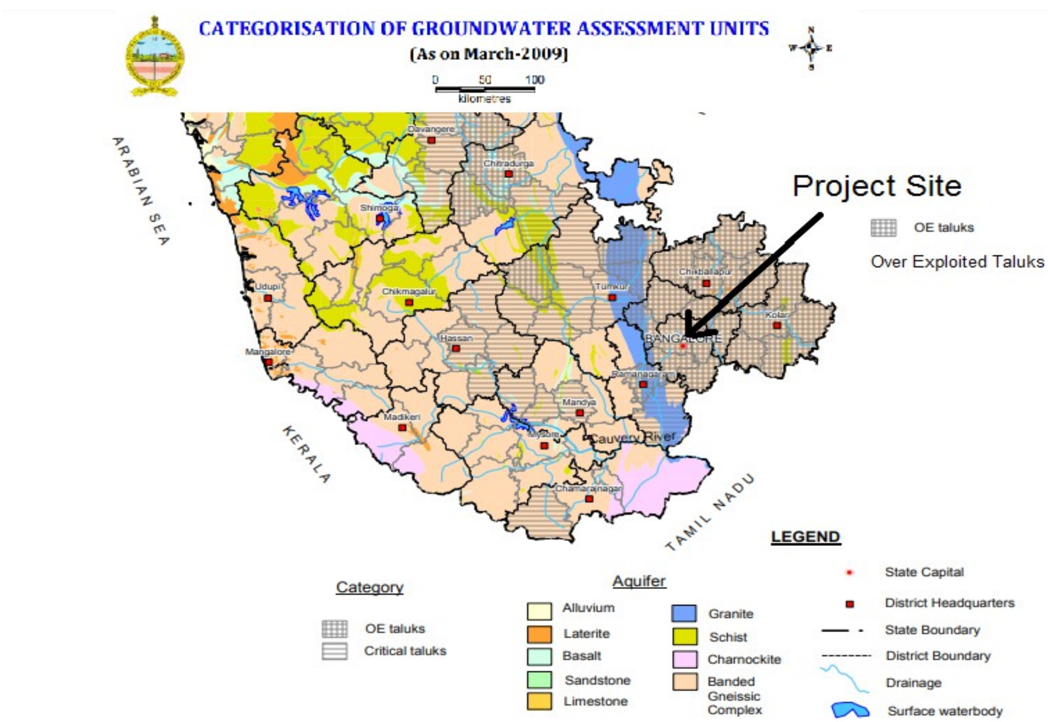


In Karnataka, the aquifer systems are classified into nine major groups depending upon their characteristics and distribution namely Banded Gneissic Complex (BGC), Basalt, Schists, Granites, Charnockites, Limestones, laterites, Sandstones and alluvium. The project activity area lies above the BGC aquifer system. BGC forms a better aquifer as compared to the basalts. Studies indicate that maximum numbers of fracture occurs between the depth range of 50 – 100 m in BGC. Maximum productive fractures occur within 0 – 100 m depth in BGC. Similar studies on the BGC aquifer with wells analyzed, showed that 67 % of the wells are high yielding in BGC as compared to other aquifers. The wells drilled in BGC are more sustainable compared to the wells in basalts.

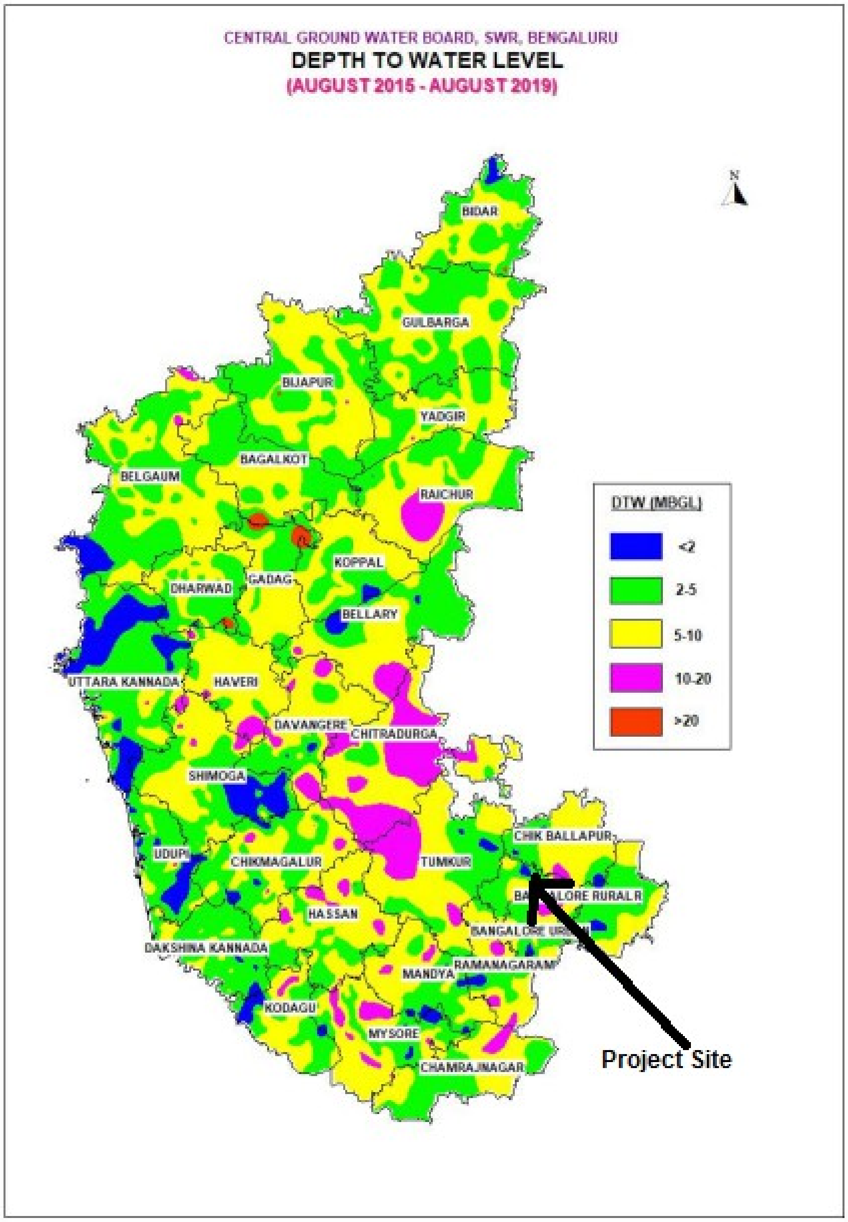

Udupi
Chikmagalur
Tumkur
Kolar
Hassan
Mangalore
BANGALORE
Ramanagaram
Mandya
Madikeri
Mysore
Cauvery River
Chamarajnagar
KERALA
TAMIL NADU
Project Site
RIVER BASIN WISE AQUIFER DISTRIBUTION
LEGEND
Basins
Godavari basin
Krishna basin
West Flowing River basin
Pennar basin
Cauvery basin
Aquifer
Alluvium
Laterite
Basalt
Sandstone
Limestone
Granite
Schist
Charnockite
Banded Gneissic Complex
State Capital
District Headquarters
State Boundary
District Boundary
Drainage
Surface waterbody


GROUND WATER DEPTH TO WATER LEVEL
(May - 2011)
0 50 100
kilometres
ARABIAN SEA
Shimoga
Udupi
Chikmagalur
Tumkur
Chikballapur
Kolar
Hassan
BANGALORE
Mangalore
Ramanagaram
Mandya
Madikeri
Mysore
Cauvery River
Chamarajnagar
KERALA
TAMIL NADU
Project Site
5 - 10
Depth to water level in mbgl
LEGEND
Depth to water level in mbgl
Less than 2
2 - 5
5 - 10
10 - 20
Greater than 20
Aquifer
Alluvium
Laterite
Basalt
Sandstone
Limestone
Granite
Schist
Charnockite
Banded Gneissic Complex
State Capital
District Headquarters
State Boundary
District Boundary
Drainage
Surface waterbody


