LAND SUITABILITY ASSESSMENT FOR STORMWATER MANAGEMENT

Water

MAYILADUTHURAI DISTRICT, TAMIL NADU

JULY 2023

AurovilleConsulting

LiLa
Earth Intelligence for Climate Action

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ACKNOWLEDGEMENT

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ABOUT LILA

LifeLands (LiLa) is an innovative digital tool that uses satellite imagery, AI & GIS Mapping and (i) creates land-cover maps at high spatial resolution for any area of interest, (ii) detects degraded/unused lands and (iil) evaluates these lands in regard to climate mitigation and adaptation interventions such as sustainable water management, reforestation, and solar energy generation.

Examples on how Lila can be used:

- It can detect degraded lands with high spatial resolution and shortlist lands that are best suited to meet India's reforestation target.
- It can undertake a high-level water demand assessment of any area of interest and identify best locations for surface and ground water management.
- It can monitor land-use change over time and help in reporting increase or decrease in forest cover.
- It can identify degraded lands that are best suited for distributed solar energy to meet energy security targets and inform utilities and project developers.
- It can inform land-use and zoning exercise at the local and state level.
- It combines socio-environmental and advanced physical terrain analysis to generate blueprints for sustainable rural development.

LiLa

Earth Intelligence for Climate Action

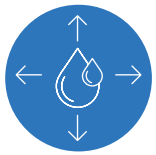
Water

KEY FINDINGS

TOTAL GEOGRAPHICAL AREA
1,186 km^2

UNUSED LAND
118 km^2

Mayiladuthurai district has a total geographical area of 1,186 km^2 of which 118 km^2 or 10% has been classified as unused or fallow lands.



WATER TARGET

The district has an existing 94.16 km^2 (7.94%) of its geographical area under the land use category of 'water'. The district's fresh water withdrawal is estimated at 625 million cubic meters (MCM) per year. The target is to harvest 25% or 156 MCM water from additional surface water management interventions at the identified unused lands.

25%	withdrawal/year
156	MCM/year

TECHNICAL POTENTIAL

The suitability analysis revealed that 9,816 acres of unused land have a technical potential for stormwater harvesting. These lands are distributed over 2,179 plots. The suitable lands identified would help achieve 54% of the target.

84.28	MCM/year
9,816	acres
2,179	plots
54%	of target

HIGHEST POTENTIAL

1,046 plots of unused lands that have been ranked as having a high potential have a stormwater harvesting potential of 43.55 MCM per year, this represents 28% of the water harvesting target set.

43.55	MCM/year
2,728	acres
1,046	plots
28%	of target

TABLE OF CONTENTS

01 INTRODUCTION

The objective of this report is to identify unused lands and evaluate its potential for stormwater management in order to ensure the districts long-term water security.

Land is a finite resource with competing and conflicting use. Unplanned and unscientific use of land can exacerbate climate change, and disasters like drought or floods. Judicious use of land resources is key in meeting the state's social, economic, and environmental development goals. A comprehensive land suitability assessment can guide responsible and sustainable development practices and land-use policies.

According to India's Composite Water Management Index (Niti Aayog 2018), 600 million people in the country are suffering from an acute shortage of water. A shrinking and sometimes contaminated water supply, heavy reliance on rainfall and a lack of alternative irrigation systems are some of the major problems. Agriculture alone accounts for nearly 90% of water use. Two-thirds of India's irrigation needs and 80% of domestic water needs are met using groundwater, contributing to the significant groundwater depletion rate.

In a changing climate scenario water security is a prime concern of the government. The National Water Mission (NWM) is one of the eight programmes in the National Action Plan on Climate Change, reflecting the high political priority given to water security in India in the face of climate change.

Some of the areas under the NWM include:

- studies on management of surface water resources,
- management and regulation of ground water resources,
- and the conservation of wetlands

In this context this report aims to identify unused lands in Mayiladuthurai district and evaluate to what extent these unused lands can be utilized for storm water management, thereby contributing to the districts long--term water security.

02 TECHNOLOGY OFFERING

ANALYSING INTERLINKAGES FOR INFORMED DECISION MAKING

Lila combines geo-spatial and socio-economic data-layers to address the core aspects of sustainable land-use management. It identifies and evaluates unused lands for its potential in terms of solar energy, forestation, and water management.

The tool is designed to provide flexible solutions with in-built climate intelligence that enables to understand the physical constraints and social demand of a local region and facilitate rapid decision-making & implementation.

It allows a 360° view of a highly interlinked problem by analysing multiple layers of information at once and by creating rapid data-based insights derived from earth observation data, machine learning algorithms, integrated public datasets and in-depth subject expertise. An automated data pipeline performs a comprehensive evaluation of the natural potential of a land with respect to its ecosystem as well as the socio-economic context, to ensure that its protection and development get the “right” context.

We have an in-house land-cover algorithm that analyses satellite imagery across a year and assigns every pixel a land-cover class based on its recorded electromagnetic spectral signature. This way we can reliably identify lands that have been lying barren over a certain period of time or those that remain unused. We perform advanced terrain analysis based on digital elevation maps to understand the physical constraints. And we assess the true potential of a land with respect to its ecosystem as well the socio-economic context. This information is further fed to our suitability analytics for site rating and selection.

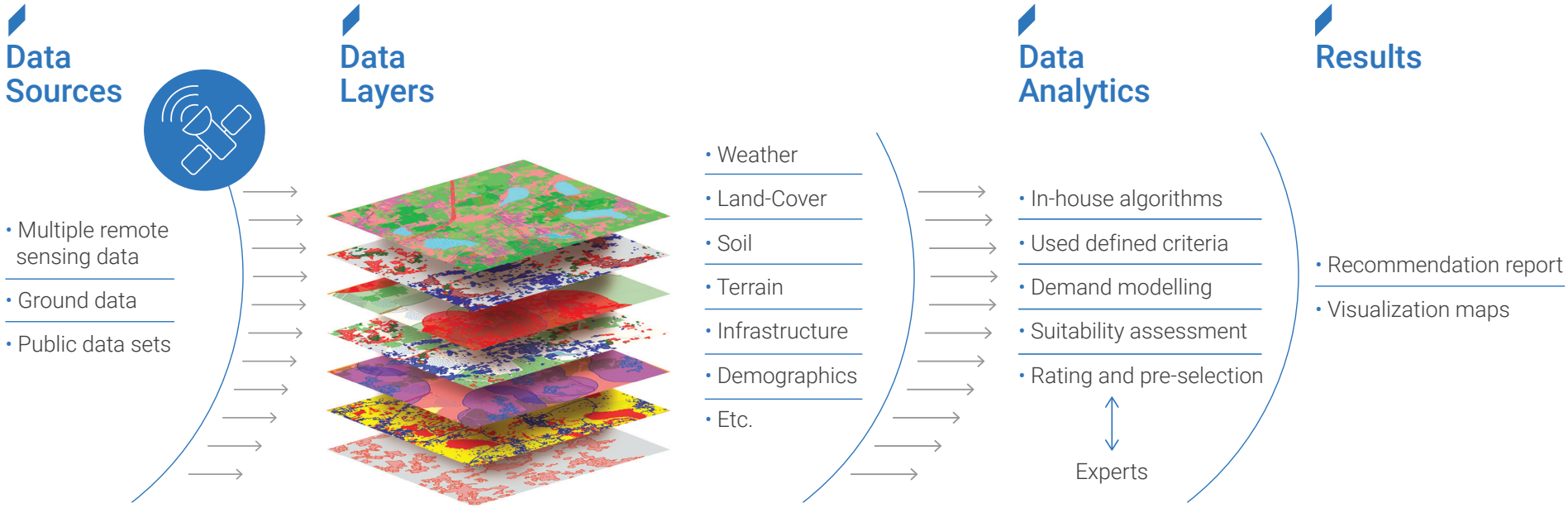
This can replace the current outdated ways of infrastructure expansion that involve long lead times and lack of reliable data for planning and impact measurement. By creating more transparency and delivering sustainable development goals (SDGs) faster in a more diligent and precise manner.

03 METHODOLOGY

ANALYSING INTERLINKAGES FOR INFORMED DECISION MAKING

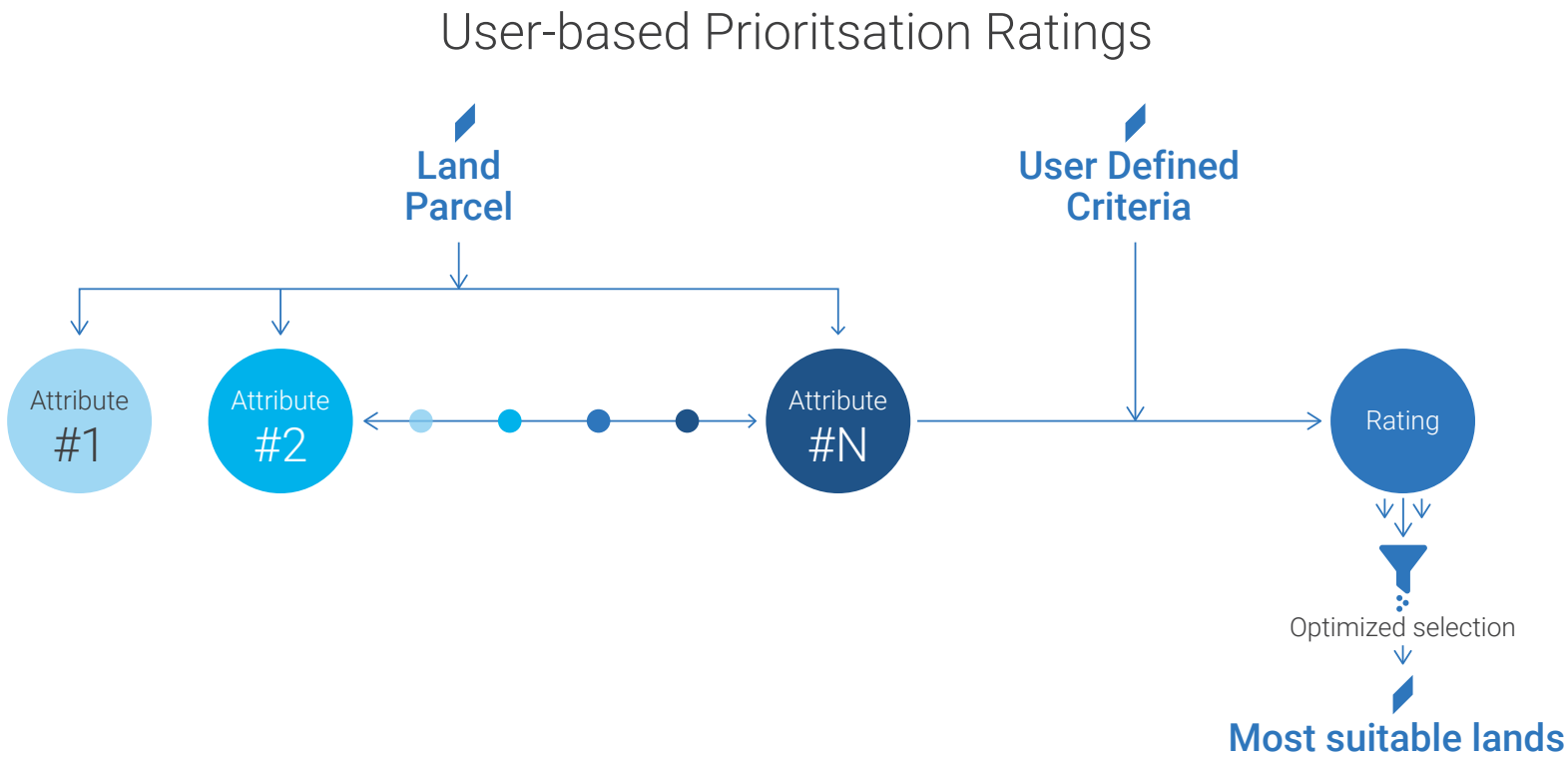
Lila combines geo-spatial and socio-economic data-layers to address the core aspects of sustainable land-use management. It identifies and evaluates unused lands for its potential in terms of solar energy, reforestation and water management.

Analysing multiple dimensions and interlinkages & making the right decisions



Unifying diverse data & expertise on a single platform

Insights from the integrated technology layers along with user-defined criteria are utilised to optimise the land evaluation and recommendation process.



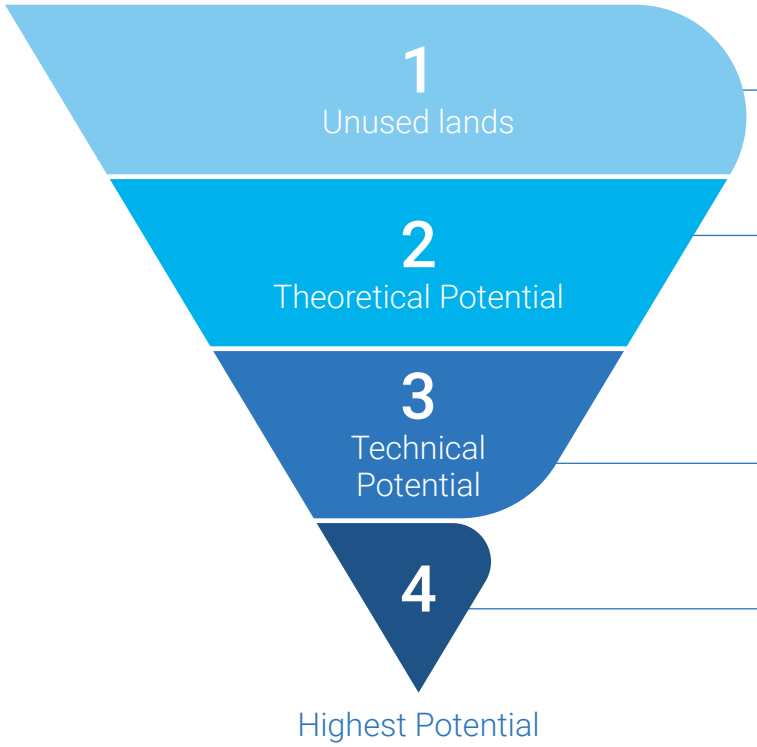
The criteria definition is overall a flexible process and serves as an adaptability measure, specifically designed to provide agility in terms of meeting the requirements of different projects and stakeholders for any geo-location. Further details w.r.t land evaluation and criteria for solar suitability are outlined in the next page.

Additional value that our tool provides:

- Accurate land-use maps that extract unused lands with better precision.
- Additional data layers on key infrastructure services and socio-economic metrics for each selected site for supporting better planning and development.
- A comprehensive analysis that detects potential competing land utilizations for solar energy, reforestation and water harvesting. Which can result in recommendations for co-location of solar, water and forest initiatives thereby resulting in high impact climate action..

EVALUATION STEPS

The land suitability assessment is undertaken in a 4-step filtration process to identify unused lands that consecutively meet theoretical, technical and highest potential criteria (refer to tables below).



Unused lands:
All lands that have not been cultivated for a period of one year.

Theoretical Potential:
In this study we assume all unused lands have a theoretical potential to capture storm water, in the form of surface or ground water.

Technical Potential:
All suitable lands meeting a minimum set of technical criteria.

Highest Potential:
Lands with the highest potential for water harvesting.

DISTRIBUTION BY TYPE OF INTERVENTION	
Categories	
Surface water	Plots
Ground water	Plots
Surface and ground water	Plots

COMPETING USE FOR CLIMATE ACTION	
Criteria	
Solar potential	High & Medium
Forest potential	High & Medium

TECHNICAL POTENTIAL	
Criteria	
Elevation	low*
Run-off capture	yes

*Within 30% of watershed basin height

HIGHEST POTENTIAL			
Criteria	**High**	**Medium**	**Low**
Yearly run-off (m3 per pixel)*	>200	>70-200	0-70
Water demand (% of watershed area with cropland that has high ET)**	>50%	>30 - 50%	<30%

* 1 pixel = 20m x 20m
**High ET areas are pixels with ET greater than 700mm/year

HIGHEST POTENTIAL			
Rating of unused lands	**High**	**Medium**	**Low**
Yearly run-off (m3 per pixel)	H &M	H, M, L	H, M, L
Water demand (% of watershed area with cropland that has high ET)*	H	M	L

*Lands with high water demand and low run-off capture are filtered out.

