"Evaluation of Groundwater Potential Zone using Remote Sensing data in Palar River basin in Kancheepuram District, Tamil Nadu, India".

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Amity University Uttar Pradesh

In partial fulfilment of the requirements of the award of the degree

Of

Master of Science

Applied Geology

By

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Under the Guidance of

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Declaration

I, Gowcigan.M, Enrolment Number A13088922002, hereby declare that the project entitled **“Evaluation of Groundwater Potential Zone using Remote Sensing data in Palar River basin in Kancheepuram District, Tamil Nadu, India”** is my original work carried out by me as a post-graduate student of AIGIRS, Amity University, Noida and to the best of my knowledge contains no materials previously published or written by another person. Any contribution made to this project by others with whom I have worked at **Amity Institute of Global Warming and Ecological Studies**, is explicitly acknowledged in this project. Works of other authors that are cited in this project have been acknowledged in the reference section.

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19 July 2023

Certificate

This is to certify that **Mr. GOWCIGAN.M**, Enrollment Number –A13088922002 of M.Sc. (Applied Geology) 2022-24 is doing his NTCC – Field Work/Major Project entitled "**Evaluation of Groundwater Potential Zone using Remote Sensing data in Palar River basin in Kancheepuram District, Tamil Nadu, India**" under my guidance at AIGIRS, J1 Block - Amity University, U.P. Commencement Date - 05/06/2023 will be followed up to (16/07/2023) 42days.

We wish him all the best in his future.

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Abstract

Natural water resources as groundwater are extremely important to the planet. It takes place below the surface of the ground in the aquifer, or gaps between soil and rock pieces. For instance, the Coastal Aquifer, Alluvial Aquifer, Confined Aquifer, Karst Aquifer, Fractured Rock Aquifer, and Basaltic Aquifer. The field of geology known as hydrology studies groundwater. The planet has 30% of fresh groundwater, which may be found in both rural and urban regions. Groundwater can be created by rainwater seeping into the earth during the rainy season. Due to irrigation and industrial growth sucking off the water, the groundwater in Palar area in Kancheepuram district is not available all year. By drilling wells, the groundwater is developed as well as filter points, bore wells, wells for tubes and bore wells. According to Dynamic Ground Water Resources, (Dar.I.A, Sankar.K and Dar.M.A, (2010)), the annual demands for household as well as industrial water supplies is now expected to be 54.9304MCM. The Palar River is not considered a permanent river; while it has sufficient volume during the rainy season, it may be insufficient during the summer. Digital Terrain Method (DEM) and satellite images of the research region may be used to identify the potential for groundwater mapping utilising remote sensing data. Assessment of hydrological characteristics such flow direction, flow buildup, patterns of drainage, stream order, and slope might be useful. GIS may be used to analyse weighted overlays for groundwater potential. Five classification of groundwater maps, include extremely very high, high, moderate, low, very low.

1.**Introduction**

On our planet, liquid water can be found in three different forms: very large, medium-sized, and small bodies for standing water, like oceans, seas, and numerous lakes; bodies of flowing water, like major rivers, streams, rivulets, and springs; and subsurface water, like films around cereal grains, tiny particles in pore spaces, and cavities in rock that partially or completely fill them over a variety of areas to form underground reservoirs. This includes all subterranean eater that extends down to the point when the soil and rocks pore spaces, apertures, and other cavities are totally filled with water. The groundwater reservoirs in a certain location are made up of the aquifer's thickness, length, and breadth. Water movement is mostly influenced by hydro statistic head in this zone. Percolation is a phrase that is frequently used to describe it, and it typically has a lateral nature. The upper surface below the zone of saturated is referred to as the "water table", and it is very important when studying groundwater reservoirs. One of the most significant natural resources is groundwater. This may be the only source of water availability in areas that are dry, arid, or semiarid. For numerous economic and sanitary reasons, groundwater is regarded as preferable resources even in humid areas. The three main sources of groundwater are meteoric, connate, and juvenile. It is difficult to oversaturate the importance of water from the ground in maintain the human species on our planet. Millions of gallons of groundwater are already pumped out every day to satisfy household, agricultural, and industrial needs. It is true that surface water sources such as seas, oceans, and other water bodies are usable for commercial purposes. Kancheepuram is one of the industrialized and agricultural areas so there is a demand of water because it is not a perennial water, groundwater is high in time of rainy season in summer groundwater is low.