GROUND WATER VULNERABLE AREAS
0 50 100
kilometres
Shimoga
Udupi
Chikmagalur
Hassan
Mangalore
Madikeri
Mysore
Mandya
Tumkur
Chikballapur
Kolar
BANGALORE
Ramanagaram
Chamarajnagar
Cauvery River
KERALA
TAMIL NADU
Project Site
Groundwater over exploited areas
LEGEND
Area vulnerable to ground water contamination
Fluoride contamination
Nitrate contamination
Groundwater over exploited areas
Intensive irrigation and application of Fertilizers / pesticides contamination
Inland salinity
Pollution from Industry
Aquifer
Alluvium
Laterite
Basalt
Sandstone
Limestone
Granite
Schist
Charnockite
Banded Gneissic Complex
State Capital
District Headquarters
State Boundary
District Boundary
Drainage
Surface waterbody


CATEGORISATION OF GROUNDWATER ASSESSMENT UNITS
(As on March-2009)
0 50 100
kilometres
ARABIAN SEA
Davangere
Chitradurga
Shimoga
Udupi
Chikmagalur
Hassan
Mangalore
Madikeri
Mysore
Mandya
Tumkur
Chikballapur
Kolar
BANGALORE
Ramanagaram
Chamarajnagar
Cauvery River
KERALA
TAMIL NADU
Project Site
OE taluks
Over Exploited Taluks
LEGEND
Category
OE taluks
Critical taluks
Aquifer
Alluvium
Laterite
Basalt
Sandstone
Limestone
Granite
Schist
Charnockite
Banded Gneissic Complex
State Capital
District Headquarters
State Boundary
District Boundary
Drainage
Surface waterbody

Depth to water level (May 2015-2019)										
S.No	**District**	**No of Wells analysed**	**Min**	**Max**	**No/Percentage of Wells showing Depth to water table (mbgl) in the range of**					
					0-2	**2-5**	**5-10**	**10-20**	**20-40**	**>40**
1	Bagalkot	27	2.9	26.62	0	7	12	7	1	0
2	Bangalore Rural	39	1.94	19.22	1	13	16	9	0	0
3	Bangalore Urban	23	0.72	13.58	4	11	7	1	0	0
4	Belgaum	84	0.82	21.23	3	14	42	24	1	0
5	Bellary	31	2.13	12.76	0	12	16	3	0	0
6	Bidar	39	3	20.3	0	6	14	18	1	0
7	Bijapur	58	1.99	21.44	1	12	32	12	1	0
8	Chamarajanagar	19	2.27	16.73	0	6	11	2	0	0
9	Chikmagalur	77	0.88	18.65	4	16	33	24	0	0
10	Chitradurga	30	1.66	18.1	1	5	13	11	0	0
11	Dakshin Kannada	97	1.66	15.05	2	15	60	20	0	0
12	Davanagere	52	1	14.24	7	14	24	7	0	0
13	Dharwad	24	3.67	24.7	0	3	12	8	1	0
14	Gadag	23	4.96	27.1	0	2	10	8	3	0
15	Gulbarga	82	2.49	15.51	0	19	35	28	0	0
16	Hassan	78	0.77	20.75	7	10	33	27	1	0
17	Haveri	26	1.82	18.52	1	2	12	11	0	0
18	Kodagu	65	1.11	15.58	1	12	23	29	0	0
19	Kolar	35	0.51	12.78	1	18	14	2	0	0
20	Koppal	32	1.83	17.32	1	7	21	3	0	0
21	Mandya	50	0.32	14.77	7	20	17	6	0	0
22	Mysore	56	0.75	22.46	2	16	22	13	3	0
23	Raichur	48	1.43	12.15	4	16	25	3	0	0
24	Shimoga	81	0.82	21.33	8	10	26	35	2	0
25	Tumkur	48	1.57	12.52	1	23	18	6	0	0
26	Udupi	60	2.39	13.87	0	7	38	15	0	0
27	Uttara Kannada	77	1.59	19.9	2	12	49	14	0	0
	Total	1361			58	308	635	346	14	0
	%				**4**	**23**	**47**	**25**	**1**	**0**


CENTRAL GROUND WATER BOARD, SWR, BENGALURU
DEPTH TO WATER LEVEL
(AUGUST 2015 - AUGUST 2019)
N
BIDAR
GULBARGA
BIJAPUR
YADGIR
BAGALKOT
BELGAUM
RAICHUR
KOPPAL
GADAG
DHARWAD
BELLARY
UTTARA KANNADA
HAVERI
DAVANGERE
CHITRADURGA
SHIMOGA
CHIK BALLAPUR
UDUPI
CHIKMAGALUR
TUMKUR
HASSAN
BANGALORE URBAN
DAKSHINA KANNADA
RAMANAGARAM
MANDYA
KODAGU
MYSORE
CHAMRAJNAGAR
DTW (MBGL)
<2
2-5
5-10
10-20
>20
Project Site

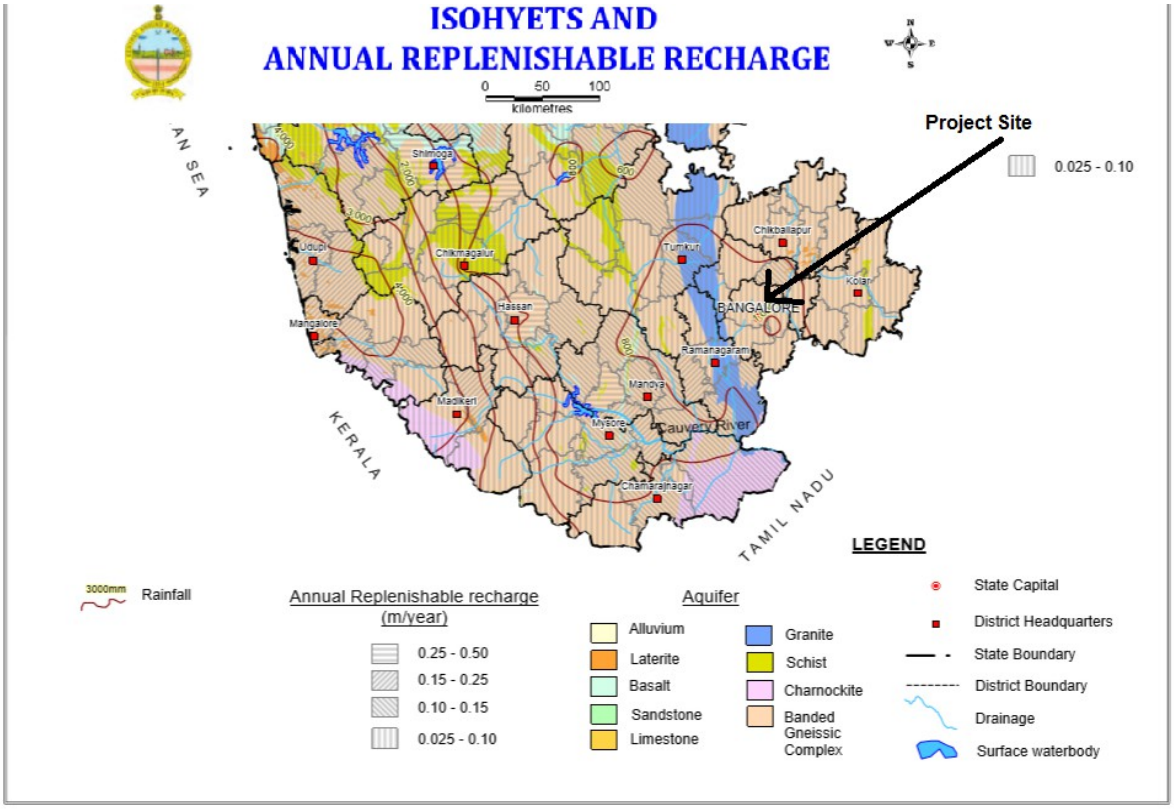


Table 17 District wise categorisation of water level fluctuation (Decadal mean 2010-2019 & Nov 2020)