TARGET SETTING

To estimate the district's annual freshwater extraction, the average annual per capita freshwater withdrawal for India as of 2010 has been utilized, which is 602.30 m^3 per year per capita (Ritchie and Roser, 2015). This figure accounts for the total water withdrawals from agricultural, industrial and municipal purposes per person.

As a result, the annual level water withdrawal is assumed as 625 million cubic meters (MCM). Considering a target of meeting 25% of this annual water extraction from new water harvesting structure, the water harvesting target is quantified to 156 MCM/year.

WATER HARVESTING TARGET	
Total water withdrawal (MCM/year)	625
Water harvesting target as % of total water withdrawal	25%
Water harvesting target (MCM/year)	156

THEORETICAL POTENTIAL

The above tables summarise the criteria set for the 4-step filtration process for the water module. The results are then evaluated against the set targets. The first step relates to identifying all the unused lands of the district.

All identified unused lands are considered to have a theoretical potential for water harvesting. To assess the technical potential of the identified unused lands a set of criteria that takes into account two parameters is applied. These parameters are the elevation of the identified unused land (polygon) within its watershed and whether the land is capturing surface water run-off. For run-off estimation, precipitation data of one year was considered for calculations.

Unused lands that fulfil these two criteria are shortlisted to meet the technical potential for capturing or harvesting run-off water as surface waterbodies or ground water. These are finally categorized into high, medium and low based on two other factors described below: (1) the yearly run-off potential and (2) the water demand of the region the unused lands are located in.

The potential yearly run-off that can be intercepted (described further in the Annexure), is estimated per pixel of the data available. Each pixel translates into approximately 20m × 20m = 400m^2 of area. The criteria for ranking into high, medium and low water harvesting potential also accounts for evapotranspiration.

Evapotranspiration is used as a proxy for water demand, and is analysed by watershed. Watersheds with high water demand are defined as those that have more than 50% of the watershed area with significant evapotranspiration (ET) (described further in the Annexure). Waterbodies and all other land cover categories except agriculture are excluded from ET estimation. The focus has been to extract pixels that show high ET due to agricultural practices. Crops like Paddy are known to have high ET due to more demand on irrigation. Watersheds with low water demand are those that have less than 30% of their area with a significant rate of ET. In this analysis, the threshold value for ET, beyond which it is considered as significant, is considered as 700mm/year.

Unused lands that have a high annual run-off and are located in watersheds with high water demand could be priorities for surface or ground water harvesting interventions.

HIGHEST POTENTIAL

Unused lands detected for the district are rated as having high, medium and low potentials for water harvesting, based on the combined rating of yearly run-off and the water demand of the region. The combinations are detailed above. For example, unused lands with high water demand and that are likely to intercept high or medium run-off (as per the quantitative thresholds described previously), are ranked high.

DISTRIBUTION BY TYPE OF INTERVENTION

Identified unused lands meeting the technical potential criteria are further evaluated on whether they are more suited for ground water recharge or surface water harvesting (such as lakes, ponds, etc. based on infiltration analysis), which are both critical objectives of the District Water Resources Management Plan. The distribution of unused lands by harvesting type is displayed by the of plots (polygons) that fall in each category.

COMPETING USE FOR CLIMATE ACTION

In addition, the unused lands suitable for water harvesting are also assessed for its competing land-use for solar energy generation and reforestation too.

KEY TERMS: The following table provides further details on the key terms utilized for this land suitability assessment.

Term	Description
Baseline unused area	The baseline unused area was based on the 2021 LandCover Map plus all common barren lands detected across the three years (2021, 2020 & 2019). This was done to ensure that lands that showed barren signature throughout the three years were included for suitability analysis as well.
Competing use	The suitability of unused lands for other purposes, such as water harvesting, forestation, industrialisation, housing, agriculture, and solar development.
Elevation	Elevation is often used as a criterion, which considers the height of the area of interest relative to the highest point of the watershed it is in. Ex: lands with elevation > 0.7 are lands that lie above 70% of the region's watershed elevation, and lands with elevation < 0.3 are lands that lie below 30% of the region's watershed elevation. Elevation of lands are also provided in terms of their height in meters from mean-sea-level.
Evapotranspiration (ET)	Evapotranspiration (ET) is the combined loss of water in the form of evaporation from the soil surface and transpiration from the plant. ET can be used as a proxy indicator for water demand.
Freshwater extraction	Represents the total water extracted from groundwater and/or surface water sources per person. This total accounts for water-use in agriculture, industries and for municipal/domestic purposes.
Ground water	Saturated zones of water found below the ground (ex: acquifers). Also refers to areas that are suitable for harvesting ground water in the analysis.
High potential	A sub-category of technical potential criteria that ensure the most preferable conditions based on the purpose of the evaluation. The criteria vary based on the type of assessment.
Land use	The LiLa algorithm identifies 6 categories of land use: unused/barren, sparse vegetation, cropland, tree cover, water, and built-up. Land is recognized under each of these categories by the algorithm based on the pixel properties obtained through satellite imagery.
Largest plot	The largest plot refers to the plot with maximum area that meets the technical criteria.
Low potential	A sub-category of technical potential criteria. This is a minimum criteria.
Medium potential	A sub-category of technical potential criteria, satisfying a higher number of criteria than 'low'. The criteria very based on the type of assessment.
Population density	Number of people per unit area (in this case acres). The population data is from (Meta, 2022).
Protected areas/Reserve forest/Notified forest	These are areas allocated for reserve forests and other such classified lands.
Roads	Different types of pathways are recognized as roads, including highways, primary, secondary, tertiary and residential roads. The roads included in this analysis consider those sufficient to allow mini-trucks to pass.
Run-off capture potential	The potential to intercept, catch or receive run-off water flows that are a result of considerable precipitation.
Surface and ground water (both)	Refers to areas that are suitable for surface and ground water harvesting.
Surface water	Water collected areas that lie on the earth's surface (ex: lakes, ponds, rivers, etc…). Also refers to areas that are suitable for harvesting water on the surface.
Technical potential	A set of criteria that characterizes unused lands with a relatively good potential, in terms of social, economic and environmental factors. The criteria vary based on the type of assessment.
Terrain/geology	Terrains are classified as either suitable or not suitable for forestation. Only terrains that are not at suitable for forestation, such as rocky ones, have been marked out as unsuitable.
Theoretical potential	A set of criteria that characterizes unused lands that have a basic potential depending on the purpose of evaluation. The criteria vary based on the type of assessment.
Water demand	Water demand is characterized by high evapotranspiration (ET) regions. This is categorized based on the percentage area of vegetation with high ET pixels based on the watershed basin. High ET pixels are characterized as those that have greater than 700mm of water loss per pixel per year, which translates to 1.75mm per m^2 per year.
Water harvesting potential	Lands with water harvesting potential are areas that intercept run-off water and in addition also have a considerable percentage of vegetation cover (30% and above).
Watershed basins	A water basin also called a catchment area, or a watershed, is the area from which all precipitation flows to a single stream. This 'single stream' is at the lowest elevation of the respective water shed.

WATER BASINS

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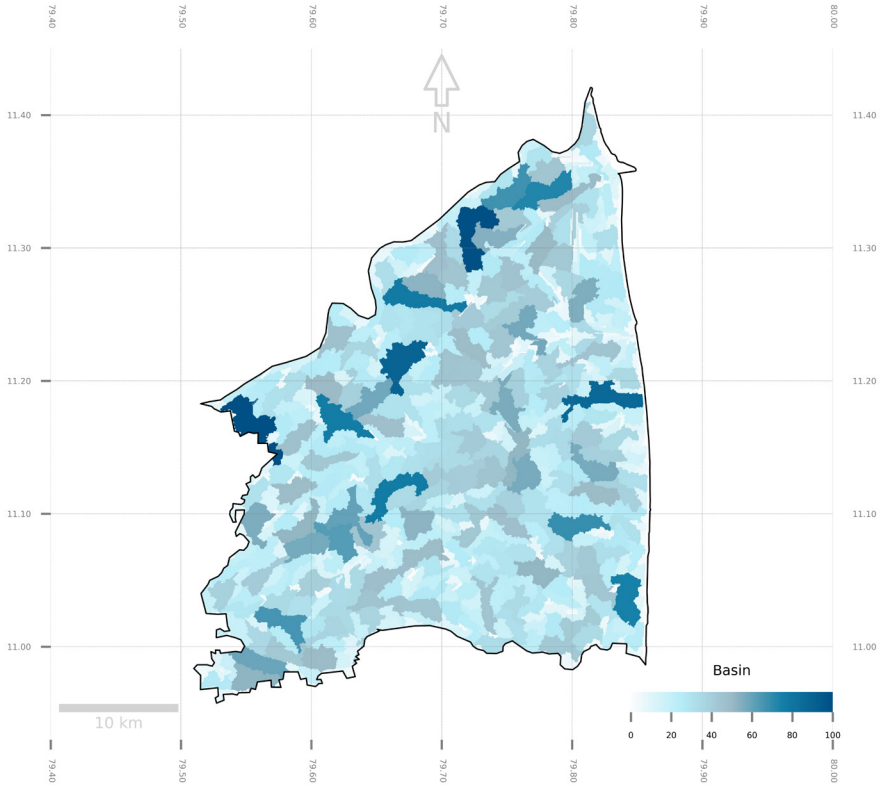
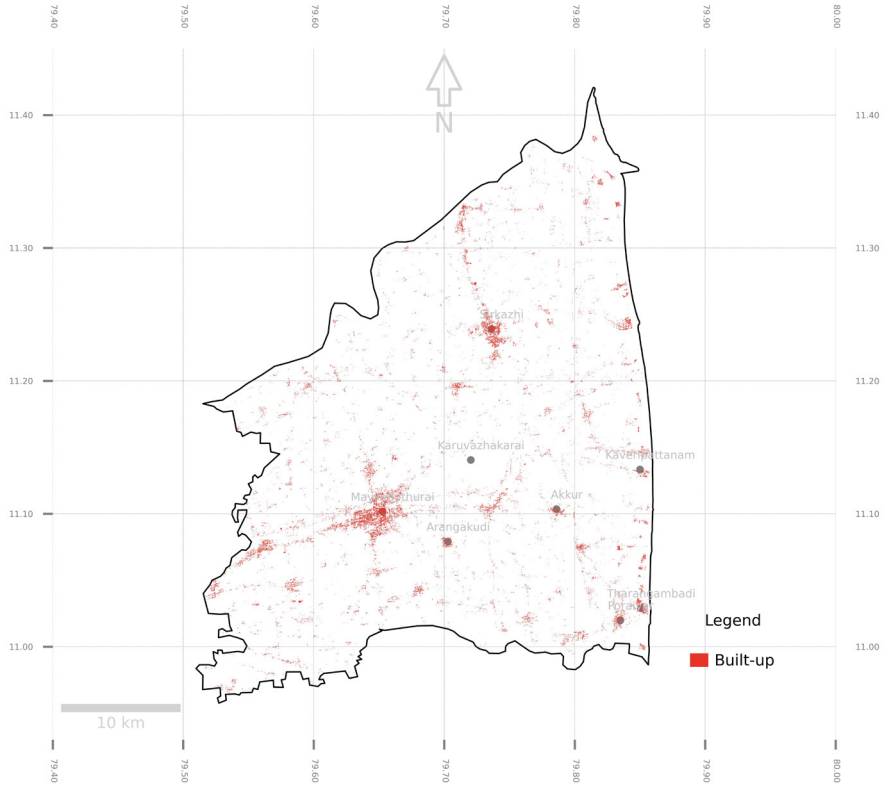


BUILT-UP

Build-up areas typically have a higher storm water runoff, unused lands in vicinity to built up areas therefore are often ideal for water harvesting interventions.

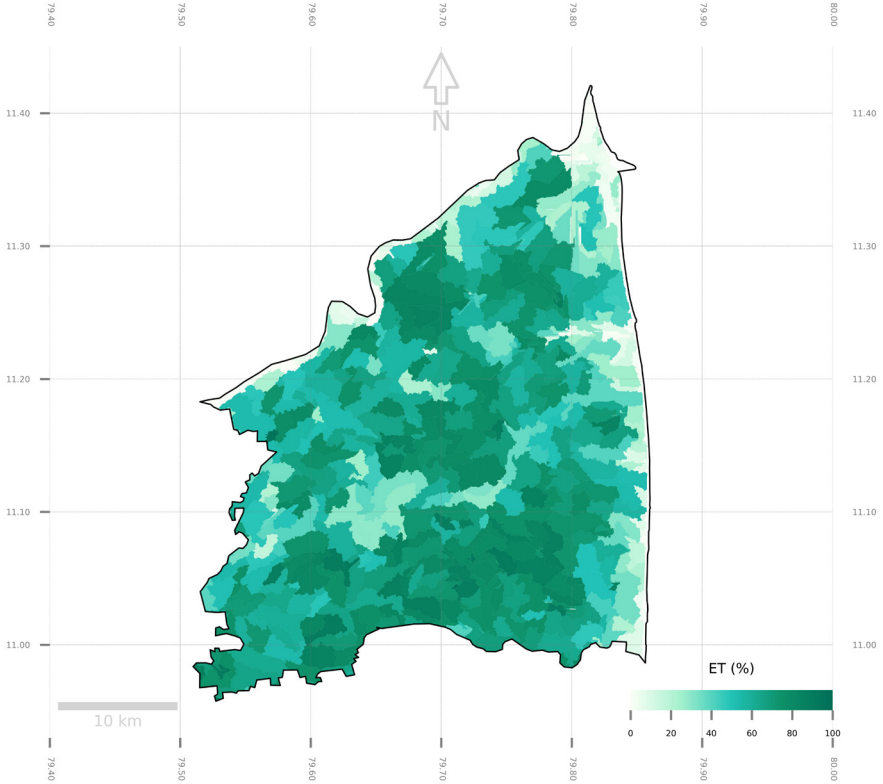


ELEVATION

Lands with relatively low elevation with respect to the region's watershed elevation were considered as having technical potential for surface water harvesting.

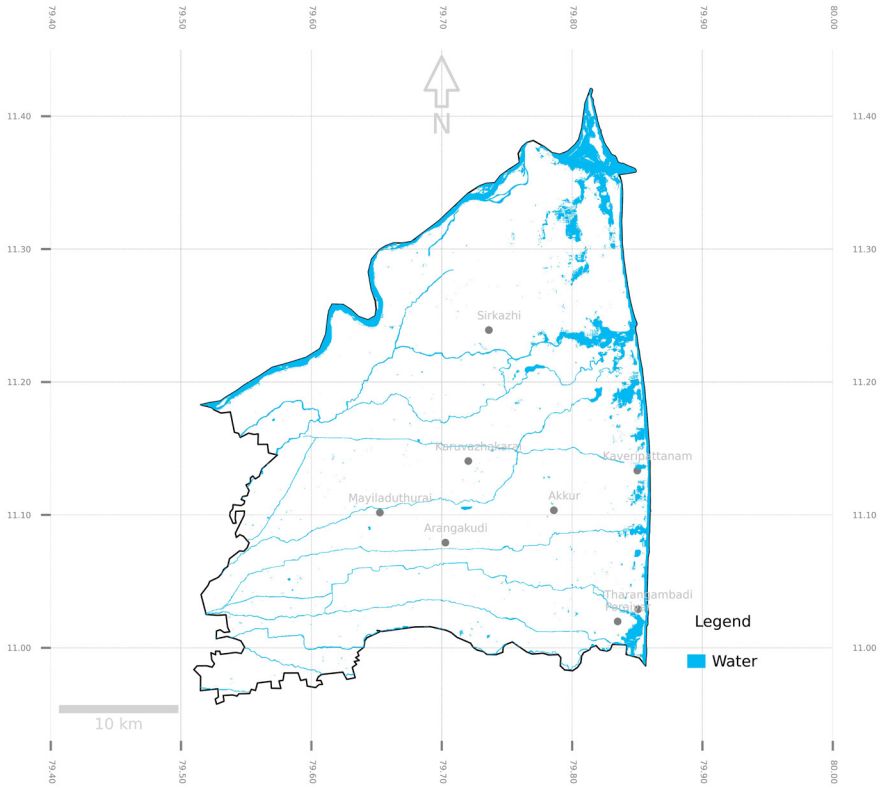
EVAPOTRANSPIRATION

Evapotranspiration (ET) is the combined loss of water in the form of evaporation from the soil surface and transpiration from the plant. ET can be used as a proxy indicator for water demand.