2.**Study area**

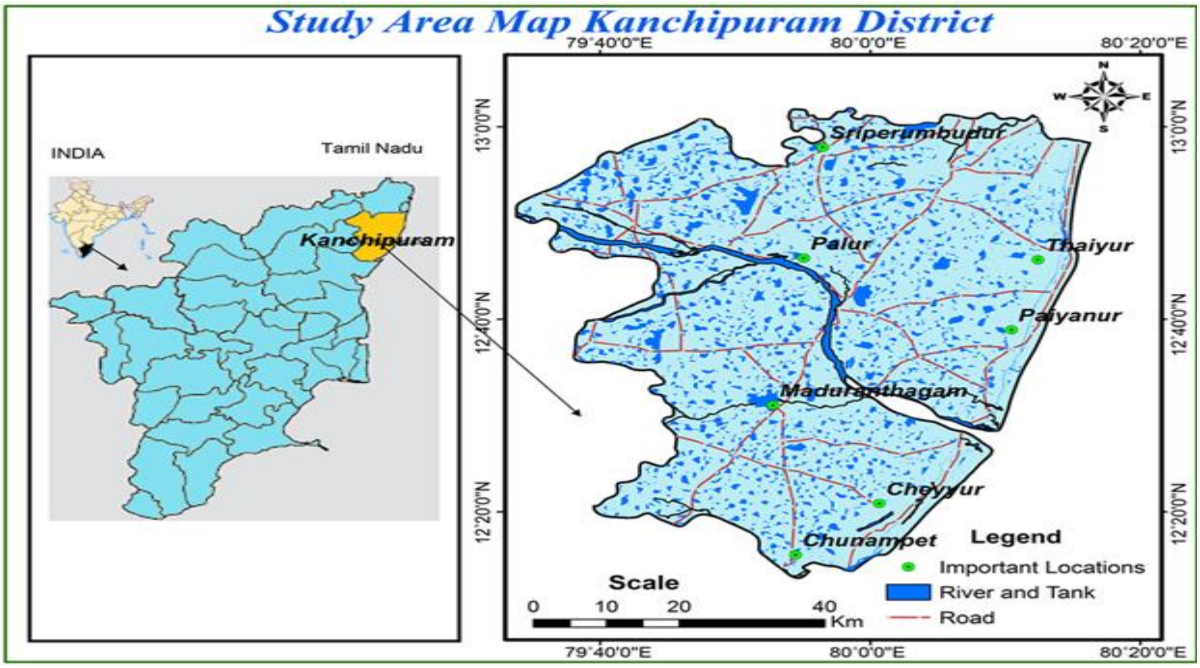
One of the 38 districts of the Indian state of Tamil Nadu is Kancheepuram. Previously, Chengalpattu district included the region that now makes up the Kancheepuram district. In 1997, the old Chengalpattu district was divided to create the Kancheepuram and Tiruvallur district that exists today. The Kancheepuram district is in Tamil Nadu's. In the east, Chengalpattu district, in the northeast, Rani pet and Tiruvannamalai districts, in the west, and Tiruvallur districts, in the north, it is bordered. It lies between 12° 14′ 00″ N to 13° 02′ 00″ N latitude, 79° 31′ 30″ E to 80° 15′ 30″ E longitude. Geographically speaking, the district spans 4,43,210 hectares. With 54% and 36% of the total annual rainfall, respectively, the northeast and southwest monsoons are the largest contributors. In a typical monsoon, 1200mm of rainfalls in the district. (Balakrishna's and Rajamani.V, (1987)). The most significant river that flows through the area is the Palar River. Due to the building of dams across the river in Andhra Pradesh, it is dry for most of the year. Only a few hills in the area have a significant elevation. Small hills can be found in Maduranthakam Taluk's southern region. There are 25,586 hectares of forests in the district (Kancheepuram district Retrieved, 12 July 2022). The soil types can be classified as Clay Loam, Loam and Sandy Loam.

3.**Data Collection**

Data for the research region was gathered using USGS Earth Explorer's latitude and longitude functions. Data from Landsat's Type 8 and Type 9 Collection 2 Level 2 were gathered. The USGS can download DEM. To find the hydrological parameters, employ DEM. FAO soil map shape files in the ESRI shapefile standard may be used to gather soil map preparation. India Remote Sensing can gather Swat data. (Gupta.M and Srivastava.P.K, (2010). Data on rainfall was gathered by CRU and the Tamil Nadu Public Works Department. The cell size (XY) for this layer, which was judged to be a thematic layer, is 30.46741637, (Haridas.V.R, Aravindhan.S and Girish.G, (1988), and the spatial reference is WGS_1984_UTM_Zone_44N.

Study Area Map (Fig.1)

Fig 1: Study area map



4.**Methods and Methodology**

Using ArcGIS software, the study's approach includes gathering and preparing each of the nine theme layers. Make sure the imported datasets are in a suitable format, such as shapefiles, geodatabases, or raster datasets, then import the gathered datasets into ArcGIS. (Nagaraju.A, Sreedhar.Y., Thejaswi. and Dash.P, (2016)), Preprocess data as necessary by cleaning attributes, adjusting projections, and, if necessary, integrating several datasets. By defining the study area and its tributaries with the use of the proper ArcGIS tools, such as Spatial Analyst extension or the Hydrology tools, a river network dataset will be created. This will make it easier to determine the river system's connection and flow direction. Run several geographical analyses on the dataset for the study area. This may entail the figuring out the length of the river, identifying sections with high or low flows, examining the river's shape, and researching changes in land use and land cover along the river corridor.

Here,

NDVI stands for Normalized Difference Vegetation Index

NDVI = (NIR-RED)/(NIR+RED)

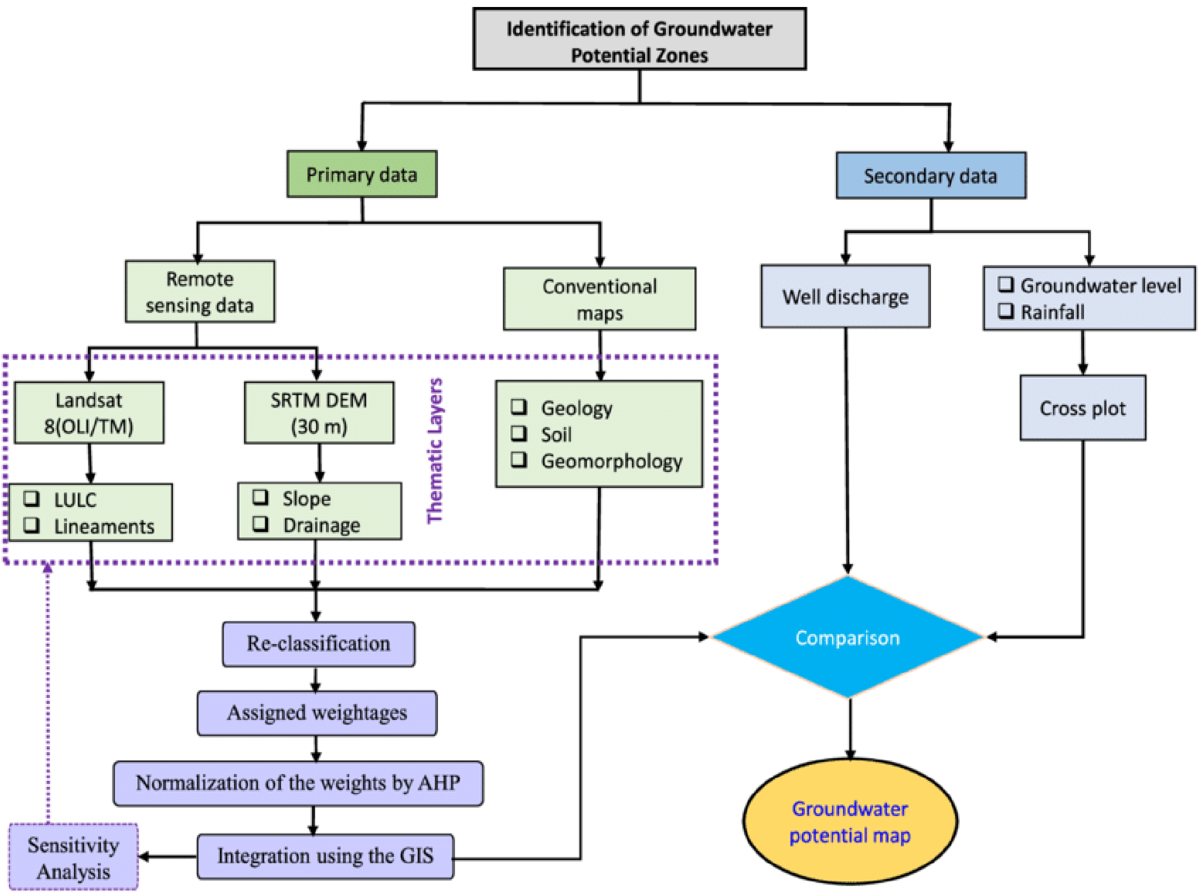
NDWI stands for Normalized Difference Water Index