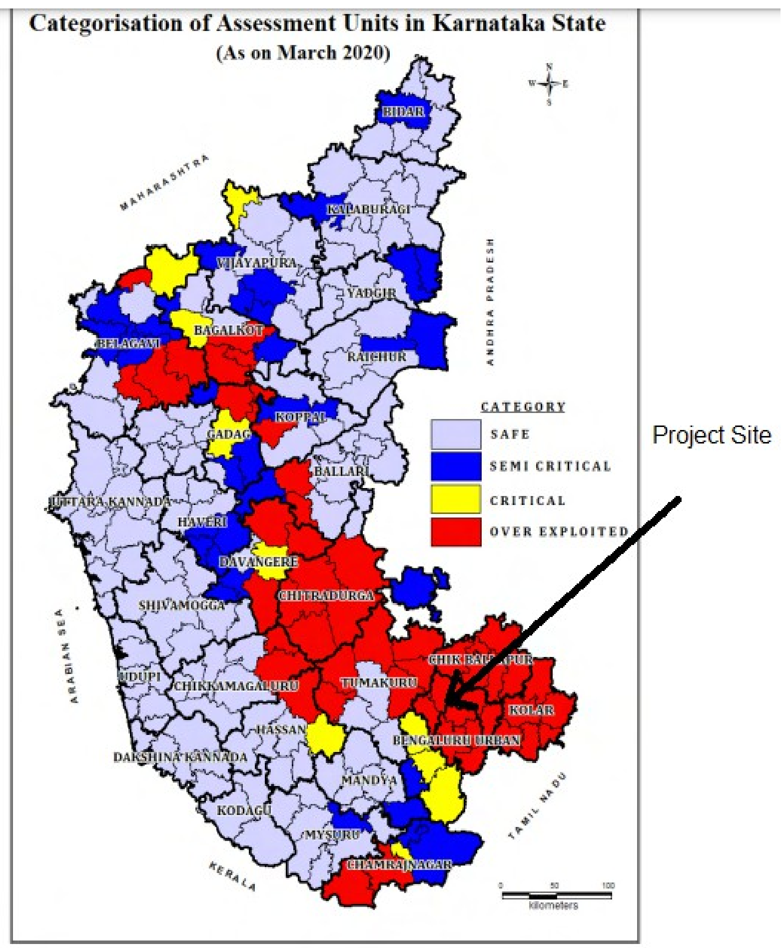
S.No	District Name	No of wells analysed	Rise_Range of Fluctuation (m)						Fall_Range of Fluctuation (m)						Rise	Fall
			0-2		2-4		>4		0-2		2-4		>4			
			No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%	No of wells	%		
1	Bagalkot	27	13	48.15	7	25.93	3	11.11	3	11.11	0	0	1	3.7	23	4
2	Bangalore Rural	38	15	39.47	10	26.32	3	7.89	6	15.79	3	7.89	1	2.63	28	10
3	Bangalore Urban	21	13	61.9	1	4.76	0	0	5	23.81	2	9.52	0	0	14	7

Mean Water Levels For The Period November 2010-2019 & November 2020:

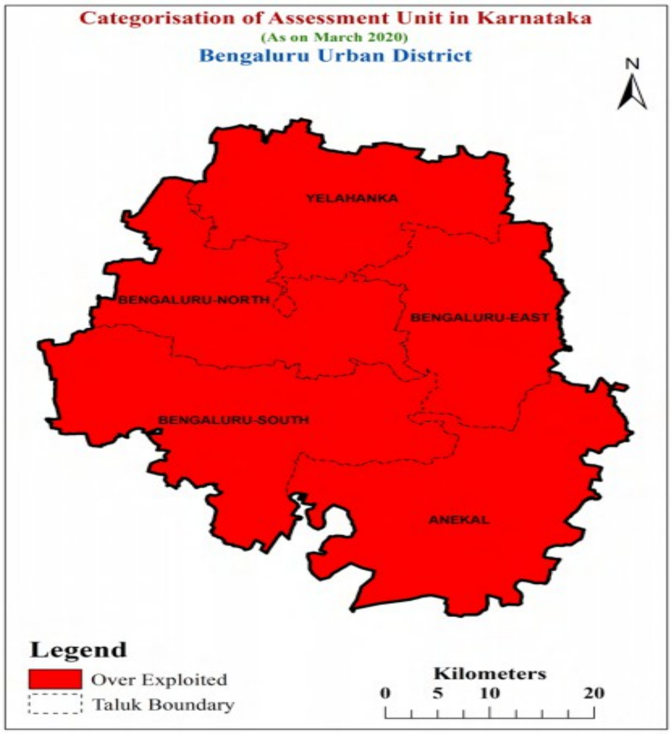
Rise in the water level in the range of 0-2 m has been observed in 48 % of wells analysed, noted all over the State. Rise in the water level more than 2-4 m has been observed in 14 % of wells analysed and noted in all over the State. Rise in the water level more than 4 m has been observed in 9 % of wells analysed and noted in all over the State except Bangalore Urban district. The fall in water level in the range of 0-2 m has been observed in 25 % of wells analysed and noted in all over the State except Bidar district. The fall in water level in the range of 2-4 m has been observed in 3 % of wells analysed and noted in Bangalore Rural***, Bangalore Urban (Project Site)***, Bijapur, Chikmagalur, Chitradurga, Dakshin Kannada, Davangere, Hassan, Mandya, Shimoga, Tumkur and Udupi districts. The fall in water level more than 4 m has been observed in 1 % of wells analysed and noted in Bagalkot, Bangalore Rural, Chikmagalur, Chitradurga, Dakshin Kannada, Gadag, Gulbarga, Hassan, Mandya, Mysore, Shimoga, and Tumkur districts.

CATEGORISATION OF WATERSHEDS AS ON MARCH- 2020

Watersheds wise Category	Watersheds as on 2020
Over Exploited Watersheds	61
Critical Watersheds	13
Semi critical Watersheds	36
Safe Watersheds	124
Total	234



The annual extractable groundwater resources as on March 2020 for the state of Karnataka is 16.40 BCM, while the gross annual draft is 10.63 BCM and the net available for future development is 7.08 BCM. The stage of groundwater extraction in the state is 65%.



DISTRICT WISE CATEGORIZATION OF TALUKAS IN KARNATAKA STATE (2020)														
NAME OF STATE/UT - KARNATAKA STATE														
S.No	Name of District	Total No. Of Assessed Units	Safe		Semi-Critical		Critical		Over-Exploited		Saline			
			No.	%	No.	%	No.	%	No.	%	No.	%		
1	BAGALKOT	9	3	33.3	2	22.2	1	11.1	3	33.3	0	0		
2	BANGALORE RUR	4	0	0.0	0	0.0	0	0.0	4	100.0	0	0		
3	BANGALORE URB	5	0	0.0	0	0.0	0	0.0	5	100.0	0	0		

The volume of space available for artificial recharge is given by the product of specific yield and volume of unsaturated zone and is found to be of the order of 10234 MCM. Considering the efficiency of 75%, water required for artificial recharge is assesed as 13611 MCM.

Karnataka State Ground Water Resources Availability, Utilization and Stage of Extraction (as in 2020)

KARNATAKA STATE GROUND WATER RESOURCES OF INDIA, 2020 (in bcm)															
S. No.	States / Union Territories	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction				Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)
		Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	Industrial	Domestic	Total			
		Recharge from rainfall	Recharge from other sources	Recharge from rainfall	Recharge from other sources										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	KARNATAKA	7.47	4.68	2.23	3.77	18.16	1.76	16.4	9.6	0	1.03	10.6	1.16	7.08	65

NOTE-Data on Ground Water Extraction for Industries is not available for Karnataka.