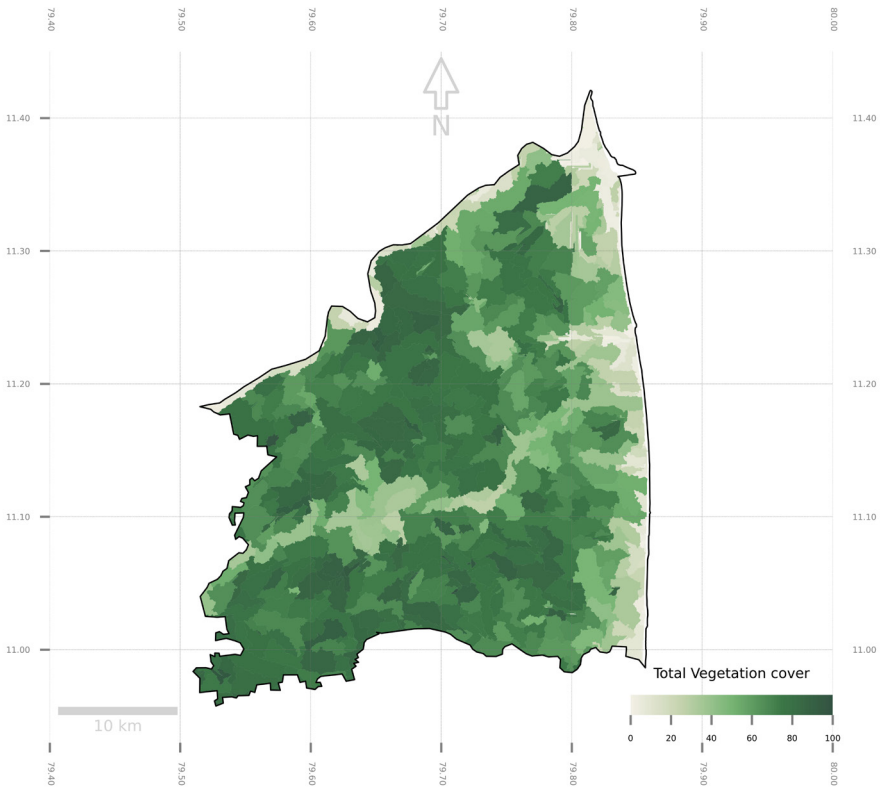
WATER BODIES

Large water bodies, if available, could be utilized for nurturing developing forests.



VEGETATION COVER

Vegetation cover defines the percentage of soil which is covered by green vegetation. It is essential for soil and water conservation and can be efficient even against wind erosion. Well-established vegetation slows water movement across the soil surface, which both reduces erosion and allows for more of the water to soak in.



To view the interactive map with these features: Click here

LANDCOVER DEFINITIONS:

Unused Lands	Lands that have been unused throughout the year (in terms of cultivation/built-up/water/trees) and does not belong to the other categories. They could also be in a barren condition sometimes.
Sparse Vegetation	Includes scrubs, grassland and sparse vegetation.
Cropland	Land covered with annual cropland that is sowed/planted and harvestable at least once within the 12 months after the sowing/planting date. The annual cropland produces a herbaceous cover and is sometimes combined with some tree or woody vegetation. Note: perennial woody crops will be classified as the appropriate tree cover or shrub land cover type. Greenhouses are considered as built-up.
Tree-cover	This class includes any geographic area dominated by trees with a cover of 10% or more. Other land cover classes (shrubs and/or herbs in the understorey, built-up, permanent water bodies, …) can be present below the canopy, even with a density higher than trees. Areas planted with trees for afforestation purposes and plantations (e.g. oil palm, olive trees) are included in this class. This class also includes tree covered areas seasonally or permanently flooded with fresh water.
Permanent Water Bodies	This class includes any geographic area covered for most of the year (more than 9 months) by water bodies: lakes, reservoirs, and rivers. Can be either fresh or salt-water bodies.
Built-up	Land covered by buildings. Buildings include both residential and industrial building.

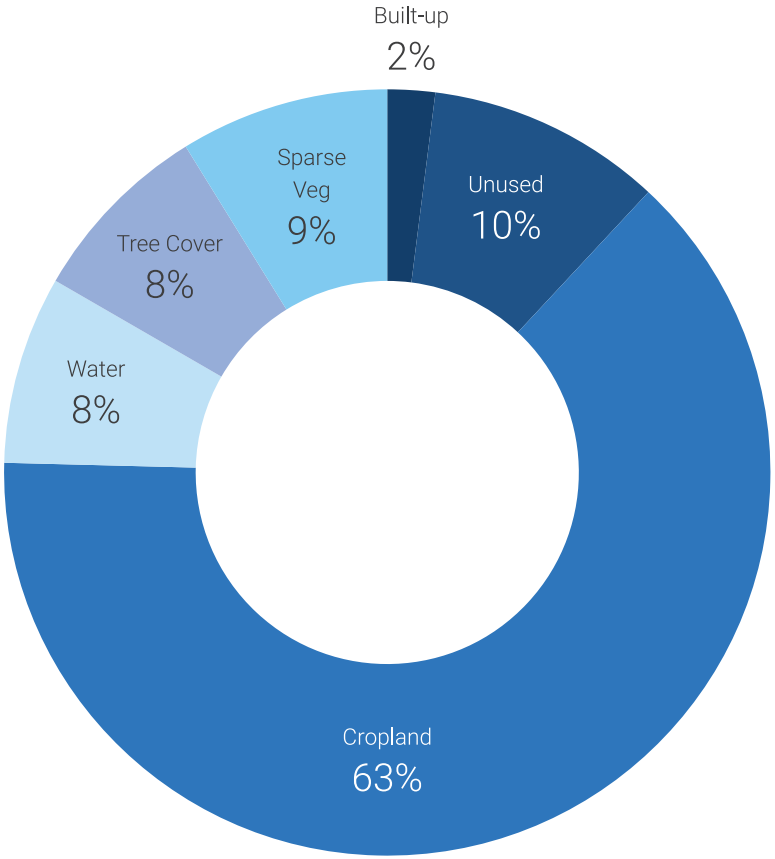
04 LAND COVER

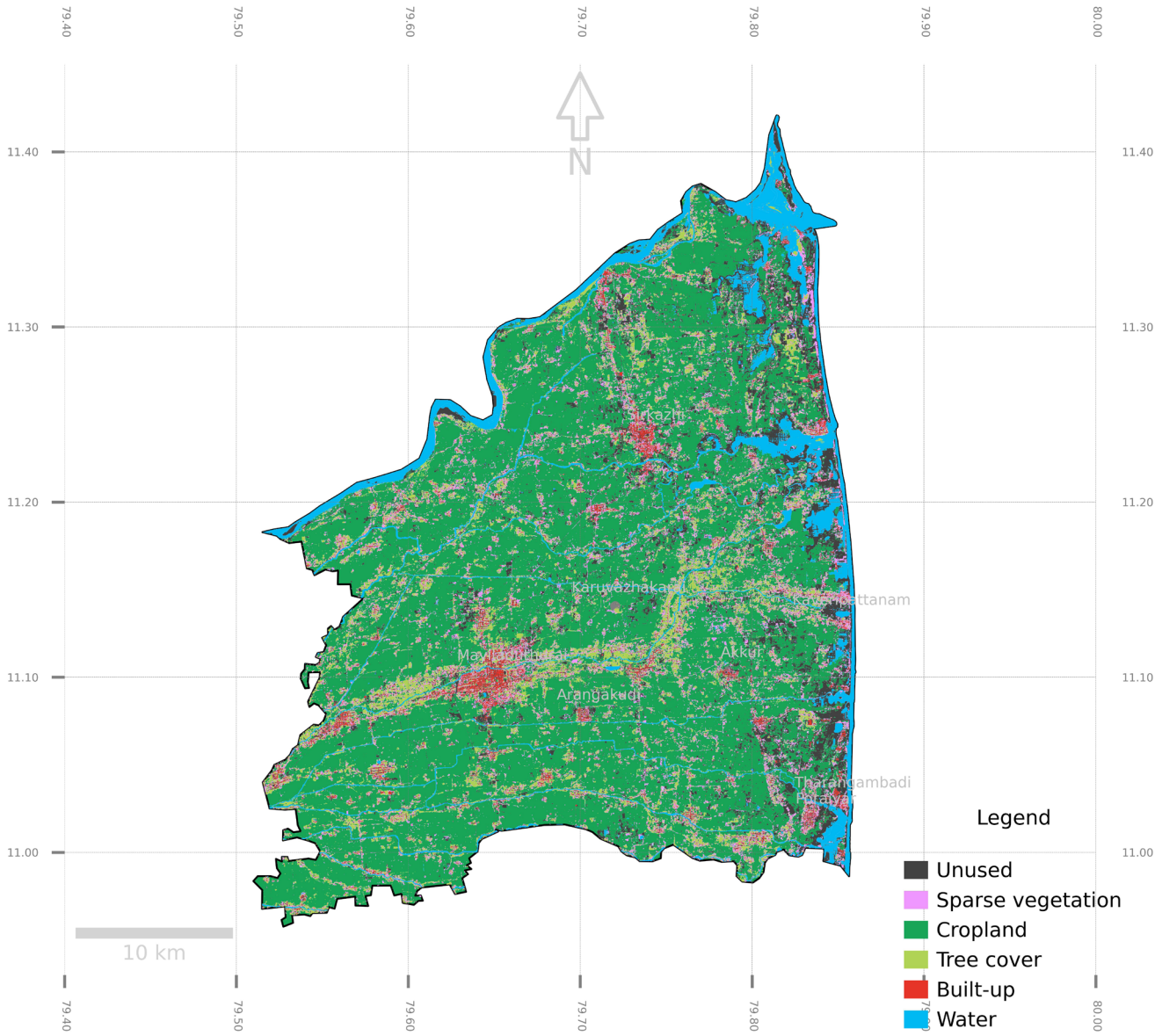
The districts land cover has been identified as per details below:

Land Cover	Km^2
Built-up	23.83
Unused	117.78
Cropland	753.00
Water	94.16
Tree Cover	93.07
Sparse Veg	104.59
Total	**1,186**

The districts land cover is dominated by agriculture, 45% of TGA is under crop land. It has 8% of its land under tree cover, considering the state average of 23.80% (MOEF 2017) this is a relatively low tree cover share. Unused or fallow lands account for the second highest recorded land-use in the district, with 10% of TGA or 117.78 km^2. This availability of unused lands could present rich opportunities for climate mitigation and adaptation actions including water harvesting infrastructure.

Unused or fallow lands account for the second highest recorded land-use in the district, with 10% of TGA or 117.78 km^2. These lands will be assessed for its suitability for water harvesting.





To view the interactive map with these land cover layers: **Click here**

05 WATER RESULTS

Technical suitability

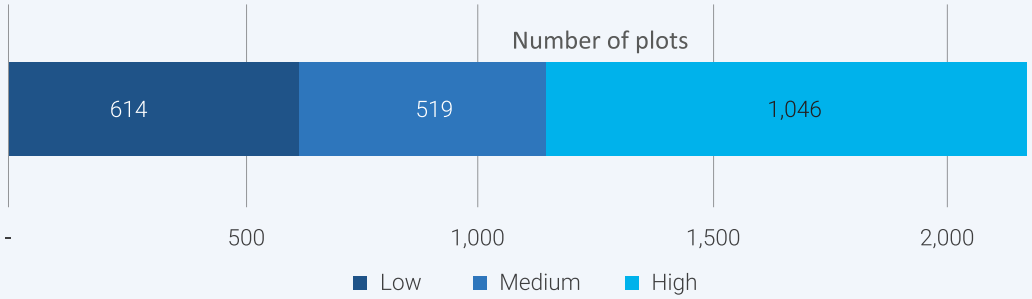
KEY RESULTS

Suitable land	9,816	acres
Share on total area	3.30	%
Run-off	84	MCM/year
Share of target	54	%

RESULTS

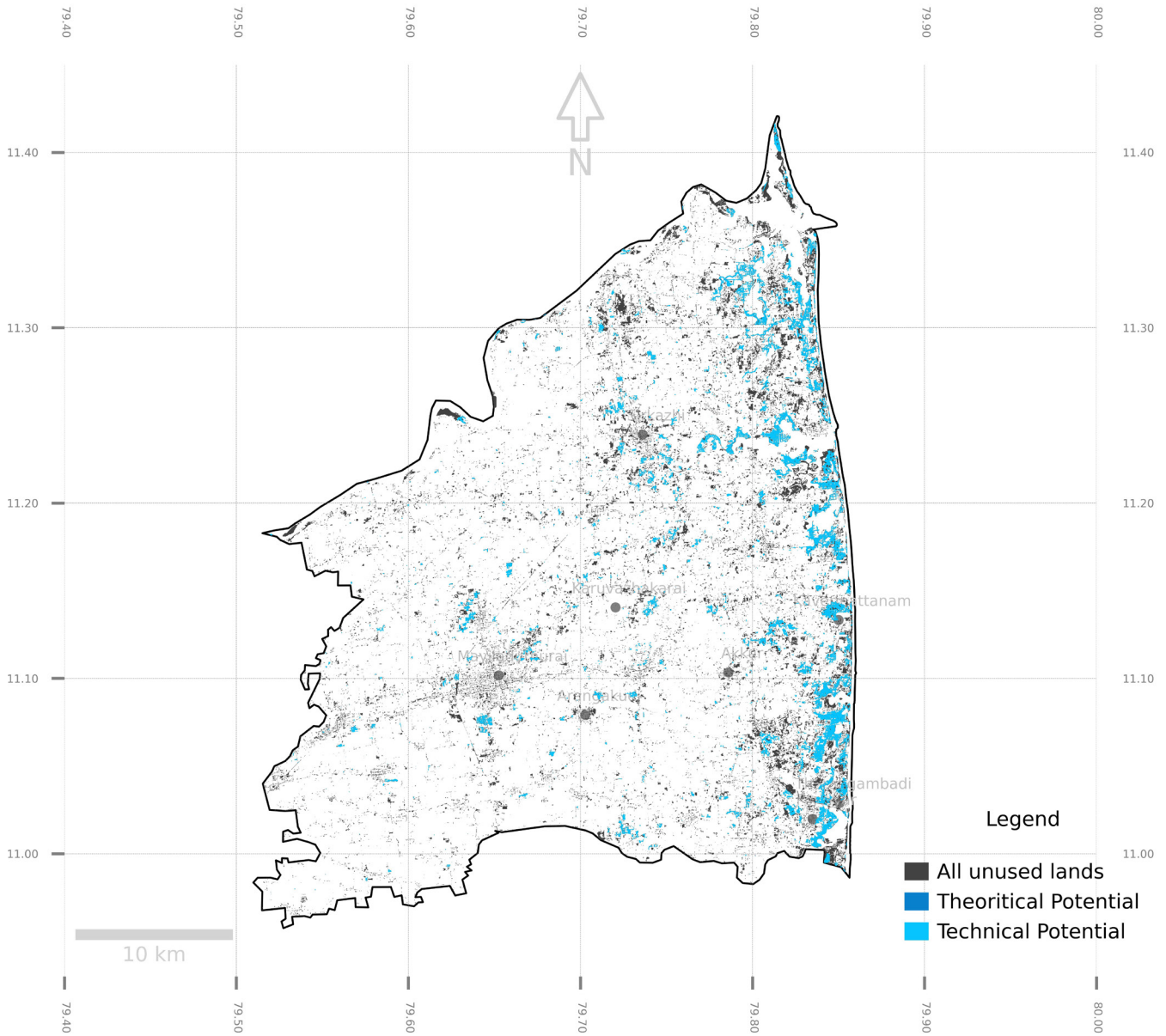
Filters	Plots (nos)	Share on total plots	Area (acres)	Run-off MCM/year
No Potential	31,395	94%	19,652	-
Technical Potential	2,179	6%	9,816	84