NDWI = (Green-NIR)/(Green+NIR)

BSI stands for Bare Soil Index

BSI = (SWIF-RED)/(SWIR+RED)

Groundwater Potential is depending on the Land Use and Land Cover, Watershed, Line density, Soil, Slope, Rainfall data can be identified by the tool of Weighted Overlay's in Spatial Analyst.



5.Result and Discussion

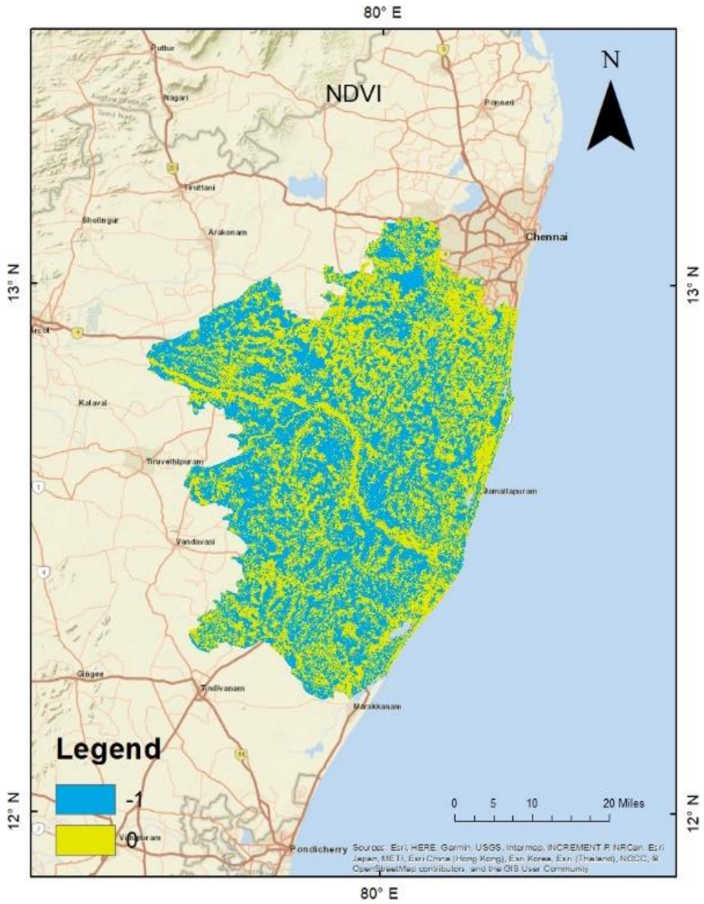
The presence of groundwater under the surface of the earth may be determined by the thematic sections of satellite images. Groundwater is mostly dependent on geology and geomorphology and can permeate the ground through precipitation.

6.Normalized Difference Vegetation Index

A popular remote sensing statistics called NDVI measures the greenness or health of vegetation using reflectance values of near-infrared (NIR) and red light. The NDVI calculation is as follows: NDVI is equal to (NIR – RED) / (NIR + RED). The values vary from -1 to 1, where -1 represents minimal or no vegetation and 1 signifies the vegetation.

The total square kilometre of the area is 2461.6 (little or no vegetation) and 2192.32 (vegetation)

Fig 2: Normalized Difference Vegetation Index of study area



7. Normalized Difference Water Index

A popular remote sensing statistics called NDWI measure the water bodies. Using reflectance values of NIR and Green light. Values ranges from -1 to 1, NDWI is equal to (Green – NIR) / (Green + NIR). Lower numbers or negative values reflect non-water characteristics of 4552.63 square kilometre and whereas higher positive values indicates that there is some sort of water in 100.937 square kilometre.