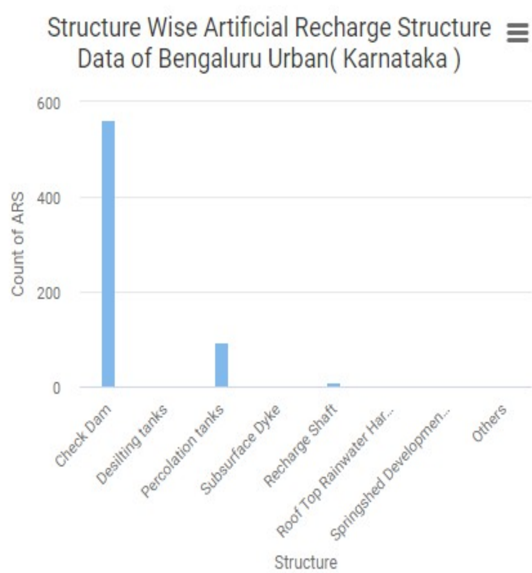
Ground Water Scenario of Bengaluru Urban	
Area (Sq.km)	2208
Average Annual Rainfall (mm)	1146.9 (State)
Area Identified for Artificial Recharge (AR) (Sq.Km.)	1606
The annual extractable groundwater resources (Karnataka)	163.4 BCM
Depth to water (Pre-monsoon)	10mbgl
Volume of Unsaturated Zone (MCM)	3972.73
Surplus Available for Recharge (MCM)	105.67
Availabe Subsurface Space for AR (MCM)	79.45
Water Required for Recharge (MCM)	105.67

(Source: DYNAMIC GROUNDWATER RESOURCES OF KARNATAKA, 2020)

A.7. Alternate methods

Monsoon rainfall run off is the only source water for artificial recharge in the state. The surface water spreading structures, viz., percolation tank, check dam, recharge shaft, sub-surface dyke and vented dams (Dakshina Kannada District) are considered in the State. Other artificial recharge structures (ARSs) that have been installed in the surrounding district includes the following:

S.No.	ARS type	No of ARS	Total Cost (Rs. Lakh)
1	Check Dam	562	5650
2	Desilting tanks	0	0
3	Percolation tanks	95	1900
4	Subsurface Dyke	0	0
5	Recharge Shaft	8	12
6	Roof Top Rainwater Harvesting (RTRWH)	0	0
7	Springshed Development/Watershed Development	0	0
8	Others	0	0



State: Karnataka | District: Bengaluru Urb | Type of Structure: - Select Type o

Statistics

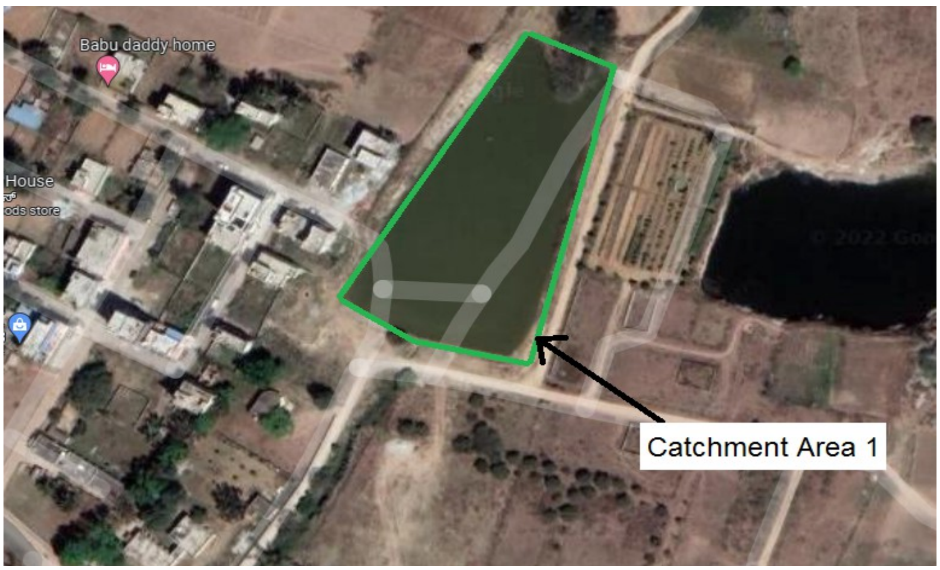
Total Geographical Area (Sq. Km.)	2208.00
Area Identified for ARS (Sq. Km.)	1606.00
Volume for Unsaturated Zone (MCM)	3972.73
Available subsurface volume for ARS (MCM)	79.45
Water Required for recharge (MCM)	105.67
Surplus water available for recharge (MCM)	105.67

(Source:http://cgwb.gov.in/Master%20Plan%20to%20GW%20Recharge%202020.pdf)

A.8. Design Specifications

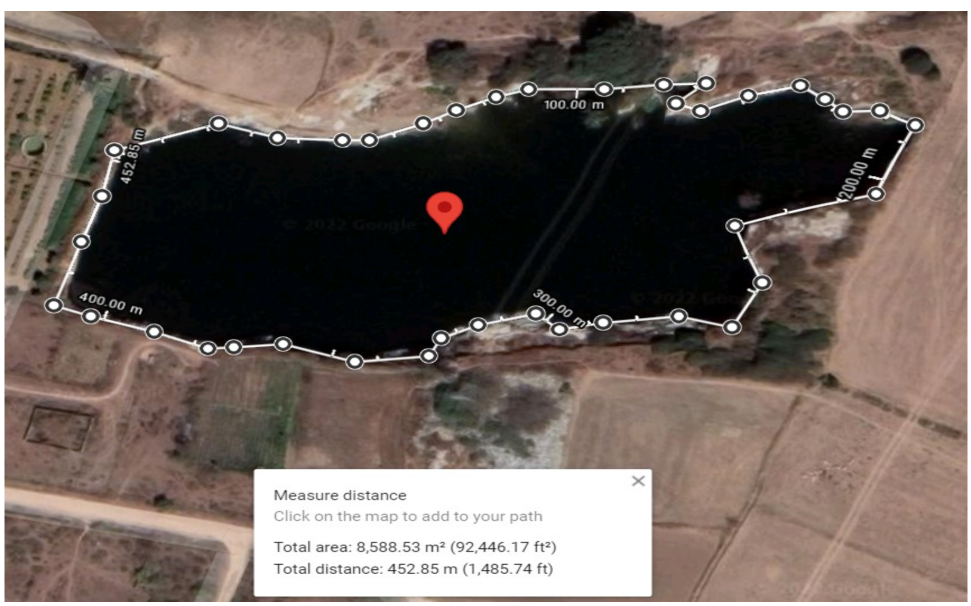
The project activity involves three (3) distinct RWHs as below:

- A pond type catchment system with associated recharge soak pits to capture rainfall runoff during the monsoons, constructed by increasing the depth of a naturally occuring depression with high terrain on all four sides to collect rainwater (**Catchment Area 1**). The project activtiy in Catchment Area 1 hence creates potable drinking water via bore wells from previously untapped water resources.