Number of plots for per potential



No Potential
19,652 acres

Technical Potential
9,816 acres



To view the interactive map with these land suitability layers: Click here

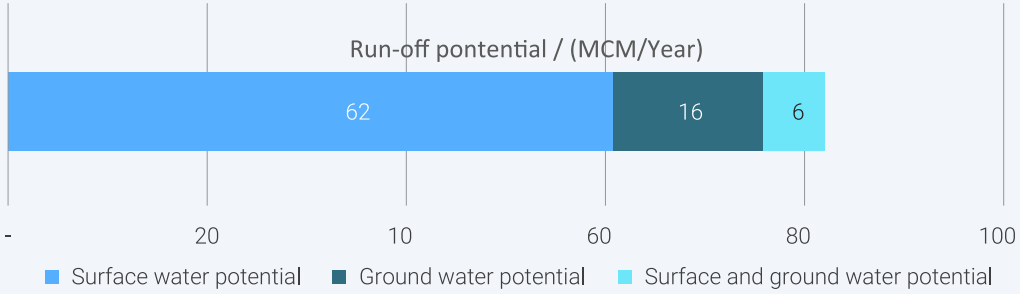
Distribution by water harvesting type

KEY RESULTS

Largest plot	243	acres
Surface water potential	40%	of target
Ground water potential	10%	of target
Surface and groundwater potential	4%	of target

Type	Plots (nos)	Area (acres)	MCM/year
Surface water potential	1,617	4,938	62
Groundwater potential	449	2,461	16
Surface and groundwater potential	113	2,417	6

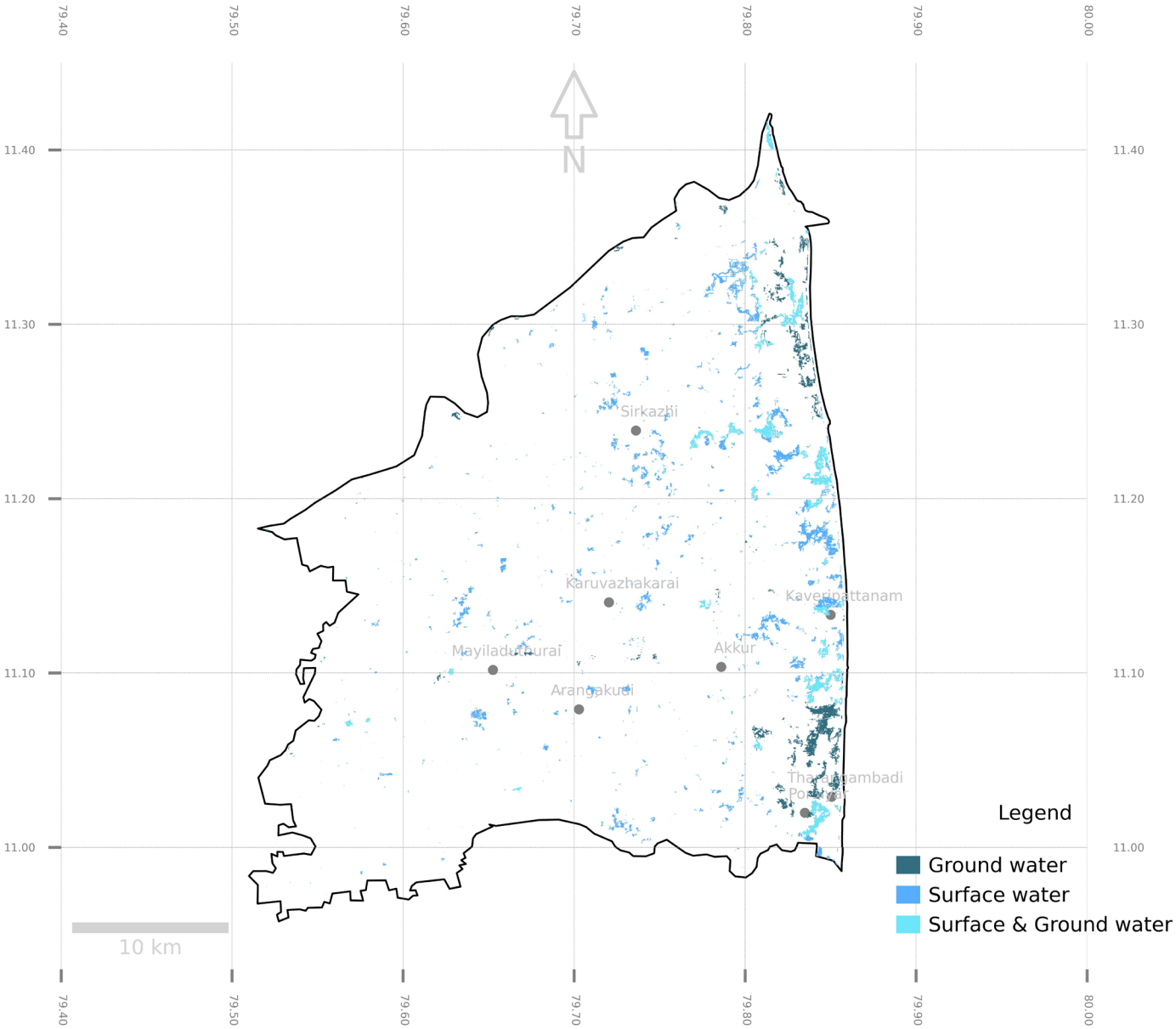
Run-off catchment potenial by type



Ground Water
2,461 acres

Surface Water
4,938 acres

Surface &
Ground Water
2,417 acres



To view the interactive map with these land suitability layers: Click here

Highest potential

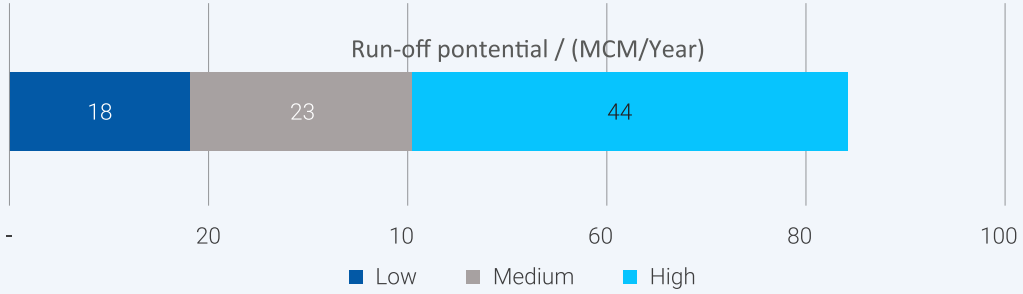
KEY RESULTS

Total area	2,728	acres
Plots	1,046	nos
Run-off	44	MCM/year
Share of target	28	%

RESULTS

Plots (nos)	Surface	Ground	Surface and ground
High	953	68	25
Medium	339	146	34
Low	325	236	53

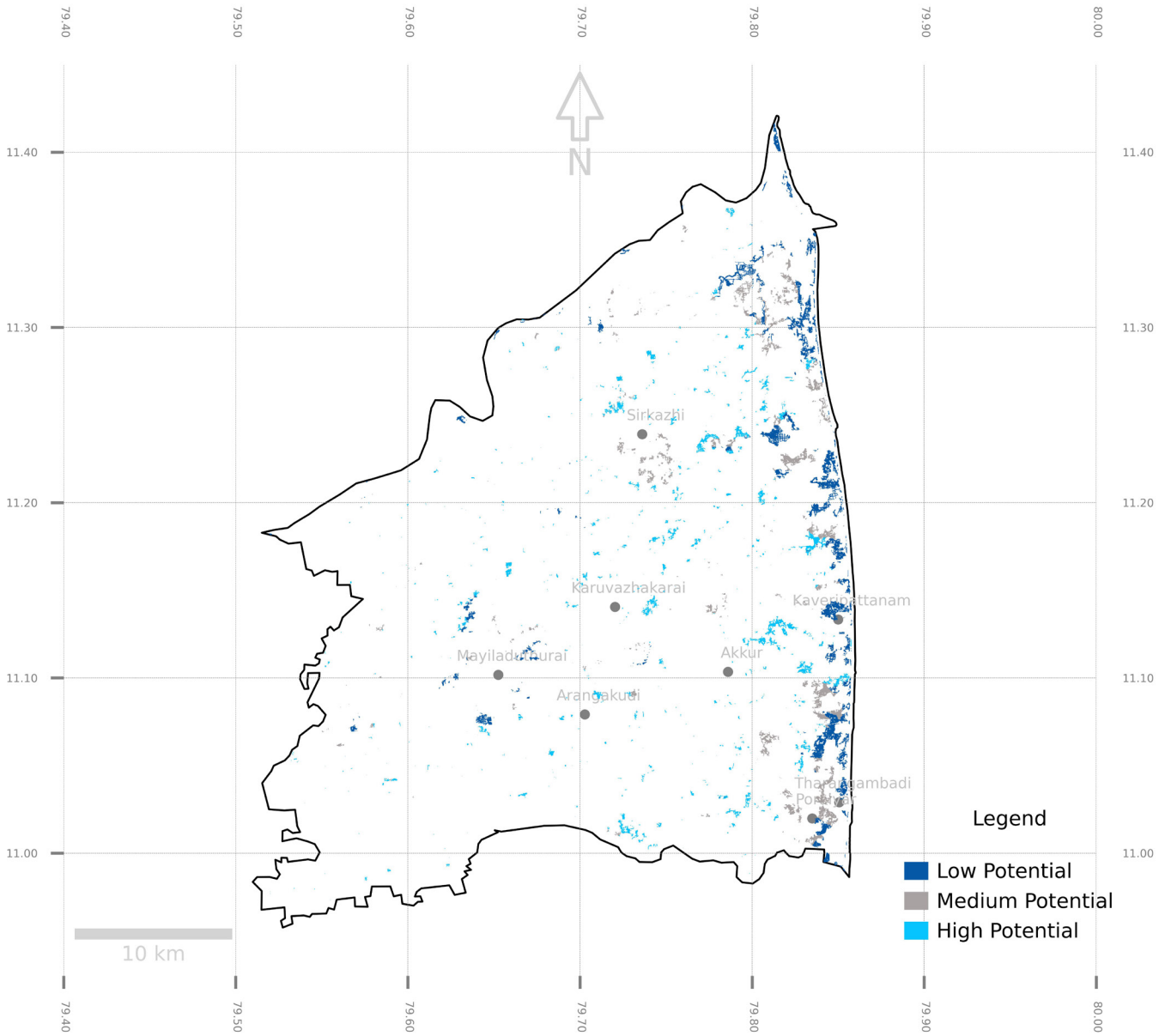
Run off potential



Low
4,228 acres

Medium
2,860 acres

High
2,728 acres



To view the interactive map with these land suitability layers: Click here

Competing use for Climate Action

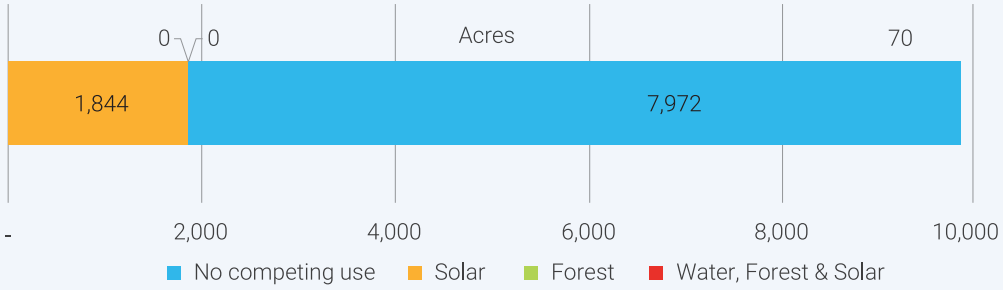
KEY RESULTS

Competing use	1,844	acres
Share of suitable area	81	%
Forest use	0	acres
Solar Use	1,844	acres

RESULTS

Plot sizes	Solar (acres)	Forest (acres)	S&F (acres)
High	651	0	0
Medium	484	0	0
Low	709	0	0