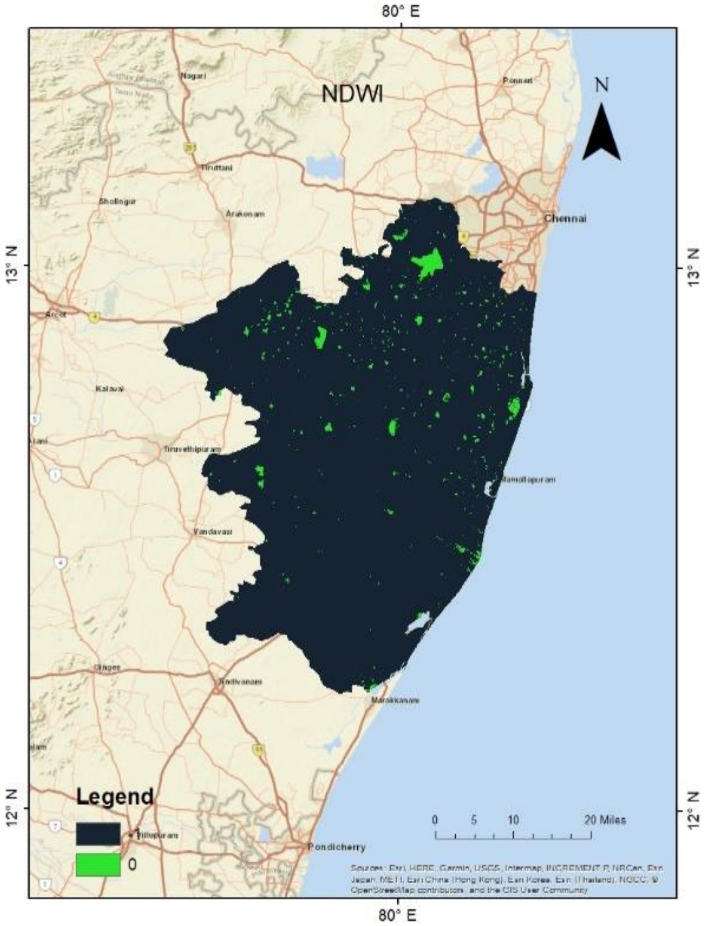


Fig 3: Normalized Difference Water Index of study area.

8. Bare Soil Index

A popular remote sensing statistics called BSI, monitor the bare soil or non-vegetated using reflectance volume of short-wave infrared and red light. Bare Soil Index is equal to (SWIR – Red) / (SWIR + Red). The value is very low – 8943 to 27532, low- 27532 to 30696, moderate- 30696 to 35047, high-35047 to 53240, very high- 53240 to 109800.

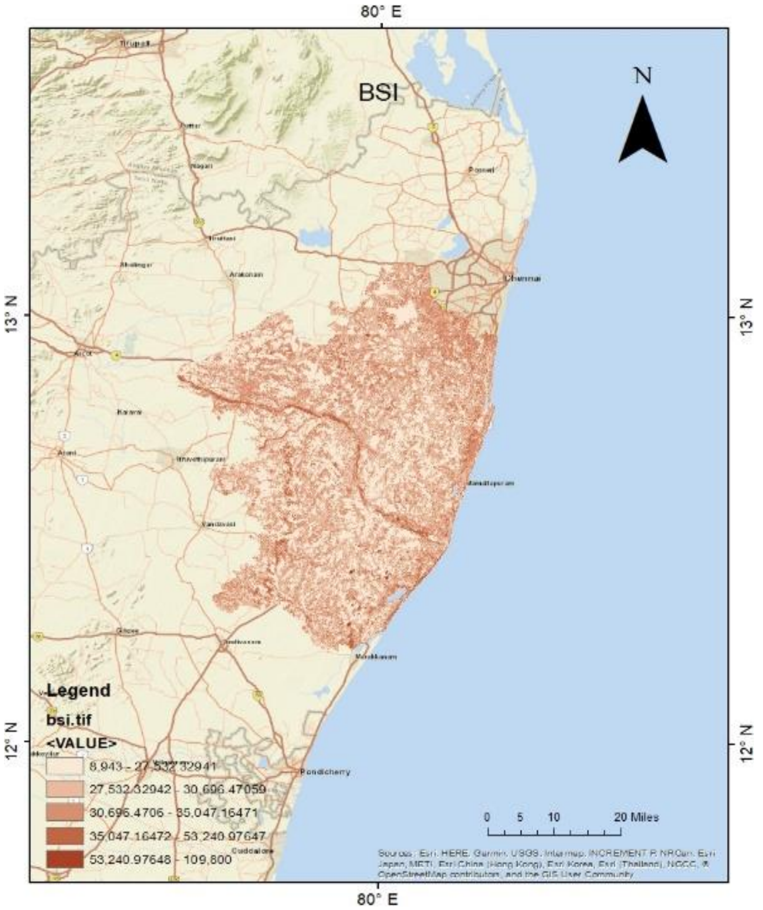


Fig 4: Bare Soil Index of study area

9. GEOLOGY (GSI technical report)

Table 1: Categories of Geology

S.no	Stratigraphy
1	Cuddalore Fm, MIOCENE-PLIOCENE
2	Charnockite Gneissic Complex (Southern Granulite Terrain), Archaen-Proterozoic
3	Undiff Fluvial/Aeolian/Coasta&Glacial Sediments, Quatenary
4	Lower Gondwana Group, (Talchir, Barakar, Raniganj, Karharbari Fm), Late Carboniferous-Permian
5	Migmatite Gneissic Complex (Southern Granulite Terrain), Archean-Proterozoic
6	Upper Gondwana group(Yerrapalli, Terain, Sriperumpudurf,Kota, Maleri, etc.,) Triassic-Early