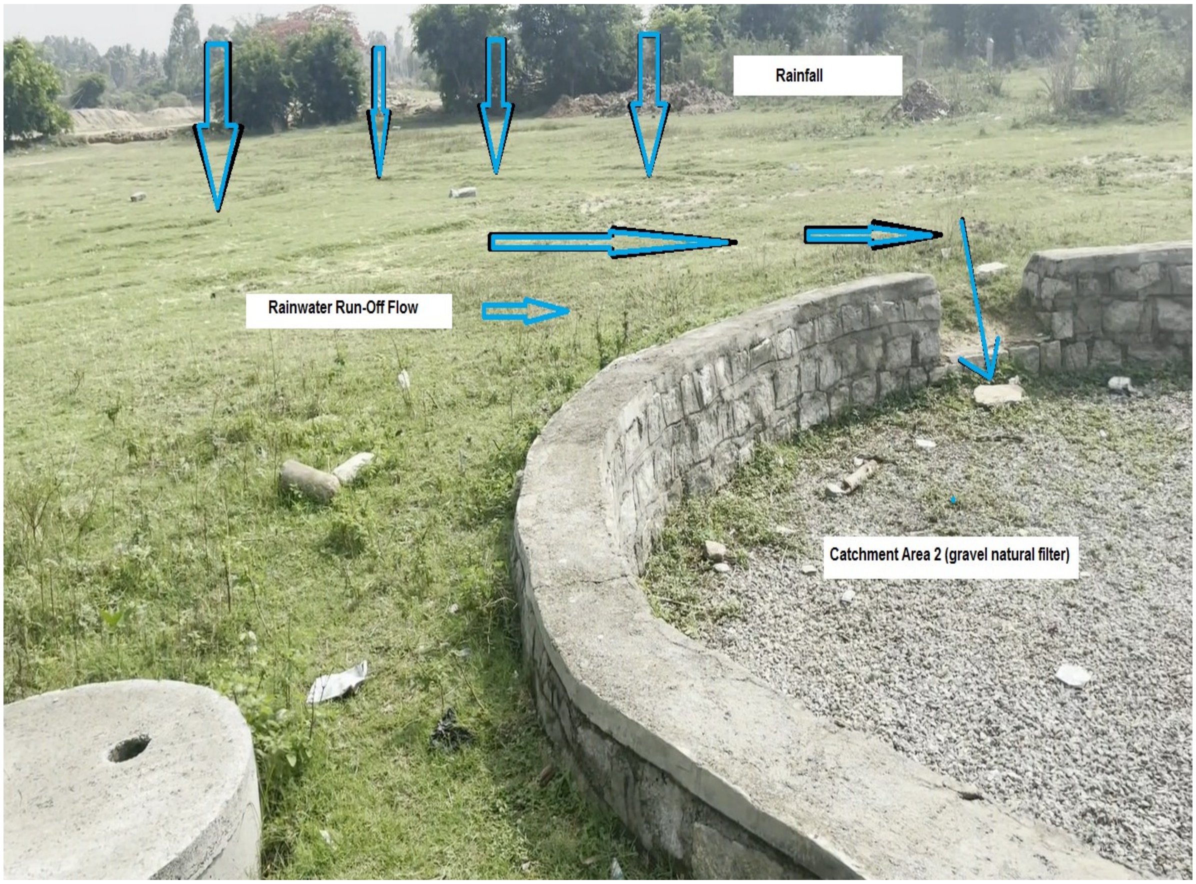


- A circular manmade catchment area with stones and concrete (**Catchment Area 2**) with associated recharge soak pits. The project activtiy in Catchment Area 2 creates potable drinking water from previously untapped water resources by recharging the groundwater aquifer.

- An irregular (Catchment Area 3) abandoned quarry that has been cleaned by the PP and harvested for rainwater since 2016. The water collected and reused (from **Catchment Area 3**) is not fit for drinking purposes, hence the water is pumped and used by the local villagers for agricultural purposes only. In doing so, the PP has saved the groundwater from being over exploited.

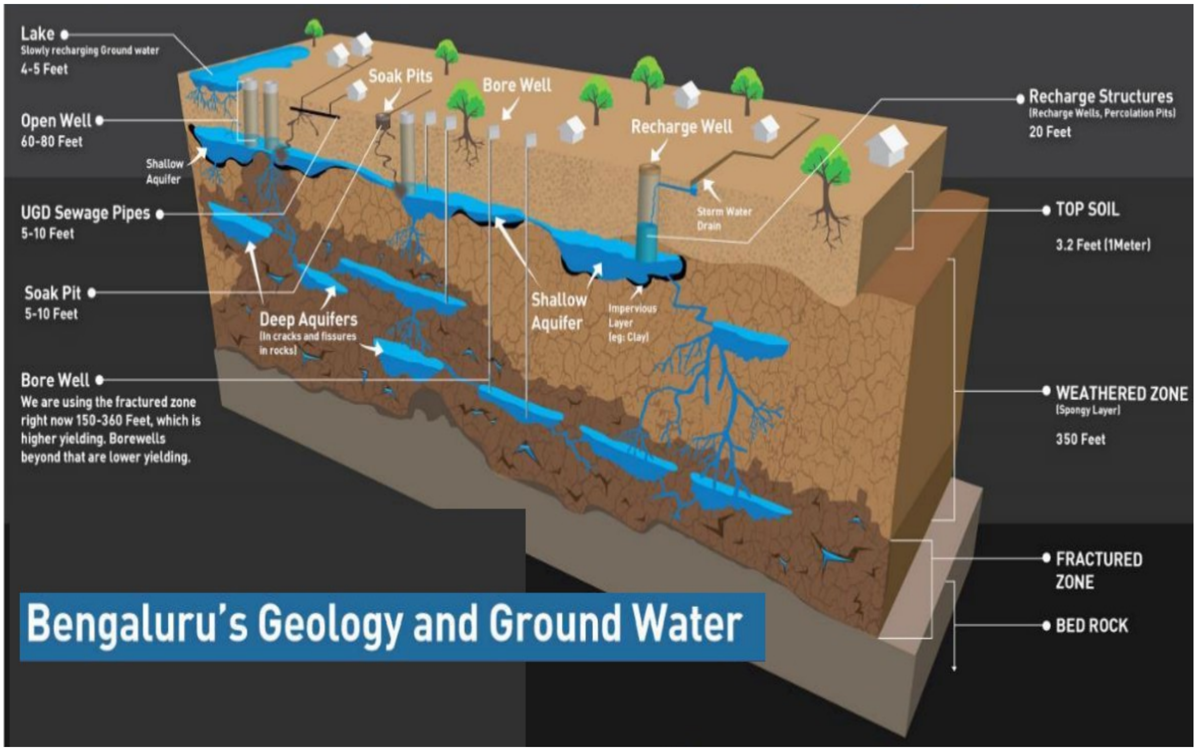


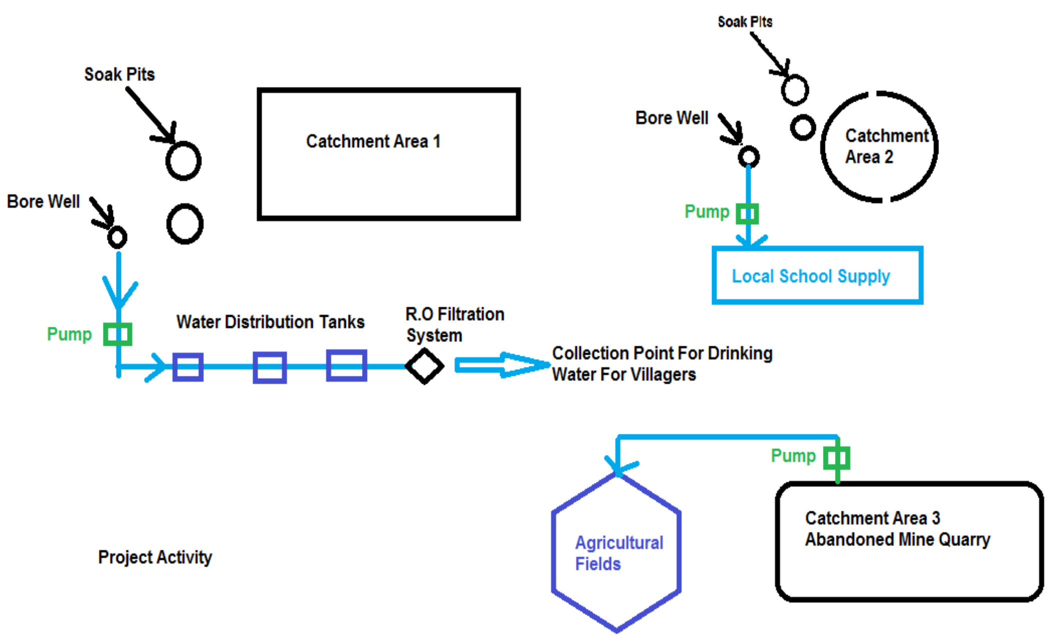
The PP has constructed 15 ft deep soak pits (recharge pits) near catchment areas 1& 2, that are used to recharge the borewells in the vicinity. This method allows the rainwater to replenish groundwater by recharging the underground aquifers and also pumping of water from the bore wells to provide for potable driniking water (after filtration) to the villagers.