Cumulative Capacity

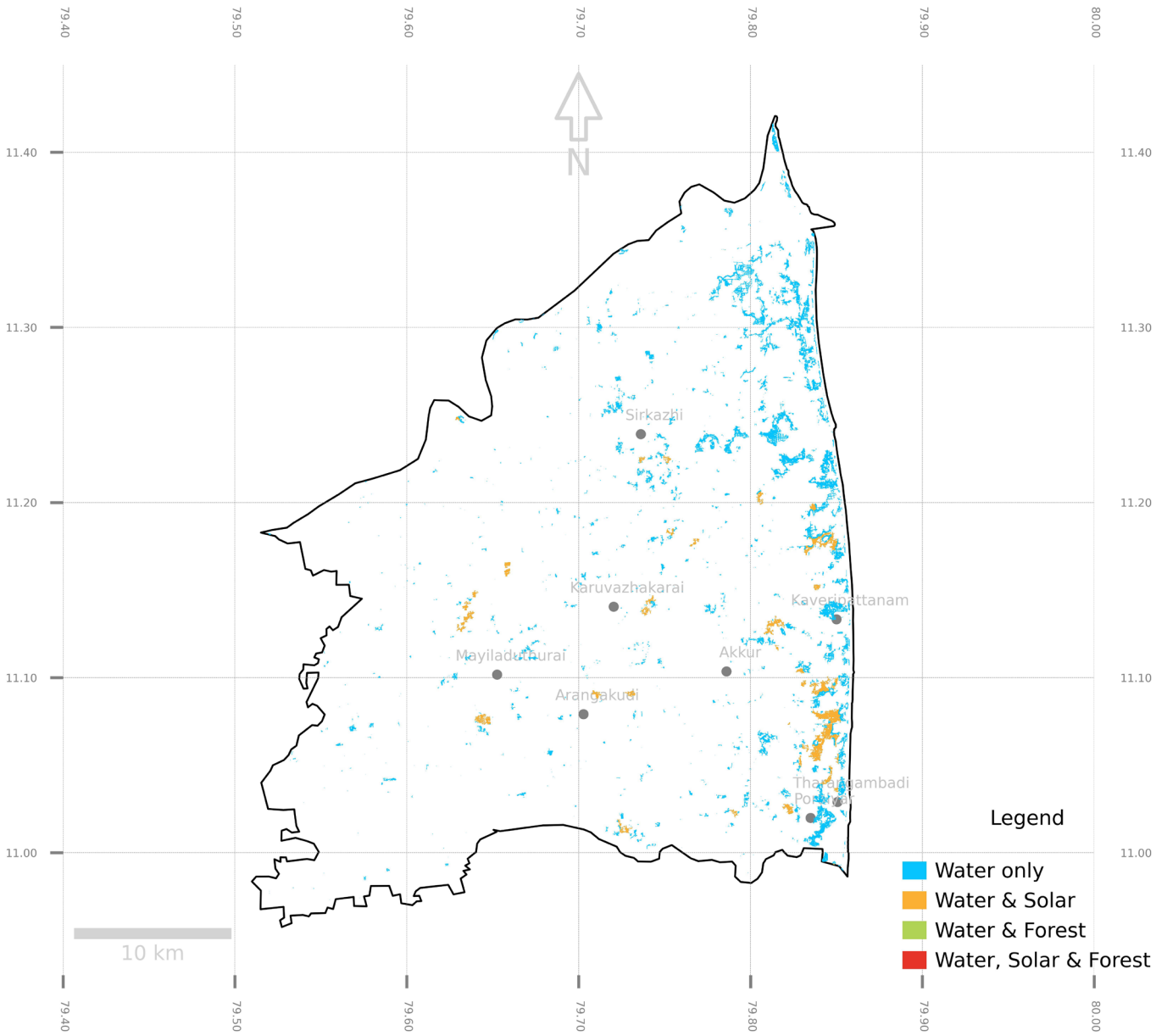


No competing use
7,972 acres

Solar
1,844 acres

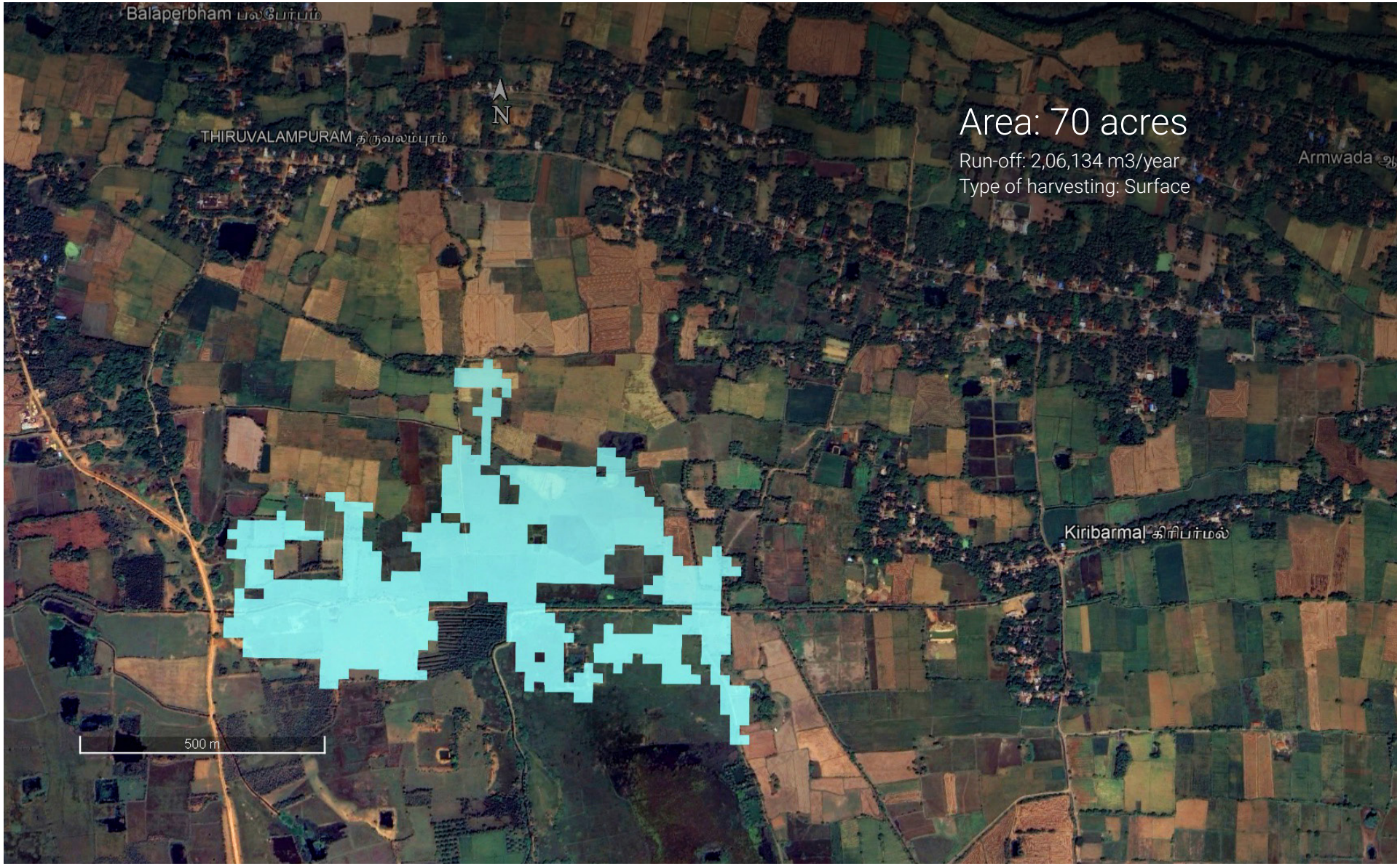
Forest
0 acres

F & W
0 acres



To view the interactive map with these competing lands: Click here

Example I High potential site



Top 15 Lands Identified

ID	Location		Elevation		Area	Runoff	High ET	Type of harvesting		Competing use	
	Long (°)	Lat (°)	Min (m)	Max (m)	(acres)	(m3/year)	(% area)	(% area)	Type	(acres)	Type
1	79.82	11.13	0.00	6.90	70	2,06,134	55.79	100 0	Surface Ground	0 70 0	Forest Solar F&S
2	79.72	11.02	0.01	3.14	54	1,97,262	65.87	100 0	Surface Ground	0 48 0	Forest Solar F&S
3	79.74	11.14	0.01	4.20	35	1,85,740	79.04	100 0	Surface Ground	0 35 0	Forest Solar F&S
4	79.72	11.25	0.00	7.47	35	1,50,378	56.32	100 0	Surface Ground	0 0 0	Forest Solar F&S
5	79.74	11.28	0.01	4.69	38	1,43,440	59.24	100 0	Surface Ground	0 0 0	Forest Solar F&S
6	79.74	11.14	0.02	2.80	31	1,40,062	67.22	100 0	Surface Ground	0 17 0	Forest Solar F&S
7	79.82	11.13	0.01	8.22	29	1,30,124	55.79	100 0	Surface Ground	0 0 0	Forest Solar F&S
8	79.79	11.24	0.01	4.52	69	1,26,780	62.3	98 2	Surface Ground	0 0 0	Forest Solar F&S
9	79.77	11.24	0.01	9.25	57	1,23,864	61.03	79 21	Surface Ground	0 0 0	Forest Solar F&S
10	79.81	11.20	0.02	9.68	38	1,23,171	56.51	96 4	Surface Ground	0 31 0	Forest Solar F&S

ID	Location		Elevation		Area	Runoff	High ET	Type of harvesting		Competing use	
	Long (°)	Lat (°)	Min (m)	Max (m)	(acres)	(m3/year)	(% area)	(% area)	Type	(acres)	Type
11	79.84	11.18	0.01	3.73	69	90,792	60.63	100 0	Surface Ground	0 36 0	Forest Solar F&S
12	79.81	11.13	0.00	6.60	33	83,293	68.75	100 0	Surface Ground	0 32 0	Forest Solar F&S
13	79.85	11.10	0.01	5.09	30	76,732	55.15	69 31	Surface Ground	0 0 0	Forest Solar F&S
14	79.83	11.10	0.01	5.23	32	65,374	62.99	100 0	Surface Ground	0 22 0	Forest Solar F&S
15	79.83	11.28	0.00	5.80	36	48,199	57.61	0 100	Surface Ground	0 0 0	Forest Solar F&S

To view the interactive map with the top 15 lands: Click here

06 SETTLEMENT – LEVEL ANALYSIS

The analysis conducted at settlement-level indicates the potential for run-off water harvesting on identified unused land for each settlement in Mayiladuthurai district.

Due to a lack of data available in the public domain the settlements in the table are not an exhaustive list, they include 252 out of 287 revenue-based villages in Mayiladuthurai district.

For each settlement the total geographic area (TGA), the existing land use share for water and the unused lands with technical potential for surface water harvesting were derived using remote sensing. The zones with high evapotranspiration are an indicator for a high water demand, possibly on account of agriculture.

A distinction between the type of water harvesting, ground water recharge or surface water holding is being made. It can be observed that settlement with the highest water harvesting potential are located along the district's coast line. The north-eastern tip and the south-eastern tip of the district's coast line appear to have favourable conditions for ground water recharge. In terms of the share of the district's TGA, when considering the top 10 settlements with the highest areas suitable for surface water recharge and groundwater recharge, they have similar potentials.

A detailed table with the analysis for the settlements are attached in Annexure II.

Technical potential for water harvesting by settlement

KEY RESULTS

Top 10 settlements area	4,373	acres
Top 10 settlement plots	643	nos
Share on district TGA	1.49	%
Share on district potential	45	%

RESULTS

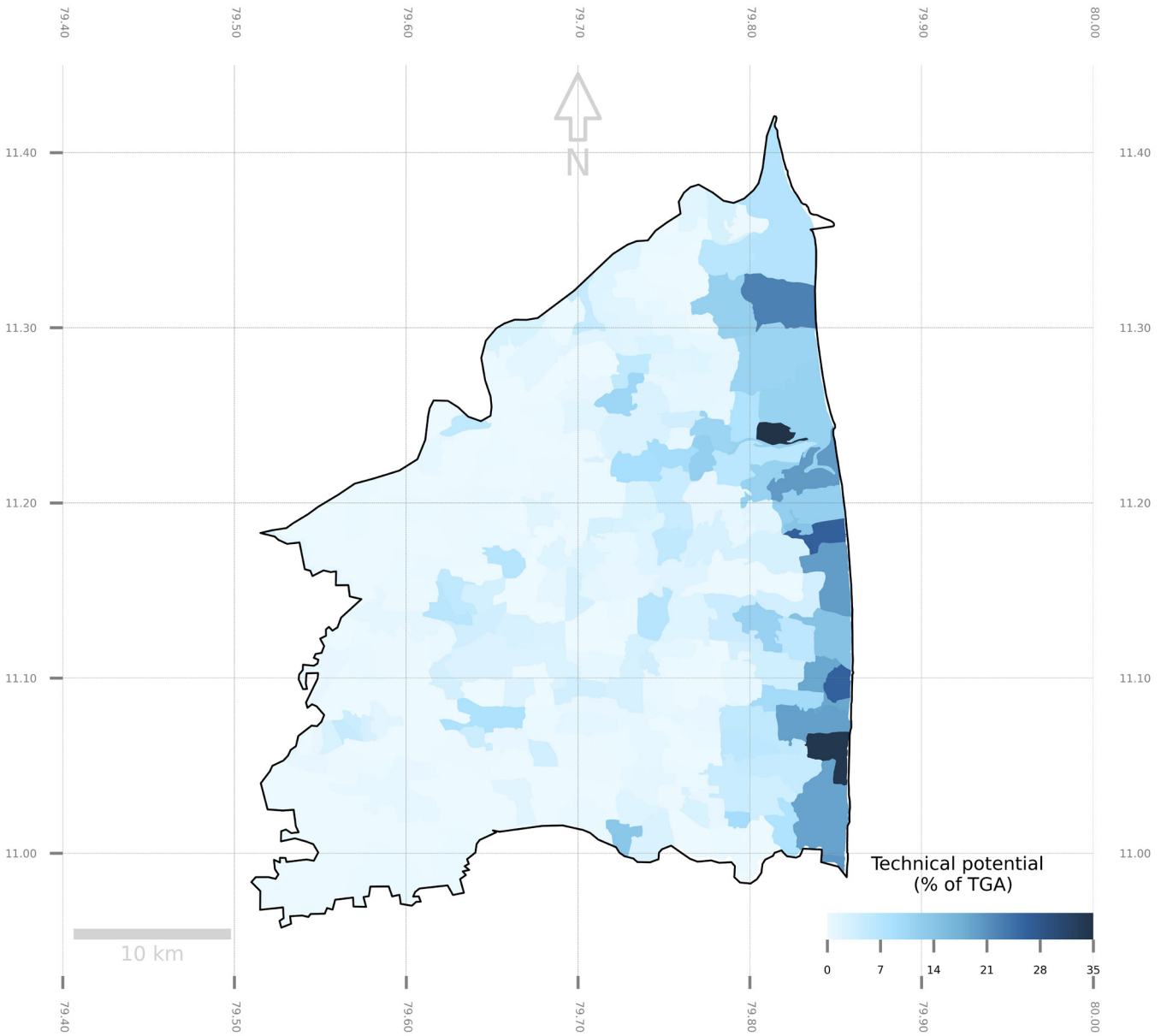
SETTLEMENT	TGA (acres)	Waterbodies (% of TGA)	Plots (nos)	Technical potential (acres)	Technical potential (% of TGA)
Tharangambadi	3,773	24	59	640	17
Thandavankulam	3,128	23	108	632	20
Thirumullaivasal	4,390	20	101	446	10
Manikkapangu	1,418	12	18	432	30
Vettangudy	4,242	10	73	413	10
Pudupattinam	6,314	60	78	409	6
Keelaiyur	2,316	21	57	407	18
Thennampattiam	2,051	26	38	364	18
Pillaiperumalnallur	2,043	7	57	353	17
Palayapalayam	2,605	13	54	275	11

Insights

Settlements with the highest technical potential are mostly located in east of the district along the coastline.

The ten-top settlements account for 45% of the district's potential area from the identified unused lands.

Tharangambadi settlement has the highest suitable area (640 acres) for harvesting water.



To view the interactive map with these settlement level layers: **Click here**

Surface water harvesting potential by settlement

KEY RESULTS

Top 10 settlements area	2,613	acres
Top 10 settlement plots	241	nos
Share on district TGA	0.89	%
Share on district potential	27	%

TOP 10 SETTLEMENTS

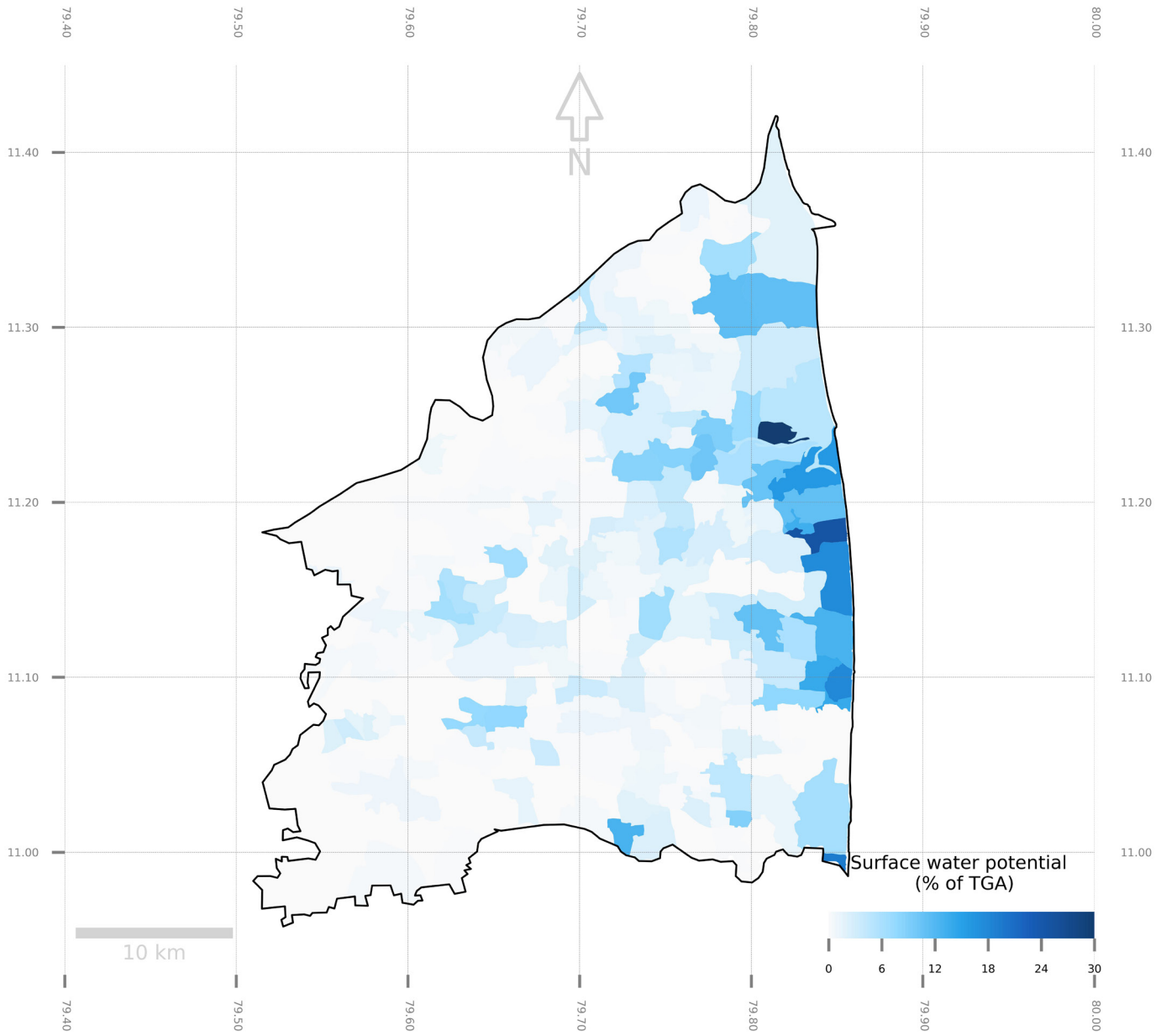
SETTLEMENT	TGA (acres)	Plots (nos)	Surface water harvesting (acres)	Surface water harvesting (% of TGA)
Keelaiyur	2,316	33	382	16%
Thandavankulam	3,128	34	329	11%
Thennampattiam	2,051	24	311	15%
Palayapalayam	2,605	26	275	11%
Perunthottam - II	1,031	12	242	23%
Vanagiri	1,923	29	230	12%
Tharangambadi	3,773	15	224	6%
Perunthottam I	2,077	26	214	10%
Radhanallur	713	8	202	28%
Thirumullaivasal	4,390	34	202	5%

Insights

Settlements with the highest potential for surface water harvesting are mostly located along the coast and in some central parts of the district.