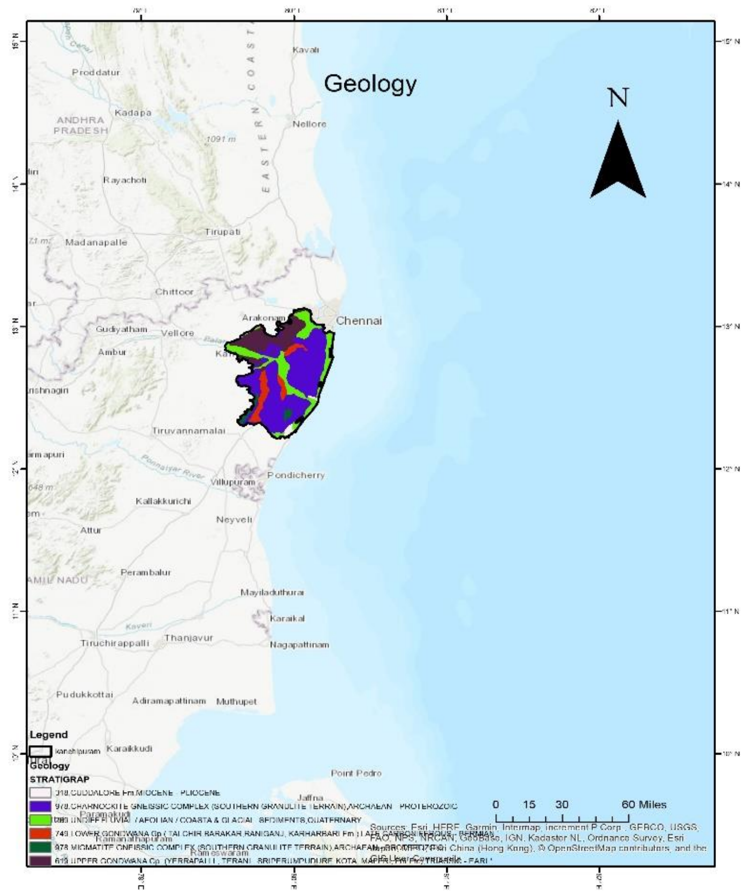


Fig 5: Geology of study area

10. Geomorphology

The atmosphere's gases, heat, surface and subsurface water, wind, seas and ice are only a few of the natural forces that may directly or indirectly affect rocks exposed at the surface of the planet. Season after season and year after year, these agencies continuously operate on the surface rocks, both independently and in close coordination with one another. Thus, they oversee altering the surface -level physical characteristics. Here Abandoned Quarry, Active Quarry, Back water, Badlands, Beach, Beach Ridge, Channel Bar, Channel Island, CosOri-Older Coastal Plain, CosOri-Older Deltaic Plain, CosOri-Younger Deltaic Plain, Creek Network, Cuesta, Dam and Reservoir, Dome, Dyke, Estuarine Island, FluOri-Active Flood Plain, FluOri-Older Flood Plain, Gullied Land, Gullied Tract, Hill, Inselberg, Inter Tidal Flat, Inter-distributary Marsh, Mangrove swamp, Marsh, Natural Levee, Paleo Distributary, Pediment, Pediment-Corestone-Tor-Composite, Pediplain, Plain (Laterite), Point Bar, Residual Hill, Residual Mound, Ridge, Sand Dune, Spit, Strike Ridge, Swale, Tidal Flat, Tidal Inlet, Valley Fill, Wash Plain, WatBod-Others, WatBod-River. (GSI technical report)

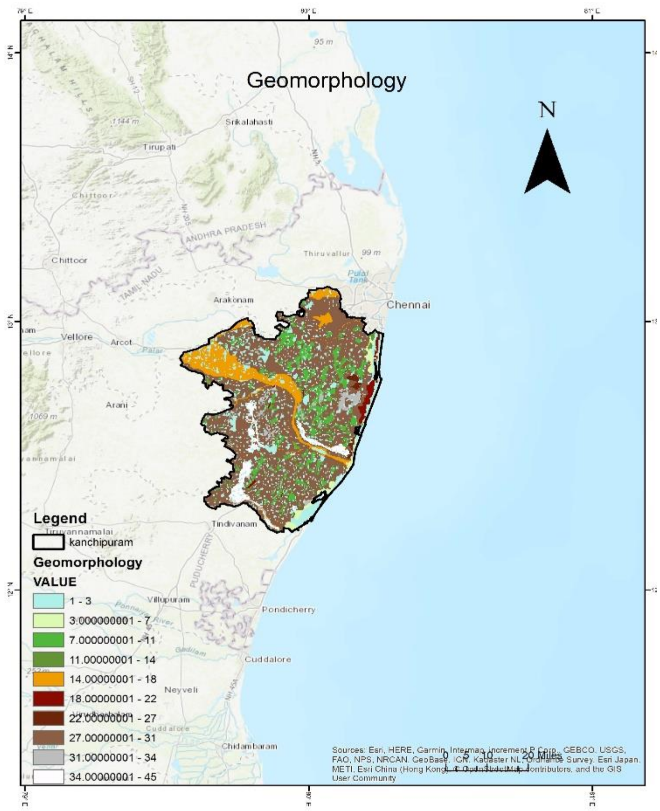


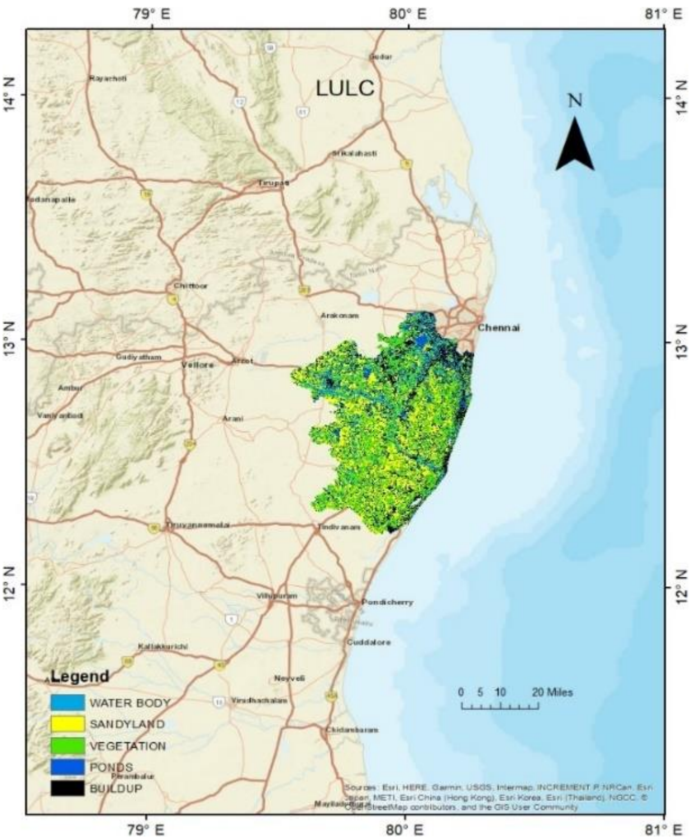
Fig 6: Geomorphology of study area

11. Land Use and Land Cover

LULC stands for land use and land cover, and remote sensing is utilized to determine the physical effects of human activity on the land. Here, classification is done using maximum likelihood classification, which depends on supervised classification. Water bodies make up 780.353 square kilometres, whereas sandy ground accounts for 1363.97, vegetation for 1380.08, ponds for 274.66, and accumulation for 853.705

Table 2: Categories of Land Use and Land Cover

Sn.no	Area	Square kilometres
1	Water body	780.353
2	Sandy land	1363.97
3	Vegetation	1380.08
4	Ponds	274.66
5	Buildup	853.705