The concept behind recharge wells is that water collected in these wells during rains percolates into the ground and recharge shallow aquifers. Shallow aquifers are water-bearing formations that exist about 10-100 ft underground. These are supposed to get replenished naturally during rains, hence, with recharge wells, rainwater can be routed into the shallow aquifers, which enhances groundwater levels. Surface water run-off typically seeps into the ground through natural cracks in the earth then into the aquifer. This natural percolation takes time, and only a small percentage of the surface water actually reaches the aquifer. Surface water also contributes more to soil moisture than groundwater does, and some is lost to evapotranspiration.


Bore Well


Lake
Slowly recharging Ground water
4-5 Feet
Open Well
60-80 Feet
Shallow Aquifer
UGD Sewage Pipes
5-10 Feet
Soak Pit
5-10 Feet
Bore Well
We are using the fractured zone right now 150-360 Feet, which is higher yielding. Borewells beyond that are lower yielding.
Soak Pits
Bore Well
Recharge Well
Storm Water Drain
Shallow Aquifer
Impervious Layer (eg: Clay)
Deep Aquifers (In cracks and fissures in rocks)
Recharge Structures
(Recharge Wells, Percolation Pits)
20 Feet
TOP SOIL
3.2 Feet (1Meter)
WEATHERED ZONE
(Spongy Layer)
350 Feet
FRACTURED ZONE
BED ROCK
Bengaluru's Geology and Ground Water


Soak Pits
Catchment Area 1
Bore Well
Pump
Water Distribution Tanks
R.O Filtration System
Collection Point For Drinking Water For Villagers
Soak Pits
Bore Well
Catchment Area 2
Pump
Local School Supply
Pump
Agricultural Fields
Catchment Area 3
Abandoned Mine Quarry
Project Activity

Distribution network:

The village has water tanks installed at different locations. Recharged water from the bore wells are pumped into these tanks and a distribution network is set up to help circulate the water to houses across the village efficiently, there are many of these placed in different parts of the village so that there is efficient distribution of clean water.

Filtration System:

In 2019, PP and the local villagers had installed a filtration system (Reverse Osmosis-RO) to provide clean drinking water using the captured rainwater to the residents at a nominal cost. This filters up to 500+ liters per day. The revenue from the sale of RoUs can be used to install more RO systems.

Area of each catchment (1, 2 & 3)


100.00 m
452.85 m
200.00 m
400.00 m
300.00 m
© 2022 Google
Measure distance
Click on the map to add to your path
Total area: 8,588.53 m² (92,446.17 ft²)
Total distance: 452.85 m (1,485.74 ft)

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 rain water utilizing suitable civil construction techniques, such as soak pits and rechagre wells for rainwater harvesting.

Such artificial recharge techniques normally address the following issues -

(i) Serve 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 and recharge of rainwater run off.

(iv) Raises the underground water table

(v) Reduces groundwater pollution

(vi) Reduces soils erosion

(vii) Supplements domestic water needs

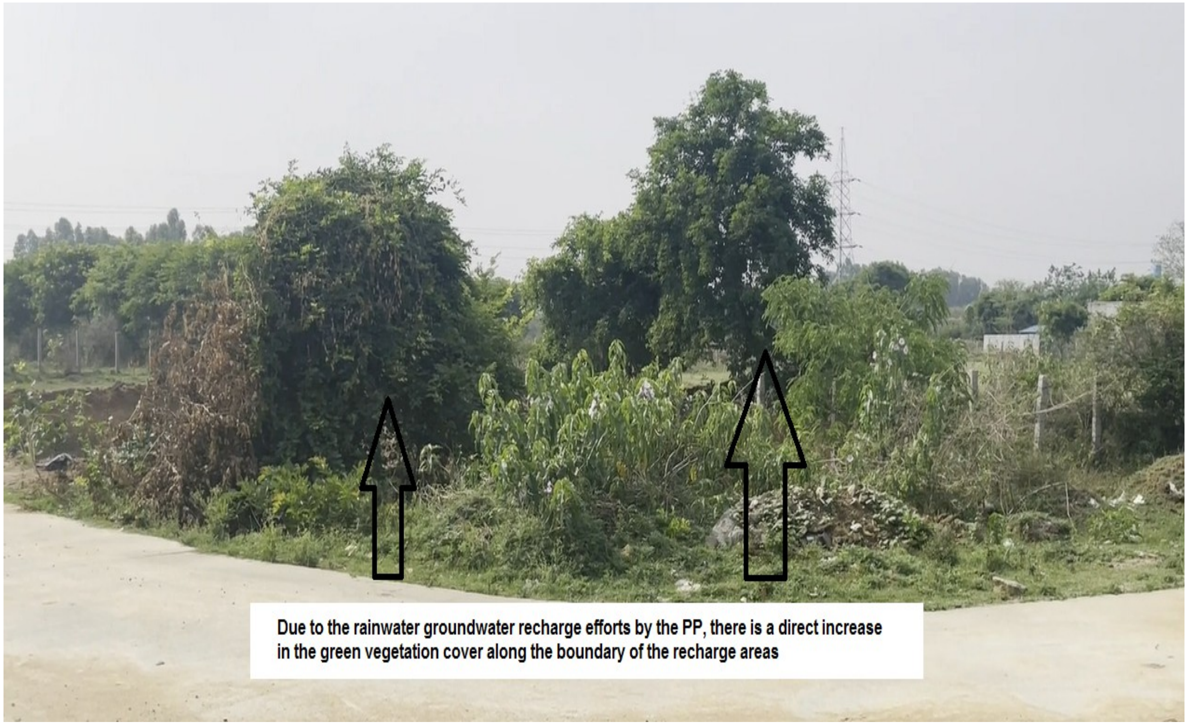
The basic purpose of artificial recharge of ground water is to restore supplies from aquifers depleted due to excessive ground water development.

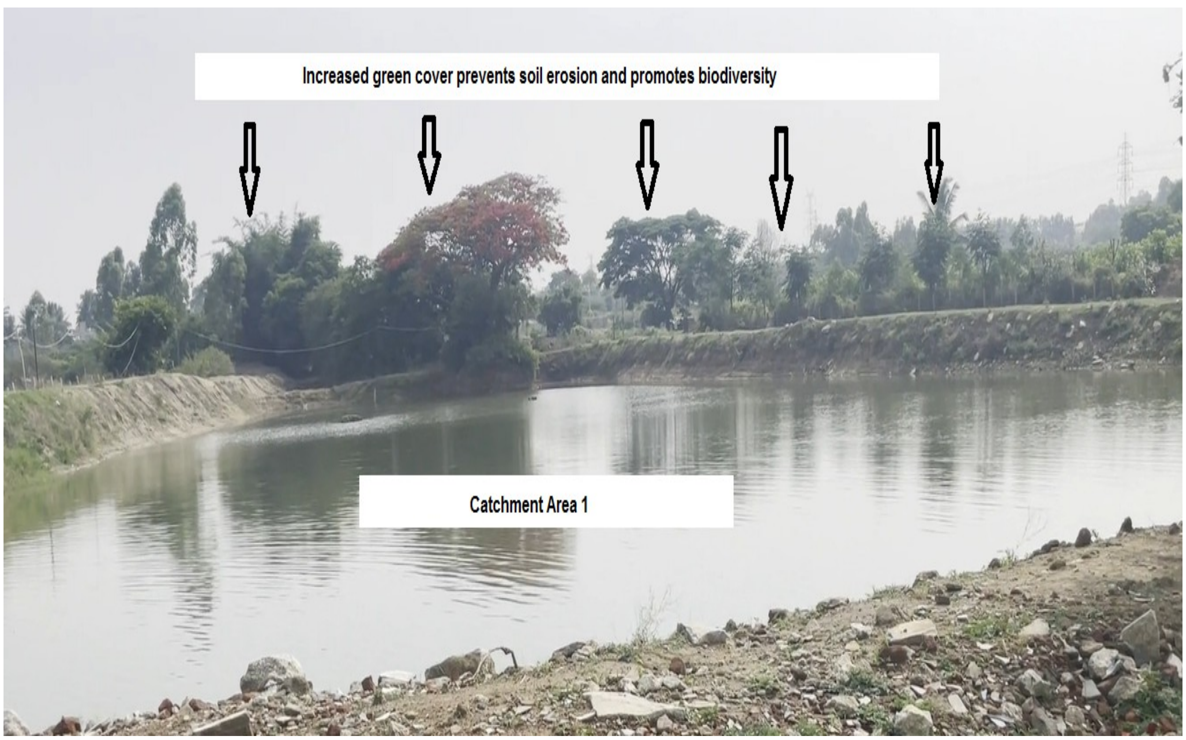
The availability of source water, one of the prime requisites for ground water recharge, is basically assessed in terms of non committed surplus monsoon run off, which as per present water resource development scenario is going unutilised. This component can be assessed by analysing the monsoon rainfall 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 or Outcomes