The ten-top settlements suitable for surface water harvesting have a total unused area that makes up 27% of the district's total potential.

Keelaiyur settlement has the highest suitable area (382 acres) for surface water harvesting.



To view the interactive map with these settlement level layers: **Click here**

Ground water harvesting potential by settlement

KEY RESULTS

Top 10 settlements area	2,577	acres
Top 10 settlement plots	250	nos
Share on district TGA	0.88	%
Share on district potential	26	%

RESULTS

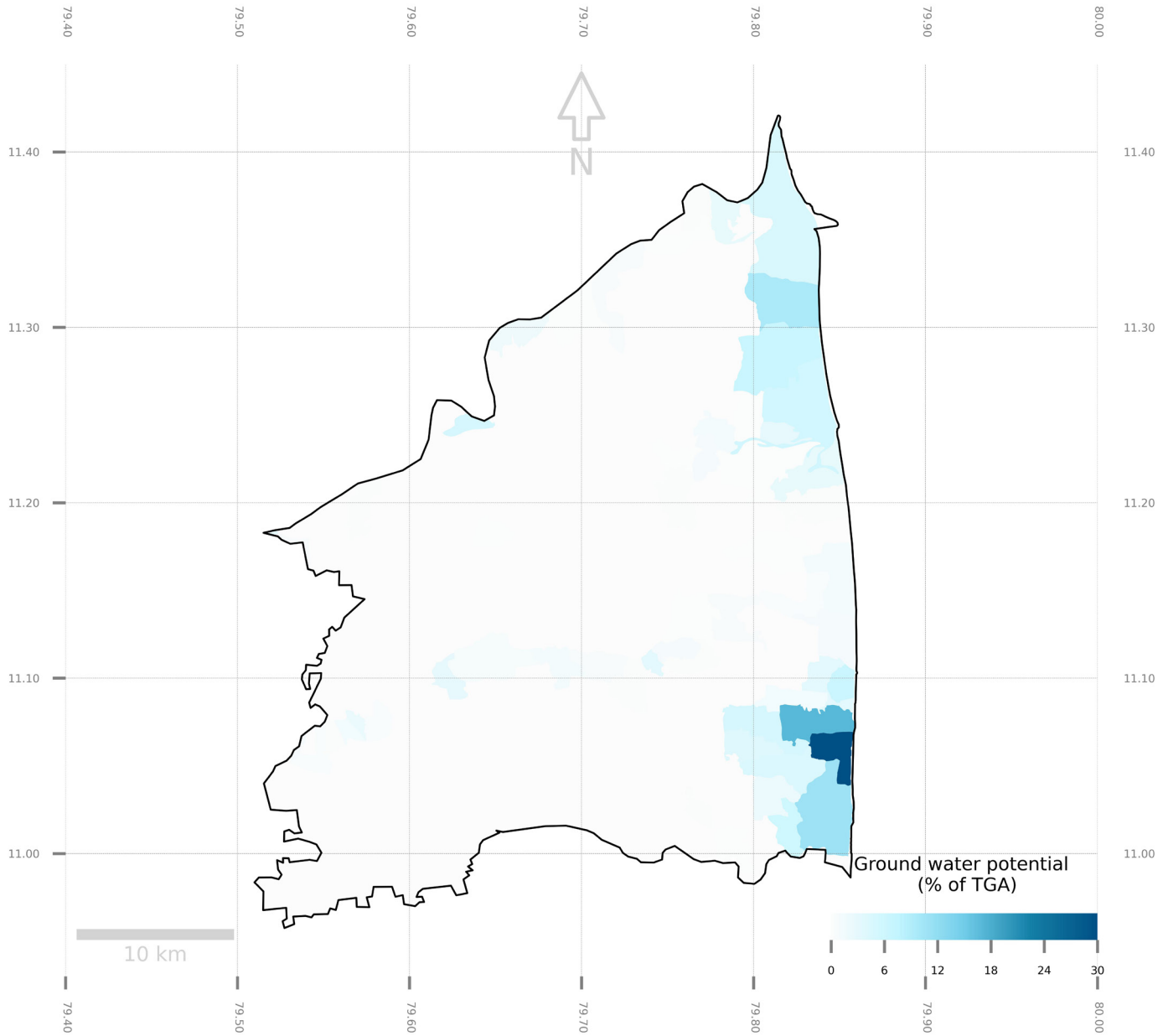
SETTLEMENT	TGA (acres)	Plots (nos)	Ground water harvesting (acres)	Ground water harvesting (% of TGA)
Manikkapangu	1,418	10	432	30%
Tharangambadi	3,773	30	416	11%
Pillaiperumalnallur	2,043	25	352	17%
Thandavankulam	3,128	41	303	10%
Pudupattinam	6,314	50	296	5%
Vettangudy	4,242	24	283	7%
Thirumullaivasal	4,390	40	245	6%
Thirukkadaiyur	1,949	12	98	5%
Kahiyappanallur	1,992	13	88	4%
Kattucheri	1,107	5	65	6%

Insights

Settlements with the highest groundwater recharge potential are mostly located along the southern part of the coastline, in contrast to the areas suitable for surface water recharge.

The ten-top settlements suitable for ground water harvesting have a total unused area that makes up 26% of the district's total potential.

Manikkapangu settlement has the highest suitable area (432 acres) for ground water harvesting.



To view the interactive map with these settlement level layers: **Click here**

07 RECOMMENDATIONS

PRIORITIZE WATERSHEDS WITH HIGH RECORDED EVAPOTRANSPIRATION

Watersheds with high water demand can be prioritized for surface water management interventions. A high share of agricultural land use in a given water shed area and a high recorded evapotranspiration are used as a proxi-indicator for high water demand in this model. Targeted surface water management intervention at identified unused land with high suitability for harvesting shall be prioritized.

CO-LOCATE SOLAR AND WATER HARVESTING

We have identified a competing use between water harvesting and distributed solar energy of 19% or 1,844 acres. Solar energy generation and surface water management can easily be co-located. Land-use guidelines that promote the dual use of lands for solar energy generation and water harvesting could be develop at the state and district level.

PRIORITIZE GROUNDWATER RECHARGE IN COASTAL AREAS

To curb and avoid seawater ingress in the coastal aquifers ground water recharge on identified lands maybe adopted as a priority. Especially the north-eastern and the south-eastern part along the district coast line has high ground water recharge potential.

08 SUMMARY

In Mayiladuthurai district, 2,179 plots of unused lands with a total area of 9,816 acres have been identified to meet the technical criteria for run-off water harvesting. The majority of these lands (1,617 plots) are suitable for harvesting water as surface water such as ponds, lakes, or other reservoirs; 449 plots are suitable for ground water harvesting, while 113 plots are partly suitable for both. In total, all the unused lands that meet the technical potential criteria, can contribute towards 54% of the recharge or harvesting target.

Unused lands identified to have a high potential for water harvesting efforts make up 1,046 plots. These had a potential to meet 28% of the target, which translates to 44 MCM/year.

The settlement-level analysis shows that villages with the most suitable areas for water harvesting are located along the coastline. These regions also have relatively higher percentages of waterbodies, as distributaries flow through them. Water harvesting efforts maybe prioritized in these regions to facilitate in meeting the district's target.

09 REFERENCES

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2. Ministry of Environment, Forest & Climate Change (MOEF). 2017. State of Forest Report 2017. Available at: https://fsi.nic.in/forest-report-2017 (accessed on 4th June 2022)

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4. Ritchie. H and Roser. M. (2017) "Water Use and Stress". Published online at OurWorldInData.org. Available at: https://ourworldindata.org/water-use-stress (accessed on 7th June 2023).

Link to interactive maps:

- https://www.aurovilleconsulting.com/wp-content/uploads/Lila/Mayiladuthurai/Water.html

10 ANNEXURE I

Through LiLa Water Module, by analysing the various criteria such as terrain, watershed analysis, weather, demand and runoff, we identify most suitable lands for creating water harvesting interventions in the form of ground water recharge systems or surface water reservoirs. This is done through definition of a complex set of scientific methods and procedures for evaluating the potential of different barren/unused lands in this context.

An in-depth research has been done on existing literature regarding regional geology, hydrogeology and climatic conditions; literature on surface water management, watershed analysis, hydrological parameters, runoff quantification models, have also been studied to establish a scientific framework. At the same time an extensive research on latest open source technologies on digital terrain modelling, vegetation classification from aerial or satellite imagery, treatment of complex geospatial datasets, has been conducted to find effective tools able to process the large amount of data collected and give tangible results.

Literature offers several types of models, oriented mainly on watershed analysis rather than focused only on rainfall-runoff potential evaluation. The model proposed here can be defined as a “medium resolution, distributed deterministic static (event-based), physically based model in ungauged catchment”.

In essence, the water analysis for unused lands is conducted based on their location with respect to the watershed basins they are situated in. The location, topographical features and the vegetation cover of the watershed basins are determinants of the hydrological dynamics of those regions, which influence run-off capture potential and water demand of the region. Thus, details on how the watershed basins, run-off capture and water demand are defined and estimated are explained below.

WATER DEMAND ESTIMATION

Water Demand analysis is done at the scale of watersheds. Evapotranspiration is used as a proxy for the watershed level water demand. Only agricultural lands were considered. For each watershed, the pixels contributing to high ET (due to cultivation) are identified. Threshold value for pixels which have high ET is 700mm per pixel per year.). Watersheds with high water demand are defined as those that have more than 50% of the watershed area with significant evapotranspiration (ET). Watershed’s low water demand are those that have less than 30% of their area with a significant rate of ET. Unused lands that have a high annual run-off and are located in watersheds with high water demand could be priorities for surface or ground water harvesting interventions.

10 ANNEXURE II

Note:

1. A plot that crosses a settlement boundary is counted as two plots. Thus, the total number of plots under settlement-wise analysis is higher than the district total.
2. The data used for the analysis had inherent disparities, causing slight differences in the overall settlement and district boundary.
3. The settlement boundaries accounted for areas dedicated for reserve forests separately. Thus, the total number of boundaries are higher than the official number of administrative boundaries (928) in the district.

Settlement - Level Stats

Settlement	Lat (°)	Lon (°)	Population (nos)	TGA (acres)	Technical Potential (acres	Technical potential plots (nos)	Share of technical potential area (% of TGA)	Surface water (acres)	Surface water (plots)	Ground water (acres)	Ground water (plots)	Waterbodies (% of TGA)	Type
Achalpuram	79.75	11.33	5,017	1,376	1.32	6.00	0.10	1.32	5	0.00	0	10.55	SW
Adhanur (Mannargudi)	79.54	11.19	-	37	-	-	-	-	0	0.00	0	84.39	nothing
Agani	79.70	11.24	1,045	1,230	16.49	13.00	1.34	16.49	5	0.00	0	0.11	SW
Agaradhanur	79.70	11.06	685	640	0.89	3.00	0.14	0.89	3	0.00	0	3.62	SW
Agaraelathur	79.66	11.26	1,903	1,244	-	-	-	-	0	0.00	0	20.57	nothing
Agarakkirangudi	79.66	11.08	2,885	907	65.78	18.00	7.26	65.78	7	0.00	0	2.40	SW
Agaraperunthottam	79.83	11.19	397	295	36.90	2.00	12.53	36.90	1	0.00	0	16.28	SW
agaravallam	79.68	11.05	1,259	407	0.30	3.00	0.07	0.30	3	0.00	0	-	SW
Agaravattaram	79.78	11.29	1,756	722	4.40	3.00	0.61	4.40	3	0.00	0	1.01	SW
Akkurpandaravadai	79.80	11.11	4,366	686	5.83	6.00	0.85	5.83	5	0.00	0	-	SW
Alakkudy	79.77	11.37	1,630	1,031	13.46	6.00	1.30	10.33	3	3.13	3	25.81	both
Alalasundram	79.76	11.32	1,150	660	1.21	4.00	0.18	1.21	4	0.00	0	1.15	SW

Settlement	Lat (°)	Lon (°)	Population (nos)	TGA (acres)	Technical Potential (acres	Technical potential plots (nos)	Share of technical potential area (% of TGA)	Surface water (acres)	Surface water (plots)	Ground water (acres)	Ground water (plots)	Waterbodies (% of TGA)	Type
Alangadu	79.78	11.27	2,174	1,232	11.37	12.00	0.92	11.37	8	0.00	0	1.02	SW
Alanganatham	79.61	11.24	-	11	-	-	-	-	0	0.00	0	94.30	nothing
Alangudi	79.56	11.12	117	357	0.40	1.00	0.11	0.40	1	0.00	0	3.01	SW
Alaveli	79.71	11.15	753	650	5.98	2.00	0.92	5.98	2	0.00	0	2.87	SW
Anaimelagaram	79.60	11.09	5,902	733	0.30	3.00	0.04	-	0	0.30	3	1.92	GW
Ananthanallur	79.62	11.03	556	793	-	-	-	-	0	0.00	0	6.46	nothing
Anathandavapuram	79.67	11.16	3,177	1,393	-	-	-	-	0	0.00	0	1.53	nothing
Annavasal	79.71	11.07	4,231	1,157	12.36	4.00	1.07	12.36	4	0.00	0	3.07	SW
Anniyur	79.58	10.98	94	125	0.06	1.00	0.05	0.06	1	0.00	0	-	SW
Arapallam	79.77	11.33	3,052	1,119	0.16	1.00	0.01	0.16	1	0.00	0	0.81	SW
Arasur	79.73	11.28	1,881	824	41.43	6.00	5.03	41.43	5	0.00	0	0.01	SW
Arasur	79.72	11.03	1,466	791	0.10	1.00	0.01	0.10	1	0.00	0	2.80	SW
Ariyalur	79.66	11.06	1,107	826	4.09	4.00	0.50	4.09	4	0.00	0	3.51	SW
Arpakkam	79.75	11.27	648	439	2.71	2.00	0.62	2.71	2	0.00	0	0.05	SW
Arulmolithevan	79.62	11.14	2,111	798	48.31	10.00	6.06	48.31	3	0.00	0	0.55	SW
Arupathy	79.71	11.11	5,108	1,263	10.02	14.00	0.79	1.58	2	8.44	8	7.71	both
Aruvappadi	79.64	11.16	1,401	768	0.10	1.00	0.01	0.10	1	0.00	0	4.18	SW
Asikkadu	79.61	11.07	800	895	0.20	1.00	0.02	0.20	1	0.00	0	2.77	SW
Athiyur	79.70	11.27	711	748	4.45	5.00	0.60	4.45	5	0.00	0	0.14	SW
Athuppakkam	79.79	11.02	446	362	30.07	7.00	8.30	30.07	4	0.00	0	0.03	SW
Attur	79.57	11.19	1,254	880	2.27	5.00	0.26	-	0	2.27	5	0.81	GW
Baskararajapuram	79.52	11.05	1,149	69	-	-	-	-	0	0.00	0	-	nothing
Budangudi	79.56	11.17	5,248	1,307	-	-	-	-	0	0.00	0	6.01	nothing
Chandirappadi	79.85	10.99	908	225	41.09	5.00	18.23	41.09	4	0.00	0	41.87	SW