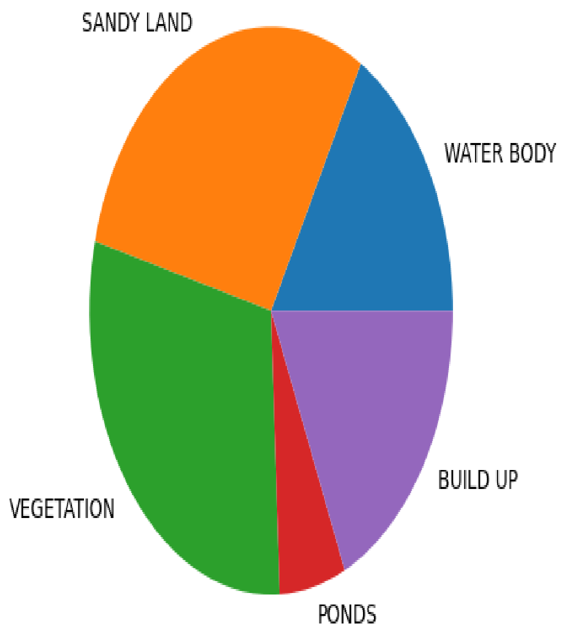


Fig 7: Land Use and Land Cover of study area

12.**Stream order**

Kancheepuram's dendritic drainage pattern emerges when streams of various sorts are all quite prevalent in an area and none seem to predominate over other groupings. When seen from above, the Palar River Pattern resembles a large tree trunk with several branches connecting it in the middle and lower reaches. Such a drainage system is typical of an area with a generally homogeneous composition of rock types.

Table 3: Categories of stream order

GRID_CODE	COUNT_GRID_CODE	MIN_STREAMLENG	MAX_STREAMLENG	AVERAGE	SUM	Stadt	Variance
1	4897	0.0301	5.6425	0.7155	3503.8864	0.6185	0.3826
2	2198	0.0154	4.7088	0.7416	1630.0077	0.5994	0.3593
3	1258	0.0151	4.0285	0.6837	860.0993	0.5274	0.2782
4	676	0.0154	3.6689	0.6433	434.8678	0.5213	0.2717
5	348	0.0154	3.6268	0.6597	229.5589	0.5324	0.2835
6	95	0.043	2.3677	0.6514	61.8	0.5123	0.2625
7	27	0.0302	1.9175	0.7544	20.3	0.5005	0.2505

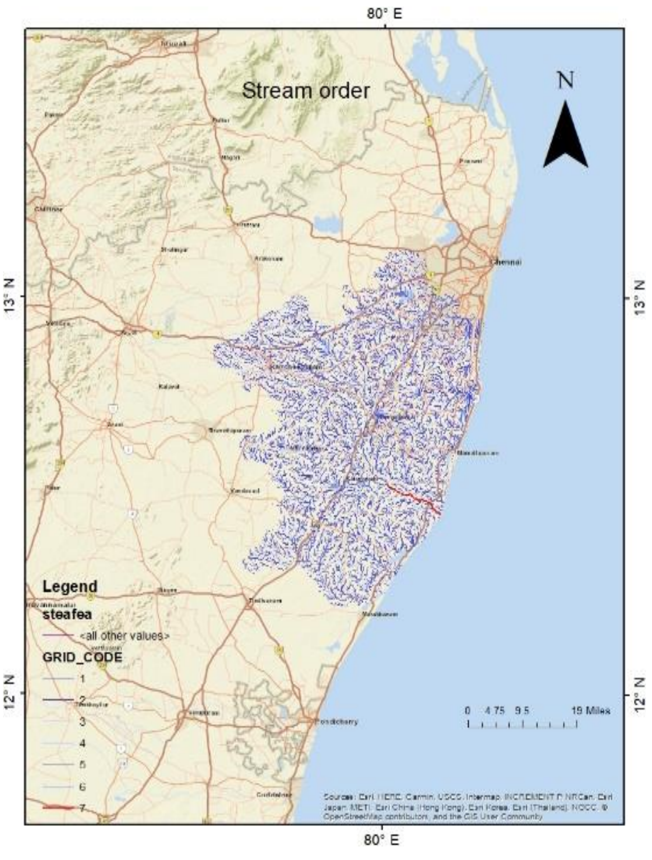


Fig 8: Stream order of study area

13. **Slope**

The land's slope to the south and east surrounding Kancheepuram, the altitude between 0 and 200 metres which is above the mean sea level. The slope's area has an impact on precipitation's infiltration and runoff. The research area, which is three may be organised as belonging to a slope since nearly all of it is flat terrain (96.07%). Table 4: Categories of slope

S.no	Sum of an area	%
1	153.1799	3.291184461
2	4501.068	96.70880192
3	0.000634	1.36162
Grand total	4654.249	100

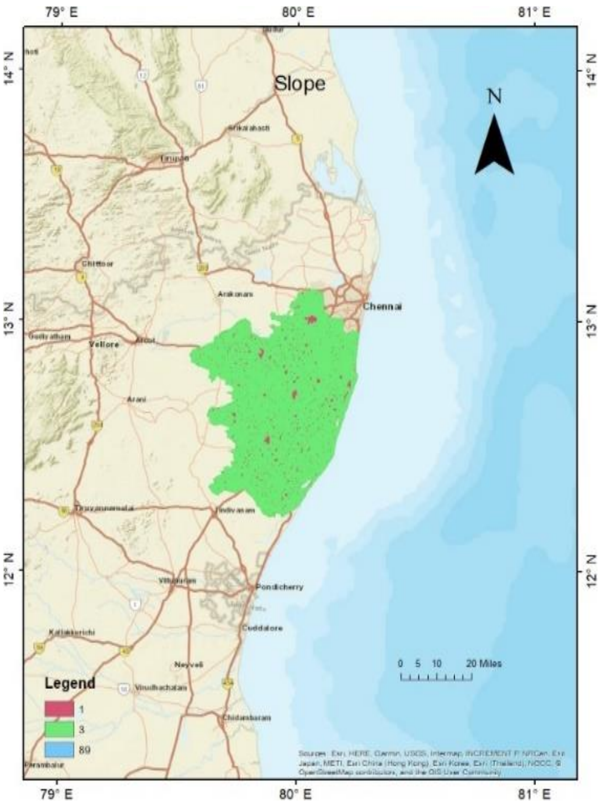


Fig 9: Slope of study area

14. **Soil**

Sandy loam, loam, clay loam are the soil types found in Kancheepuram and can be distinguished using FAO soil map shape file. The soil id in question is 3781, 3803, 3845, and it may be determined with the use of Indian Remote Sensing, which is referred to as Swat data. Around 49.84% of the research area is covered with loam, which has a balanced combination of sand, silt, and clay particles. Groundwater recharging may be hampered by the clay content of clay loam, which is roughly 33.32%. Clay loam and other types of loam have higher percentage of loam than sandy loam (16.83%), yet sandy loam is best for groundwater. Table 5: Categories of soil