The impact assessment or objectives of this RWH scheme can generally 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, a check to this and/or the intensity of decline subsequently reduces. The energy consumption for lifting the water also reduces.
- c) The ground water structures (recharge wells) in the benefitted zone of artificial structures gains sustainability and the wells provides water in lean months when these were going dry.
- d) The domestic wells have become sustainable and many of the areas become tanker free.
- e) Green vegetation cover has increased in the zone of benefit and also along the structures due to additional availability of soil moisture.
- f) The quality of ground water has improved due to dilution.
- g) 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.
- h) Catchment area and pond management have a direct impact on groundwater levels and there are visible signs around the catchment area of the project activity site.


Due to the rainwater groundwater recharge efforts by the PP, there is a direct increase in the green vegetation cover along the boundary of the recharge areas


Increased green cover prevents soil erosion and promotes biodiversity
Catchment Area 1

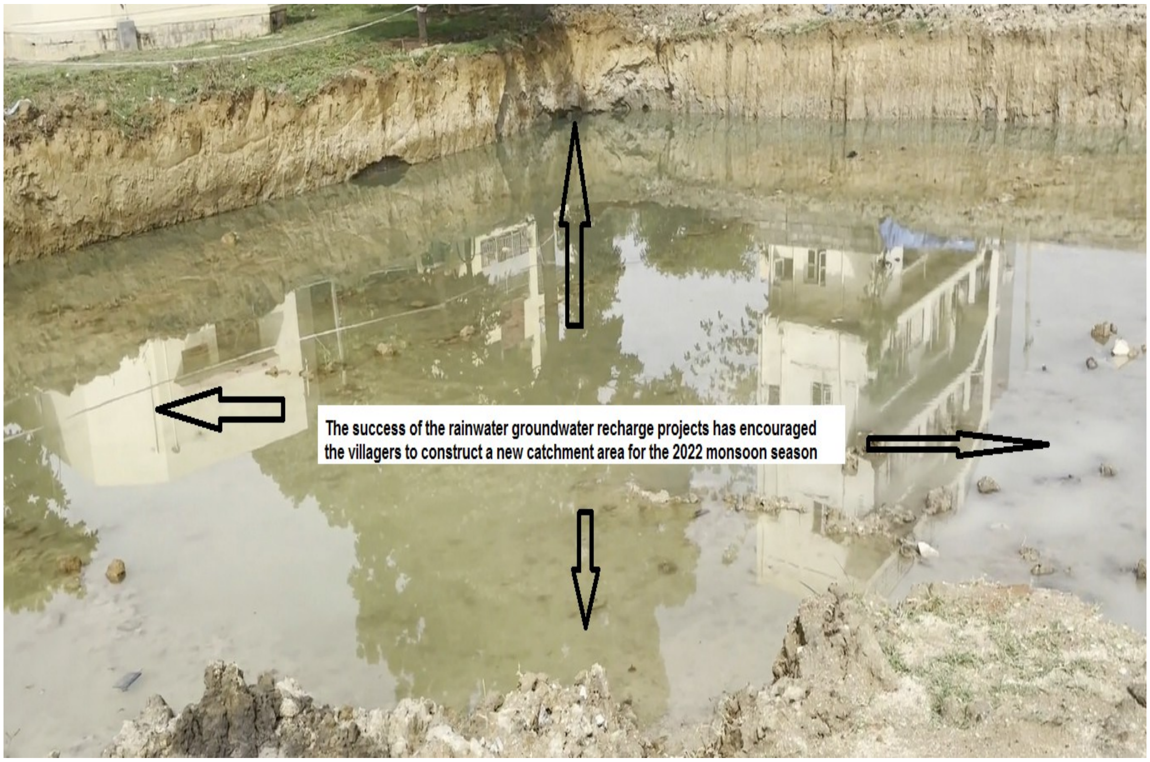
A9.2 Interventions by Project Owner / Proponent / UCR Member

The school near Catchment Area 2, had reported that prior to the implementation of the project activity in 2015, the bore well in the area had gone dry. Further the school had to rely on water supplied by local water tankers (arranged by the village authorities) for the daily water needs.

Prior to the implementation of the project activity in 2015, the local villagers received only 40 litres of water per household for daily use. Today each household in the village receives 250 litres of water, hence clearly indicating that such rainwater harvesting ssytems need to be scaled across the state.

Increase in population density and improvement in quality of life has resulted in an increase in demand of natural resources like water. Groundwater being the major source of water supply catering to about 85% of rural water supply, the stress on groundwater is ever increasing. It has resulted in over-exploitation of the resources at places. The situation demands for a reorientation of the strategy for its development and management. Scientific understating of the hydro geological conditions and the aquifer systems are the important inputs for sustainable management of ground water resource so that the requirement of present generation is met without compromising the ability of future generations to meet their own needs. The ground water development over the years has changed the hydro geological regime and the recharge and draft components to a great extent. Large areas of Karnataka have been experiencing declining ground water levels due to over-exploitation.

The intervention of the PP and the local villagers has had a direct impact on the water security of the area. Over- development of the ground water resources results in declining ground water levels, shortage in water supply, intrusion of saline water in coastal areas and increased pumping lifts necessitating deepening of ground water structures and increase in power costs.


The success of the rainwater groundwater recharge projects has encouraged
the villagers to construct a new catchment area for the 2022 monsoon season


New Catchment Area Under Construction for the
2022 monsoon season

A.10. Feasibility Evaluation

As stated in section A.7, check dams is not a viable option for recharging of groundwater using rainfall in the area. Recharge wells and soak pits are the most feasible option to recharge the groundwater in the village. This is clearly evidenced by the improved groundwater table and improvement in drinking water availability for the villagers.

A.11. Ecological Aspects :

Unfortunately, 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.

In Karnataka, as per the Central Ground Water Board (CGWB), Aquifer Report for Karnataka dated 2012, understanding the aquifer behavior in hard rock terrain is always difficult. A paradigm shift from “ground water management” to “aquifer management” by involving the farming community and other beneficiaries is expected to yield the desired impact, particularly the sustainability of the resource, said the report.

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. Moreover, 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 these systems 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, which is 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 lead to inundation of residential land.
Creation of water logging and vector disease prevention mitigation	The catchment area, soak pits, bore wells are all inter-related and provide potable drinking water to the villagers in the surrounding area.

	Catchment Area 3 water is used daily for irrigation purposes and water is pumped daily to nearby fields. There has been no reported outbreaks of vector borne water diseases in the area due to the project activity.
Deterioration of quality of groundwater	Recharging water into the aquifers helps in improving the quality of existing groundwater aquifer 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.12.1 Solving for Recharge**

Water Budget Component	Typical Estimated Uncertainty (%)	Description
Surface Inflow	1.00%	Conservative. Typical range of accuracy for minimum delivery accuracy requirements of delivery and diversion undertaken by the installed systems.
Precipitation	5.00%	Conservative. Typical range of accuracy from field-level rain gauges to extrapolation of local weather station data.
Surface Outflow	1.00%	Fairly conservatinve since the catchment areas have adequate depth.