Settlement	Lat (°)	Lon (°)	Population (nos)	TGA (acres)	Technical Potential (acres	Technical potential plots (nos)	Share of technical potential area (% of TGA)	Surface water (acres)	Surface water (plots)	Ground water (acres)	Ground water (plots)	Waterbodies (% of TGA)	Type
Chidambara Arasur	79.63	11.25	-	99	-	-	-	-	0	0.00	0	65.82	nothing
Dharmadanapuram	79.70	11.17	3,428	1,455	24.63	4.00	1.69	24.63	4	0.00	0	3.78	SW
Eachangudi	79.73	11.05	797	723	5.34	3.00	0.74	5.34	3	0.00	0	4.06	SW
Edakkudi	79.68	11.03	2,295	808	0.30	1.00	0.04	0.30	1	0.00	0	2.51	SW
Edakudivasapathy I	79.74	11.20	1,944	1,415	32.92	22.00	2.33	32.92	16	0.00	0	0.55	SW
Edamanal	79.80	11.25	3,052	1,229	86.39	15.00	7.03	84.11	9	2.27	2	5.12	both
Eduthukkatti	79.79	11.00	4,949	1,168	3.90	9.00	0.33	2.32	6	1.58	5	2.43	both
Elangambur	79.64	11.28	-	10	-	-	-	-	0	0.00	0	97.53	nothing
Elanthoppu	79.65	11.23	2,216	1,235	3.92	4.00	0.32	3.92	3	0.00	0	6.24	SW
Elumagalur	79.63	11.00	2,870	1,828	5.63	5.00	0.31	5.63	5	0.00	0	4.64	SW
Eravancheri	79.75	11.03	685	600	1.29	1.00	0.21	1.29	1	0.00	0	0.05	SW
Erukkur	79.71	11.28	4,202	1,325	0.69	1.00	0.05	0.69	1	0.00	0	1.54	SW
Eyyalur	79.52	11.18	-	38	1.20	1.00	3.19	-	0	1.20	1	93.45	GW
Gangadharapuram	79.61	11.00	2,124	1,614	0.30	1.00	0.02	0.30	1	0.00	0	2.41	SW
Gopalasamuthiram	79.71	11.31	857	789	34.62	4.00	4.39	33.13	4	1.48	3	25.86	both
Gudalur	79.77	11.05	1,498	1,002	0.89	4.00	0.09	0.89	4	0.00	0	0.42	SW
Ilaiyalur	79.71	11.08	2,191	942	4.77	7.00	0.51	4.77	5	0.00	0	0.04	SW
Iluppur	79.77	11.01	6,149	1,413	0.40	2.00	0.03	0.10	1	0.30	1	3.71	both
Inam Senniyanallur	79.57	11.07	4,709	365	16.00	5.00	4.38	11.07	2	4.94	2	-	both
Inam Tiruvalangadu	79.54	11.06	2,931	295	-	-	-	-	0	0.00	0	4.14	nothing
Ivanallur	79.60	11.16	627	803	2.04	8.00	0.25	1.74	7	0.30	1	6.36	both
Jayamkondapattanam	79.75	11.36	-	94	-	-	-	-	0	0.00	0	77.68	nothing
Kadakkam	79.69	11.06	1,532	727	1.68	2.00	0.23	1.68	2	0.00	0	1.64	SW
Kadalangudi	79.56	11.19	1,484	896	-	-	-	-	0	0.00	0	26.36	nothing

Settlement	Lat (°)	Lon (°)	Population (nos)	TGA (acres)	Technical Potential (acres	Technical potential plots (nos)	Share of technical potential area (% of TGA)	Surface water (acres)	Surface water (plots)	Ground water (acres)	Ground water (plots)	Waterbodies (% of TGA)	Type
Kadalangudi	79.57	11.11	2,701	1,064	4.35	3.00	0.41	4.35	3	0.00	0	3.09	SW
Kadambakkam	79.61	11.23	125	810	5.44	4.00	0.67	5.44	3	0.00	0	29.72	SW
Kadavasal	79.77	11.26	1,651	501	4.83	4.00	0.96	4.83	4	0.00	0	0.06	SW
Kadhiramangalam	79.70	11.18	334	540	0.79	2.00	0.15	0.79	2	0.00	0	1.22	SW
Kadiramangalam	79.54	11.06	982	150	1.58	3.00	1.06	-	0	1.58	3	7.43	GW
Kaduvangudi	79.63	11.23	1,568	1,061	-	-	-	-	0	0.00	0	2.25	nothing
Kahiyappanallur	79.82	11.05	6,358	1,992	89.28	20.00	4.48	1.09	5	88.19	13	3.71	both
Kalahasthinathapuram	79.77	11.11	2,502	1,013	3.60	3.00	0.36	0.00	1	3.60	2	-	both
Kalamanallur	79.85	11.10	4,542	774	180.30	29.00	23.31	129.88	19	50.41	16	25.47	both
Kalamanallur	79.82	11.09	1,514	1,189	103.75	23.00	8.73	87.12	15	16.62	5	8.68	both
Kali -I	79.58	11.15	579	324	-	-	-	-	0	0.00	0	7.18	nothing
Kali II Bit	79.58	11.16	1,192	1,157	0.74	2.00	0.06	0.74	2	0.00	0	2.33	SW
Kanganamputhur	79.63	11.15	2,279	875	45.72	10.00	5.23	45.72	8	0.00	0	1.73	SW
Kanjanagaram	79.70	11.13	1,456	1,233	0.30	2.00	0.02	0.30	2	0.00	0	0.01	SW
Kanjuvoy	79.55	11.03	3,965	680	-	-	-	-	0	0.00	0	3.20	nothing
Kannapiranadi	79.76	11.30	523	339	2.27	5.00	0.67	2.27	1	0.00	0	0.74	SW
Kanniyakudi	79.68	11.18	1,066	694	0.69	2.00	0.10	0.69	2	0.00	0	2.87	SW
Kappur	79.63	11.05	3,337	614	0.20	2.00	0.03	0.20	2	0.00	0	2.32	SW
Karaimedu	79.75	11.20	4,411	1,858	75.92	49.00	4.09	71.37	39	4.55	9	8.00	both
Karkoil	79.69	11.20	1,672	965	4.64	5.00	0.48	4.64	5	0.00	0	0.05	SW
Karupperi	79.61	11.23	-	5	-	-	-	-	0	0.00	0	90.45	nothing
Karuppur	79.53	11.04	11,217	1,407	0.10	1.00	0.01	0.10	1	0.00	0	5.79	SW
Karuvazhakarai	79.72	11.14	105	309	1.15	2.00	0.37	1.15	2	0.00	0	0.10	SW
Katchukattu	79.52	10.98	100	224	0.20	2.00	0.09	0.20	2	0.00	0	-	SW

Settlement	Lat (°)	Lon (°)	Population (nos)	TGA (acres)	Technical Potential (acres	Technical potential plots (nos)	Share of technical potential area (% of TGA)	Surface water (acres)	Surface water (plots)	Ground water (acres)	Ground water (plots)	Waterbodies (% of TGA)	Type
Kathiruppu	79.75	11.18	1,505	1,007	51.95	13.00	5.16	51.95	8	0.00	0	1.17	SW
Kattucheri	79.82	11.01	3,203	1,107	77.20	14.00	6.97	12.54	6	64.66	5	4.04	both
Kattur	79.80	11.36	3,951	786	1.52	5.00	0.19	1.52	5	0.00	0	31.49	SW
Kazhanivasal	79.66	11.02	3,773	1,036	-	-	-	-	0	0.00	0	2.42	nothing
Keelaiyur	79.85	11.16	12,688	2,316	407.40	57.00	17.59	381.54	33	25.86	6	21.17	both
Keelaiyur	79.60	11.06	327	786	0.57	2.00	0.07	0.57	2	0.00	0	3.11	SW
Keelamarudandanallur	79.66	11.17	564	853	52.33	3.00	6.13	52.33	3	0.00	0	0.82	SW
Keelamathur	79.69	11.27	1,401	1,010	-	-	-	-	0	0.00	0	5.55	nothing
Keelamathur	79.75	11.07	1,227	733	-	-	-	-	0	0.00	0	5.18	nothing
Keelasattanathapuram	79.79	11.19	3,428	1,285	9.56	5.00	0.74	9.56	5	0.00	0	3.99	SW
Keelpuliyampattu	79.53	11.18	-	44	-	-	-	-	0	0.00	0	96.50	nothing
Keeranur	79.67	11.01	186	130	-	-	-	-	0	0.00	0	38.85	nothing
Kesingan	79.61	11.18	2,550	1,049	0.09	1.00	0.01	0.09	1	0.00	0	5.36	SW
Kezhakundalapadi	79.75	11.36	-	204	-	-	-	-	0	0.00	0	39.10	nothing
Kidarankondan	79.76	11.13	5,242	1,984	33.07	8.00	1.67	29.77	5	3.30	3	3.77	both
Kilaparuthikudi	79.57	11.00	467	263	-	-	-	-	0	0.00	0	2.98	nothing
Kildangal	79.79	11.12	590	280	8.04	2.00	2.87	8.04	2	0.00	0	0.11	SW
Kilianur	79.68	11.06	394	607	19.57	12.00	3.23	19.57	3	0.00	0	3.73	SW
Killiyur	79.77	11.07	1,036	697	2.65	5.00	0.38	2.65	5	0.00	0	1.18	SW
Kiloy	79.61	11.20	6,397	1,222	3.26	4.00	0.27	2.67	3	0.59	1	0.01	both
Kizhaiyur	79.74	11.14	3,659	1,327	83.87	13.00	6.32	83.62	7	0.25	1	1.31	both
Kizhaperumpallam	79.83	11.12	940	1,312	72.90	14.00	5.56	72.90	13	0.00	0	0.07	SW
Kodangudi	79.68	11.08	1,171	892	2.97	3.00	0.33	2.97	2	0.00	0	2.54	SW
Kodavilagam	79.71	11.04	861	758	1.58	2.00	0.21	1.58	2	0.00	0	0.00	SW

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Kodimangalam	79.54	11.02	783	266	-	-	-	-	0	0.00	0	5.38	nothing
Kokkur	79.57	11.05	3,225	651	1.48	2.00	0.23	1.48	2	0.00	0	0.27	SW
Kollumangudi	79.63	10.99	21	115	-	-	-	-	0	0.00	0	18.93	nothing
Komal - East	79.59	11.04	5,895	1,633	13.01	4.00	0.80	13.01	3	0.00	0	4.20	SW
Komal - West	79.58	11.03	9,176	1,258	10.10	10.00	0.80	10.10	7	0.00	0	4.80	SW
Kondal	79.67	11.24	1,923	1,039	0.10	1.00	0.01	0.10	1	0.00	0	5.10	SW
Kondathur	79.71	11.18	962	470	12.26	6.00	2.61	12.26	6	0.00	0	-	SW
Kondathur	79.72	11.17	1,651	1,199	8.60	5.00	0.72	8.60	5	0.00	0	3.49	SW
Konerirajapuram I Bit	79.54	11.01	-	104	-	-	-	-	0	0.00	0	7.13	nothing
Konerirajapuram II Bit	79.55	11.01	-	129	-	-	-	-	0	0.00	0	-	nothing
Koothiyampettai	79.73	11.30	4,912	1,585	22.78	6.00	1.44	22.78	6	0.00	0	0.01	SW
Korukkai	79.61	11.16	2,195	919	3.71	3.00	0.40	3.71	3	0.00	0	2.90	SW
Kothangudi	79.74	11.03	2,629	1,010	16.94	7.00	1.68	16.94	7	0.00	0	3.92	SW
Kothangudi	79.59	11.02	4,282	415	-	-	-	-	0	0.00	0	4.74	nothing
Kovangudi	79.64	11.08	2,550	713	50.41	12.00	7.07	50.41	5	0.00	0	3.66	SW
Kozhaiyur	79.61	11.05	501	632	3.36	3.00	0.53	3.36	3	0.00	0	2.24	SW
Kshetrapalapuram	79.58	11.09	15,404	904	-	-	-	-	0	0.00	0	1.46	nothing
Kulichar	79.70	11.09	1,888	925	29.93	7.00	3.24	29.93	4	0.00	0	-	SW
Kunathalapadi	79.55	11.08	283	166	-	-	-	-	0	0.00	0	3.34	nothing
Kunavasal	79.55	11.20	-	18	-	-	-	-	0	0.00	0	95.00	nothing
Kunjamedu	79.60	11.22	-	23	-	-	-	-	0	0.00	0	95.76	nothing
Kunnam	79.67	11.28	1,077	1,891	20.45	36.00	1.08	20.45	11	0.00	0	0.37	SW
Kurichi	79.64	11.24	230	566	28.47	2.00	5.03	-	0	28.47	2	38.61	GW
Kuthanur	79.70	11.02	124	109	-	-	-	-	0	0.00	0	9.92	nothing

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Kuttalam	79.56	11.09	7,902	1,300	1.04	5.00	0.08	0.49	1	0.54	4	4.83	both
Kuttalam (Part)	79.57	11.06	334	335	-	-	-	-	0	0.00	0	5.02	nothing
Lakshiminayanapuram I	79.72	11.13	48	367	0.75	4.00	0.20	0.75	4	0.00	0	0.57	SW
Lakshminayanapuram II	79.72	11.12	2,279	239	0.20	1.00	0.08	0.20	1	0.00	0	-	SW
Madapuram	79.78	11.10	3,091	915	1.09	1.00	0.12	1.09	1	0.00	0	0.16	SW
Madhanam	79.77	11.31	418	621	1.35	3.00	0.22	1.35	3	0.00	0	1.17	SW
Madhirimangalam	79.56	11.08	383	62	-	-	-	-	0	0.00	0	15.62	nothing
Madiravelur	79.66	11.30	1,494	1,179	28.55	20.00	2.42	7.70	2	20.85	3	24.53	both
Maharajapuram	79.77	11.28	376	523	8.40	1.00	1.61	8.40	1	0.00	0	0.04	SW
Maharajapuram	79.61	11.13	690	566	5.09	3.00	0.90	5.09	3	0.00	0	0.16	SW
Maharajapuram	79.52	11.04	-	9	-	-	-	-	0	0.00	0	-	nothing
Mahendrapalli	79.78	11.36	1,923	1,159	30.01	5.00	2.59	0.85	1	29.16	2	15.55	both
Mallapuram	79.52	10.97	36	55	-	-	-	-	0	0.00	0	28.76	nothing
Mamakudi	79.82	11.11	3,410	1,704	59.89	15.00	3.52	59.89	8	0.00	0	0.06	SW
Manakkudi	79.68	11.12	3,721	887	18.72	11.00	2.11	18.72	9	0.00	0	-	SW
Manalmedu	79.59	11.21	4,536	1,401	1.38	2.00	0.10	-	0	1.38	2	20.24	GW
Mandai	79.59	10.99	6,103	2,928	10.48	3.00	0.36	10.48	3	0.00	0	2.85	SW
Mangaimadam	79.81	11.19	4,599	939	13.46	9.00	1.43	13.26	7	0.20	1	6.83	both
Manganallur	79.64	11.03	4,004	909	-	-	-	-	0	0.00	0	1.22	nothing
Manigramam	79.82	11.15	8,905	1,024	-	-	-	-	0	0.00	0	0.03	nothing
Manikkapangu	79.85	11.05	8,430	1,418	432.33	18.00	30.48	-	0	432.33	10	11.94	GW
Mannampandal	79.69	11.11	6,334	1,181	23.39	6.00	1.98	8.68	3	14.71	3	1.41	both
Mannargudi (Arasur)	79.63	11.25	-	35	-	-	-	-	0	0.00	0	97.09	nothing
Maraiyur	79.62	11.08	690	596	-	-	-	-	0	0.00	0	0.97	nothing

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Marathurai	79.54	11.16	183	8	-	-	-	-	0	0.00	0	-	nothing
Marudampallam	79.84	11.10	2,024	1,151	188.99	26.00	16.42	151.49	16	37.50	18	13.09	both
Marudhangudy	79.67	11.23	2,279	1,299	0.78	5.00	0.06	0.78	5	0.00	0	4.96	SW
Maruthur	79.58	11.05	13,402	500	1.60	5.00	0.32	1.60	2	0.00	0	3.21	SW
Mathur	79.77	11.08	2,342	985	5.57	3.00	0.57	5.57	3	0.00	0	2.76	SW
Mayiladuthurai	79.65	11.11	60,622	2,783	54.11	23.00	1.94	28.40	15	25.71	8	2.39	both
Mayiladuthurai	79.67	11.10	6,020	399	-	-	-	-	0	0.00	0	2.08	nothing
Mayiladuthurai	79.65	11.09	8,048	241	-	-	-	-	0	0.00	0	-	nothing
Mekkirimangalam	79.56	11.07	3,958	481	11.21	6.00	2.33	9.93	2	1.28	4	1.40	both
Melagalangam	79.53	11.01	183	82	-	-	-	-	0	0.00	0	-	nothing
Melaiyur	79.81	11.15	8,704	1,524	48.77	20.00	3.20	41.02	16	7.75	4	4.63	both
Melaiyur	79.72	11.13	1,054	578	-	-	-	-	0	0.00	0	0.09	nothing
Melaiyur	79.58	11.07	3,503	291	7.10	4.00	2.44	6.01	4	1.08	1	1.88	both
Melaiyur	79.53	10.99	316	243	-	-	-	-	0	0.00	0	0.12	nothing
Melaiyur Thulasenthirapuram	79.56	11.08	1,232	46	-	-	-	-	0	0.00	0	8.28	nothing
Melanallur	79.65	11.18	899	902	3.09	5.00	0.34	1.01	3	2.08	2	3.64	both
Melaparuthigudi	79.64	11.28	-	12	-	-	-	-	0	0.00	0	96.88	nothing
Melaparuthikudi	79.54	10.98	9,140	4,409	1.09	4.00	0.02	1.09	4	0.00	0	1.86	SW
Melaperumpallam	79.81	11.13	1,689	1,384	142.03	23.00	10.27	142.03	12	0.00	0	0.01	SW
Memathur	79.73	11.07	2,677	1,590	13.10	8.00	0.82	13.10	8	0.00	0	1.39	SW
Mozhaiyur	79.68	11.15	523	918	8.20	8.00	0.89	8.20	8	0.00	0	3.39	SW
Mudhalaimedu	79.77	11.35	1,568	1,198	3.71	2.00	0.31	1.44	1	2.27	1	21.82	both
Mudikandanallur	79.58	11.21	293	378	1.29	2.00	0.34	0.20	1	1.09	1	48.39	both
Mudikandanallur	79.75	11.12	3,745	769	7.59	1.00	0.99	-	0	7.59	1	0.73	GW