S.no	ID	Name	Square kilometre	%
1	3781	Clay loam	14.38	33.32
2	3803	Loam	21.51	49.84

3	3845	Sandy loam	7.27	16.83
Grand total			43.15	99.99

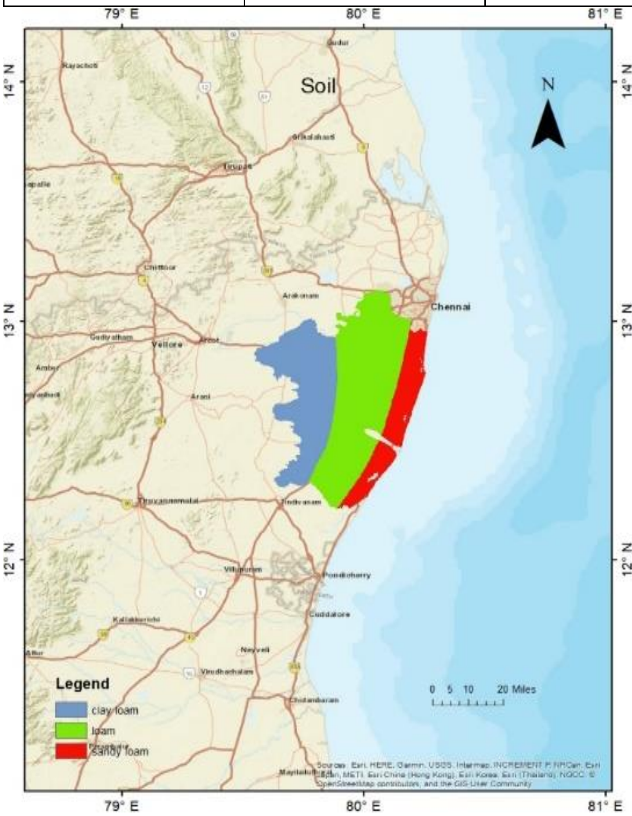
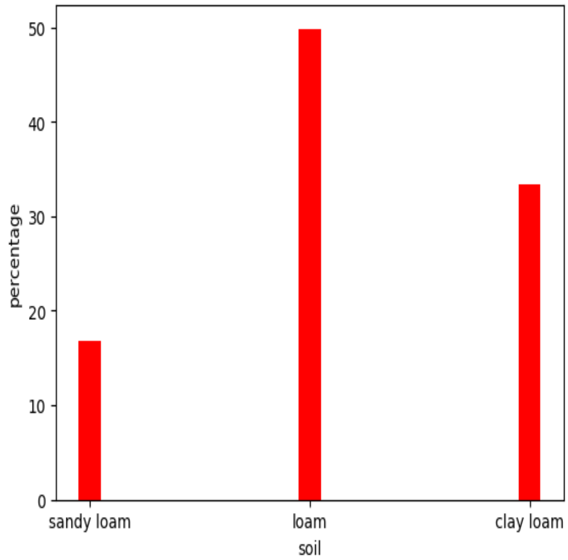


Fig 10: Soil of study area



15. **Rainfall**

Kancheepuram district receives more rainfall than other districts because of its proximity to the seashore. During the monsoon season, the western ghats of Kancheepuram, which are found in areas like Madurantakam, Walajabad, and Cheyyur, get both moderate and significant amounts of rainfall.

Table 6: Categories of rainfall analysis

s.no	Area square kilometre	characteristics	%
1	0.2763	Very low	8.093
2	0.4995	Low	14.632