Evapotranspiration	20.00%	Clemmens and Burt, 1997; typical accuracy based on free water surface evaporation coefficient.
Deep Percolation	5.00%	Typical range of calculated accuracy from field-scale water budget results (fields ranging from 56 to 125 acres).
Total	32.00%	

A.13. Quantification Tools

Baseline scenario

The baseline scenario is the situation where, in the absence of the project activity, unutilized rainwater flows uncollected into drains or is not conserved and harvested within the project boundary and hence remains unutilized. Baseline scenario, if not directly measurable, is calculated by using the following option as per UCR Standard:

Option 1:

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 (1-0.32 = 0.68)

Catchment Area: 14718.11 m^2

As per UCR RoU Standard:

Surface	Runoff Coefficient (K)
Clayey soil (Catchment 1& 3)	0.82
Gravel (Catchment 2)	0.7

***Year 2015: Area applicable = Catchments 1&2**

****Year 2016 onwards: Area applicable = Catchments 1, 2 &3**

Quantification

Year	RoUs (1000 litres) /yr
2015	3699
2016	5637
2017	8708
2018	6330
2019	7843
2020	8628
2021	11730
Total	52575

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

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

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

• *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 April 2015, prior to the monsoon season. In 2015 the village groundwater table was very low and the village authorities were able to supply only 40 litres of water per household with the rainwater harvest project the villagers are now able to get 250 litres of water per household. In 2019, the PP has also set up a RO (Reverse Osmosis) water filtration system to provide clean drinking water to the residents at a nominal cost. Revenue from the sale of UCR RoUs will enable scaling up of such project activities.

• *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 recharge unutilized water and provides potable water for drinking purposes and also agricultural purposes thereby preventing over exploitation of the groundwater aquifer. The project activity also helps in groundwater recharge efforts and water security of the country.
• *Conserve and store excess water for future use*
RWH is responsible for lessening the load on primary water sources, adding fresh and potable water availability for the masses. In the urban areas, it is shown to be beneficial by increasing the efficiency of wastewater treatment plants since the need for clean water is compensated by the harvested rainwater, to a great extent. The project activity decreases the dependence on groundwater, thereby preventing excessive depletion.

A.15. Scaling 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.

It's been 12 years since the state government (Karnataka) made it mandatory for homes and commercial establishments to install rainwater harvesting (RWH) systems, but only about two lakh of 25 lakh properties in Bengaluru have followed suit so far.

What's more worrying is that of these two lakh properties, 80% are not making use of the harvested water. They continue to depend on Cauvery and underground water for all purposes, defeating the very purpose of RWH installation. The government has no clear data on how many buildings with RWH are actually using the stored water. *(source:https://timesofindia.indiatimes.com/city/bengaluru/12-years-on-karnatakas-rainwater-harvesting-dream-stuck-in-pipeline/articleshow/86523058.cms, 2021)*

The CGWB, has already reported that construction of artificial recharge structures are to be taken up in areas covered by over-exploited aquifers to maintain the sustainability in Karnataka. In rural Bangalore, villagers need to learn to manage their groundwater better, to make sure there is more recharge. The stories of countless people suffering from intestinal infections have some clear echoes of socioeconomic realities, but they also highlight the groundwater crisis in Karnataka. In early September 2021, the first person from Vijayanagar's Makarabbi village fell ill after consuming contaminated water. Six villagers died within ten days, and more than 150 people got sick after drinking the water. The 2,000-strong village has four borewells, three of which have been deemed unsafe for human consumption. The incident underscored a disturbing reality — the state's groundwater contains fluoride and nitrate, which makes crores of people susceptible to fluorosis and cancer (source).

Hard-rock aquifer systems dominate the State of Karnataka. Groundwater exploitation in such aquifers has produced various consequences surrounding aquifer depletion and groundwater contamination, with these two often coterminous to each other in many regions of the state. With nearly half of Bengaluru relying on groundwater, it is no surprise that borewells are being drilled to unprecedented depths. In the recent past, water could be found at a depth of 300 feet in the lakeside neighbourhoods. Now, the water level has plummeted to 700-800 feet. In some areas, the groundwater has receded to the depth of 1600 feet.

Managing and governing aquifers, with a focus on reviving, restoring and recharging the shallow aquifers are part of a long-standing heritage in the State of Karnataka, and UCR RoU projects activities such as "**Rainwater Harvesting Recharge Kadusonnapanahalli Karnataka, India"** holds the key in addressing many of the current day groundwater challenges in the State. Another factor affecting the pace of such installations 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 UCR 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.

Revenue from water credits (RoUs) will provide a much needed incentive to encourage recharge of other surrounding aquifers using rainwater harvesting, at scale and faster payback on investments undertaken for installationj of filtration systems by similar PPs to build and operate recharge structures such as soak pits and recharge wells.

In order to remain operative in the long run, several parts of the system require regular operation and maintenance (O&M). Regular O&M activities include:

- Verifying all components of the system are fully intact
- Cleaning of irrigation and runoff channels
- Cultivating the bund planting around the catchment areas
- Strengthening and repairing the bund and catchment boundaries.

The villagers currently pay a nomial cost for receiving R.O. purified water from the RWHs. The revenue from the sale of RoUs could offset the nominal charge and could even be provided free of cost. Further, the villagers have already begun work on two (2) additional RWHs in the area, hence the cost of construction of all future RWHs being planned by the PP/villagers can be mitigated with the sale of UCR RoUs.

One hectare of land with just 100mm of rain -- that's what even the most barren of Indian lands recieve 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 across India.

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 the gathered 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 fit for drinking.

As for the legal 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. The authorities should focus on encouraging community rainwater harvesting. (source)

Appendix 1

Human Development Index (HDI) Ranking

From the 2020 Human Development Report

India

-	Rank	Country	HDI value (2019)	Life expectancy at birth (years) SDG3	Expected years of schooling (years) SDG 4.3	Mean years of schooling (years) SDG 4.6	Gross national income (GNI) per capita (PPP $) SDG 8.5
	131	India	0.645	69.7	12.2	6.5	6,681

Source: **Human Development Report Office 2020.** • Created with **Datawrapper**

Customized Rainfall Information System (CRIS)
Hydromet Division
India Meteorological Department
Ministry Of Earth Sciences
New Delhi-110 003

Choose the States/UTs KARNATAKA Select District. BENGALURU URBAN GO

District : BENGALURU URBAN

Note :(1) The District Rainfall in millimeters (R/F) shown below are the arithmatic averages of Rainfall of Stations under the District.
(2) % Dep. are the Departures of rainfall from the long period averages of rainfall for the District.
(3) Blank Spaces show non-availability of Data

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC	
	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP
2016	4.9	115	0.0	-100	18.2	122	6.2	-84	132.3	24	164.0	122	187.9	105	45.1	-65	48.1	-73	31.7	-80	2.9	-95	73.3	307
2017	0.5	-78	0.0	-100	27.4	234	26.0	-34	204.6	93	32.0	-57	41.1	-55	231.7	80	394.5	118	259.7	63	15.1	-72	11.5	-36
2018	0.0	-100	3.5	-47	47.4	478	24.0	-39	196.9	85	71.1	-4	66.7	-27	95.0	-26	158.5	-13	86.3	-46	16.4	-70	5.9	-67
2019	0.6	-63	31.8	500	0.0	-100	27.4	-32	142.4	47	62.7	-13	59.6	-37	143.5	14	187.7	2	254.1	71	35.4	-32	11.0	-14
2020	0.1	-96	0.0	-100	9.8	-12	106.3	163	90.7	-6	131.5	83	155.3	64	61.9	-51	235.2	28	184.8	24	64.7	24	11.6	-9