3	0.0891	Moderate	23.701
4	1.0728	High	31.426
5	0.756	Very high	22.146

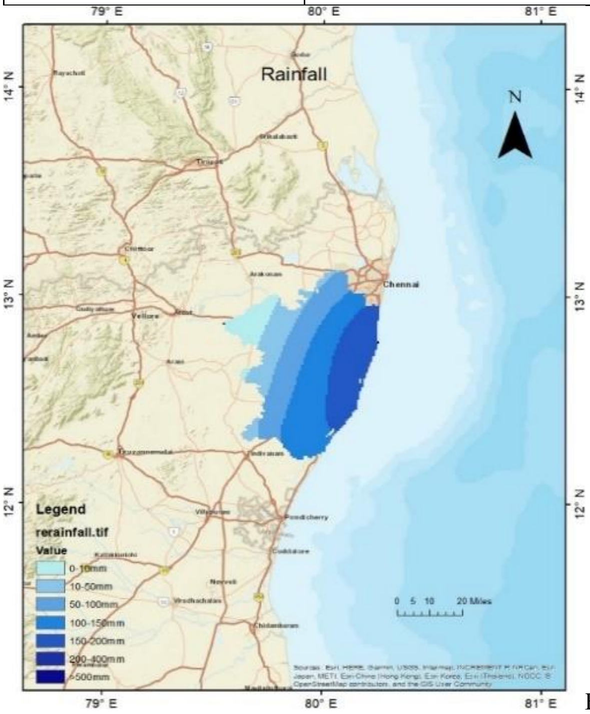


Fig 11: Rainfall of study area

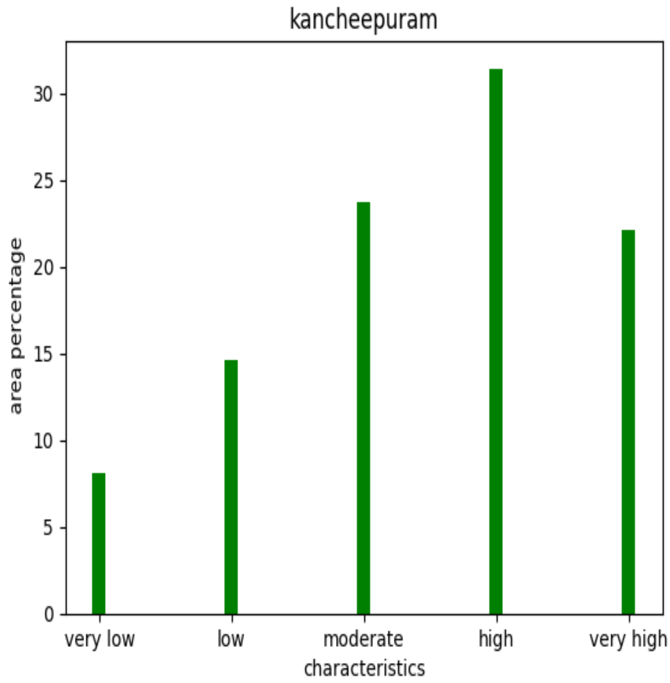


Table 7: Categories of rainfall

Location	Kancheepuram
Actual Rainfall (mm)	108.0
Normal Rainfall (mm)	92.2
Deviation from Normal (%)	17.09

16.**<u>Groundwater potential</u>** (GWPA technical report)

Table 8: Categories of Groundwater potential analysis

Area	Assessment unit (Ha)	Recharge (Ha)	Annual groundwater recharge (Ha m)	Natural discharge	categories
Arumpuliyur	5829.76	5797.535	1957.03	205.01	Over-exploited
Chittiambakkam	6429.305	6429.305	1649.27	195.7	safe
Govindhavadi	5001.595	5001.595	2099.13	164.93	Semi-critical
Kaliyampoondi	9147.05	8662.080	1601.57	209.91	safe
Kancheepuram	5884.835	5884.835	498.54	160.15	safe
Kollapakkam	1702.389	1676.139	1973.19	49.86	Semi-critical
Kunnavakkam	7309.42	7089.420	1571.75	197.32	safe
Kunrathur	5914.08	5840.580	2549.08	157.18	safe
Maduramangalam	6525.08	6525.080	2449.74	254.91	safe
Maharal	7849.65	7849.650	565.11	244.98	safe
Mangadu	3252.745	3242.245	1562.79	56.51	Semi-critical
Padappai	7850.22	7538.110	1562.79	156.28	safe
Parandur	8321.75	8321.750	3779.05	377.91	safe
Salavakkam	6312.765	5812.750	2290.13	229.02	safe
Serappanacheri	9860.506	8950.366	2317.71	115.91	safe
Sirukaveripakkam	7445.18	7445.180	2677.68	267.76	Semi-critical
Sriperumpudur	7603.62	7461.110	2346.03	234.6	safe
Sunkuvarchatram	6822.08	6798.190	2416.98	241.69	safe
Thandalam	7874.53	7792.790	1895.56	189.55	safe
Thenneri	5897.905	5897.905	1939.14	193.92	safe
Thiruppu Kuzhi	5636.47	5636.470	2334.61	233.46	Semi-critical
Thirrupulivanam	6844.515	6248.695	1955.46	195.54	Over-exploited
Uthiramerur	8654.325	8581.840	2952.56	295.26	Semi-critical
Vallam	7356.52	7157.660	1688.07	168.81	safe
Walajabad	9152.745	9152.745	2107.56	210.76	critical

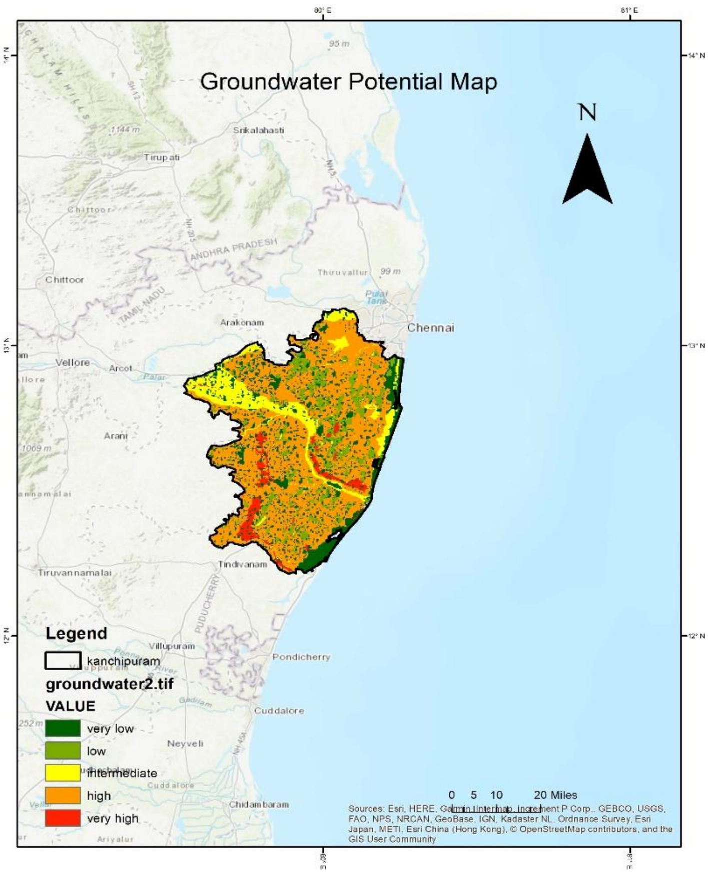


Fig 12: Groundwater potential zone of study area

Conclusion

The study area is used to understand groundwater potential zones, which are classified as safe, semi-critical, critical, over-exploited. Thematic layers and digital elevation models can be used to identify, these zones, and they are primarily used to understand the geology, geomorphology, soil characteristics, rainfall analysis, stream order and drainage maps. It may be helpful for drilling wells for long-term sustainability.

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