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Mukkarumbur	79.76	11.09	1,530	726	-	-	-	-	0	0.00	0	0.01	nothing
Mukundanur	79.74	11.00	-	20	-	-	-	-	0	0.00	0	54.30	nothing
Mullukudi	79.55	11.09	550	327	-	-	-	-	0	0.00	0	-	nothing
Murugamangalam	79.57	11.13	725	301	-	-	-	-	0	0.00	0	2.10	nothing
Muthur	79.71	11.06	1,020	610	0.95	1.00	0.16	0.95	1	0.00	0	2.78	SW
Muttam	79.57	11.21	-	18	-	-	-	-	0	0.00	0	95.31	nothing
Muvalur	79.61	11.10	7,755	826	0.92	1.00	0.11	-	0	0.92	1	2.89	GW
Nadukkarai Keelapathi	79.74	11.12	2,438	485	13.26	15.00	2.73	13.26	15	0.00	0	1.18	SW
Nadukkarai Melpathi	79.73	11.14	-	450	1.16	2.00	0.26	1.16	2	0.00	0	0.44	SW
Naduvasal	79.77	11.04	1,370	797	2.56	5.00	0.32	2.56	5	0.00	0	4.10	SW
Nakkambadi	79.60	11.00	2,655	659	-	-	-	-	0	0.00	0	6.62	nothing
Nalladai	79.75	11.01	2,793	1,447	31.40	19.00	2.17	31.40	13	0.00	0	4.17	SW
Nallanayakipuram	79.73	11.32	5,080	1,070	3.01	8.00	0.28	3.01	8	0.00	0	-	SW
Nallathukudi	79.67	11.09	11,393	773	15.01	9.00	1.94	14.71	8	0.30	1	-	both
Nallavur	79.55	11.01	2,507	676	-	-	-	-	0	0.00	0	6.16	nothing
Namasivayapuram	79.58	11.17	3,157	1,063	0.30	1.00	0.03	0.30	1	0.00	0	2.50	SW
Nangur	79.78	11.18	3,784	1,517	38.34	19.00	2.53	38.34	12	0.00	0	1.29	SW
Narasingampettai	79.52	11.04	933	133	-	-	-	-	0	0.00	0	-	nothing
Narasinganatham	79.72	11.06	1,020	835	2.47	2.00	0.30	2.47	2	0.00	0	3.44	SW
Natham	79.70	11.15	2,007	912	25.15	15.00	2.76	25.15	11	0.00	0	1.41	SW
Nedungulam	79.74	11.00	-	1	-	-	-	-	0	0.00	0	83.93	nothing
Neivasal	79.56	11.16	258	213	2.23	1.00	1.04	2.23	1	0.00	0	2.75	SW
Nemmeli	79.70	11.23	2,153	950	1.48	1.00	0.16	1.48	1	0.00	0	-	SW
Neppathur	79.80	11.21	4,285	1,197	121.53	17.00	10.15	119.86	8	1.68	5	7.94	both

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Nidur	79.64	11.15	4,829	927	27.47	9.00	2.96	27.47	5	0.00	0	0.53	SW
Odhavanthangudy	79.75	11.29	1,296	639	12.51	2.00	1.96	12.51	2	0.00	0	-	SW
Olayampudur	79.70	11.28	105	427	0.10	1.00	0.02	0.10	1	0.00	0	6.33	SW
Olayampudur	79.72	11.26	167	325	2.31	3.00	0.71	2.31	3	0.00	0	0.07	SW
Omampuliyur	79.56	11.20	-	3	-	-	-	-	0	0.00	0	87.81	nothing
Pachaiperumanallur	79.75	11.28	941	861	10.79	9.00	1.25	10.79	4	0.00	0	-	SW
Pagasalai	79.74	11.18	1,171	1,195	19.83	9.00	1.66	19.83	8	0.00	0	2.99	SW
Palaiyur	79.57	11.02	5,394	1,013	-	-	-	-	0	0.00	0	5.13	nothing
Palayagudalure	79.56	11.05	1,946	339	0.70	3.00	0.21	0.70	3	0.00	0	4.84	SW
Palayapalayam	79.78	11.31	6,647	2,605	275.17	54.00	10.56	275.17	26	0.00	0	13.15	SW
Pandaravadai	79.65	11.05	8,335	595	1.43	4.00	0.24	1.43	4	0.00	0	1.39	SW
Pandaravadaimappadugai	79.62	11.12	1,526	698	2.62	4.00	0.38	2.62	4	0.00	0	0.20	SW
Pandur	79.60	11.15	2,253	1,289	3.01	6.00	0.23	3.01	6	0.00	0	2.85	SW
Pannangudy	79.75	11.31	794	726	5.29	8.00	0.73	5.29	8	0.00	0	0.23	SW
Parasalur	79.73	11.10	9,130	1,470	35.99	13.00	2.45	32.13	5	3.86	6	0.88	both
Pattamangalam	79.64	11.09	27,677	737	-	-	-	-	0	0.00	0	1.58	nothing
Pattavarthi	79.63	11.22	1,066	803	0.21	1.00	0.03	0.21	1	0.00	0	0.01	SW
Perambur	79.69	11.03	2,398	1,206	0.30	2.00	0.02	0.30	2	0.00	0	1.96	SW
Peravur	79.55	11.04	4,537	647	0.20	1.00	0.03	0.20	1	0.00	0	3.53	SW
Perumalkoil	79.59	11.06	167	455	0.20	2.00	0.04	0.20	2	0.00	0	0.27	SW
Perumangalam	79.68	11.21	2,279	746	1.58	3.00	0.21	1.58	3	0.00	0	0.54	SW
Peruncheri	79.66	11.05	2,120	975	0.35	2.00	0.04	0.35	2	0.00	0	0.07	SW
Perunthottam - II	79.84	11.18	3,428	1,031	242.26	25.00	23.49	242.26	12	0.00	0	32.44	SW
Perunthottam I	79.84	11.20	6,668	2,077	220.70	34.00	10.63	214.31	26	6.39	7	33.04	both

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Pillaiperumalnallur	79.84	11.07	7,282	2,043	352.97	57.00	17.28	0.85	3	352.12	25	7.38	both
Pillur	79.62	10.98	145	50	-	-	-	-	0	0.00	0	2.31	nothing
Polakudi	79.63	10.99	62	16	-	-	-	-	0	0.00	0	1.41	nothing
Ponmasanallur	79.66	11.18	42	477	1.88	1.00	0.39	1.88	1	0.00	0	-	SW
Ponnur	79.59	11.13	932	800	7.20	3.00	0.90	7.20	2	0.00	0	2.49	SW
Porumbur	79.63	11.02	5,275	1,275	-	-	-	-	0	0.00	0	1.66	nothing
Pudupattinam	79.81	11.37	20,402	6,314	409.38	78.00	6.48	113.71	13	295.67	50	59.65	both
Puduthurai	79.77	11.23	1,254	858	90.92	14.00	10.59	82.30	10	8.61	6	10.30	both
Puliyangudi (Mannargudi)	79.62	11.25	-	36	-	-	-	-	0	0.00	0	98.55	nothing
Puliyanthurai	79.79	11.34	3,324	1,745	105.96	13.00	6.07	105.96	11	0.00	0	5.13	SW
Punganur	79.69	11.22	1,756	927	1.89	5.00	0.20	1.89	5	0.00	0	5.93	SW
Puthur	79.70	11.29	2,299	527	7.18	2.00	1.36	7.18	2	0.00	0	0.11	SW
Radhanallur	79.82	11.24	481	713	221.92	29.00	31.12	202.34	8	19.59	2	41.39	both
Radhanallur	79.79	11.16	6,152	2,107	3.69	7.00	0.17	2.08	4	1.61	3	3.40	both
Ramachandrankoilpathu	79.78	11.11	255	366	0.10	1.00	0.03	0.10	1	0.00	0	0.31	SW
S.Pudur	79.55	11.00	-	69	-	-	-	-	0	0.00	0	6.64	nothing
Sarabojirajapuram	79.54	11.17	683	266	1.67	1.00	0.62	-	0	1.67	1	19.06	GW
Sathanur	79.53	11.01	622	163	-	-	-	-	0	0.00	0	7.60	nothing
Sattanathapuram	79.73	11.22	5,477	1,314	105.16	26.00	8.00	105.16	20	0.00	0	6.06	SW
Semangalam	79.73	11.16	2,315	1,494	7.41	6.00	0.50	7.41	6	0.00	0	2.81	SW
Sembanarkoil	79.74	11.11	4,892	339	11.14	7.00	3.29	0.18	1	10.95	6	3.98	both
Sembathaniruppu	79.76	11.16	3,659	1,341	20.14	12.00	1.50	20.14	12	0.00	0	5.20	SW
Semmangudy	79.76	11.25	1,902	563	18.98	1.00	3.37	18.98	1	0.00	0	-	SW
Sengudi	79.61	11.06	1,426	603	-	-	-	-	0	0.00	0	0.00	nothing

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Senniayanallur	79.57	11.07	3,292	275	10.68	6.00	3.88	4.00	1	6.68	4	1.38	both
Serudiyur	79.68	11.09	1,568	665	0.72	1.00	0.11	0.72	1	0.00	0	0.01	SW
Serugudi	79.59	10.98	321	49	-	-	-	-	0	0.00	0	-	nothing
Serugudy	79.76	11.29	188	254	1.58	1.00	0.62	1.58	1	0.00	0	-	SW
Sethur	79.66	11.19	1,881	1,089	0.86	3.00	0.08	0.86	3	0.00	0	2.43	SW
Sethur	79.70	11.02	1,707	1,376	6.19	8.00	0.45	6.19	5	0.00	0	1.42	SW
Sholampettai	79.60	11.12	815	1,069	2.37	5.00	0.22	2.37	1	0.00	0	0.10	SW
Siddamalli	79.62	11.25	1,187	753	-	-	-	-	0	0.00	0	44.65	nothing
Sirkali	79.73	11.25	27,990	3,328	76.52	19.00	2.30	76.52	18	0.00	0	0.07	SW
Sitharkadu	79.62	11.10	13,191	823	23.37	11.00	2.84	0.30	1	23.07	10	2.19	both
Sivanaragaram	79.54	11.01	67	63	-	-	-	-	0	0.00	0	6.71	nothing
Sothiyakudi	79.69	11.30	1,693	1,274	4.18	8.00	0.33	1.81	4	2.37	4	11.22	both
Srikantapuram	79.58	11.01	945	449	0.30	1.00	0.07	0.30	1	0.00	0	2.33	SW
Suraikkayur	79.61	10.98	-	22	-	-	-	-	0	0.00	0	-	nothing
T.Manalmedu	79.80	11.06	2,661	1,231	69.67	21.00	5.66	22.16	16	47.52	5	0.13	both
Talainayar	79.66	11.22	2,927	1,171	1.38	4.00	0.12	1.38	4	0.00	0	4.22	SW
Talainayar II Bit	79.65	11.20	3,324	900	3.56	3.00	0.40	3.56	3	0.00	0	4.91	SW
Thalaiyudaiyarar Koil Pathy	79.79	11.13	5,593	1,710	66.86	26.00	3.91	54.32	14	12.54	11	0.49	both
Thalancheri	79.61	11.18	648	1,064	0.11	1.00	0.01	0.11	1	0.00	0	8.20	SW
Thandavankulam	79.82	11.31	10,431	3,128	632.15	108.00	20.21	329.31	34	302.85	41	22.96	both
Tharangambadi	79.84	11.03	32,109	3,773	640.11	59.00	16.97	224.30	15	415.80	30	24.14	both
Thathangudi	79.67	11.03	6,730	1,112	15.82	3.00	1.42	15.32	3	0.49	2	1.97	both
Thennampattiam	79.85	11.22	4,411	2,051	364.12	38.00	17.75	311.37	24	52.75	18	25.53	both
Thillaividangan	79.76	11.24	397	483	4.09	1.00	0.85	4.09	1	0.00	0	-	SW

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Thillaiyadi	79.81	11.03	5,386	1,438	49.82	25.00	3.47	18.29	11	31.53	7	1.41	both
Thiruindalur	79.65	11.13	11,727	1,149	38.92	24.00	3.39	38.92	9	0.00	0	-	SW
Thirukkadaiyur	79.81	11.07	8,876	1,949	100.66	14.00	5.17	2.89	2	97.77	12	0.75	both
Thirukkalacheri	79.81	11.00	7,842	1,379	0.20	1.00	0.01	-	0	0.20	1	5.64	GW
Thirukkarukavur	79.78	11.24	4,285	950	92.18	22.00	9.71	80.95	11	11.23	8	8.26	both
Thirumailadi	79.71	11.32	18,429	2,196	35.79	18.00	1.63	17.75	11	18.04	3	26.45	both
Thirumangaicheri	79.57	11.14	17	179	0.10	1.00	0.06	0.10	1	0.00	0	14.37	SW
Thirumangalam	79.58	11.14	1,688	666	5.86	1.00	0.88	5.86	1	0.00	0	-	SW
Thirumannancheri	79.58	11.13	1,986	400	1.19	1.00	0.30	1.19	1	0.00	0	0.68	SW
Thirumannancheri	79.56	11.10	1,685	139	-	-	-	-	0	0.00	0	-	nothing
Thirumullaivasal	79.83	11.25	22,701	4,390	446.42	101.00	10.17	201.75	34	244.67	40	20.39	both
Thirunagiri	79.79	11.22	5,895	2,167	124.19	7.00	5.73	121.33	6	2.87	1	26.00	both
Thiruneelakudi	79.52	10.97	-	1	-	-	-	-	0	0.00	0	-	nothing
Thirunelkondacheri	79.64	11.07	397	467	17.32	9.00	3.71	17.32	4	0.00	0	1.08	SW
Thiruppanburam	79.61	10.97	19	45	-	-	-	-	0	0.00	0	3.74	nothing
Thiruppangur	79.68	11.19	1,547	938	12.95	5.00	1.38	12.95	5	0.00	0	1.02	SW
Thiruvalaputhur	79.62	11.21	2,843	858	-	-	-	-	0	0.00	0	0.01	nothing
Thiruvaly	79.77	11.20	4,411	1,438	7.77	6.00	0.54	7.08	4	0.69	1	11.61	both
Thiruvengadu	79.81	11.17	14,172	2,337	60.23	32.00	2.58	56.67	21	3.56	2	0.79	both
Thiruvidakazhi	79.79	11.04	2,709	1,668	68.48	29.00	4.10	68.48	14	0.00	0	2.95	SW
Thiruvillaiyattam	79.74	11.04	1,896	1,077	9.69	8.00	0.90	9.69	7	0.00	0	0.69	SW
Thittai	79.76	11.23	4,620	862	71.85	23.00	8.33	70.24	15	1.61	3	3.39	both
Tholuthalangudi	79.59	11.08	4,727	536	6.05	3.00	1.13	3.38	1	2.67	1	3.43	both
Thulasenthirapuram	79.59	11.08	111	145	1.80	1.00	1.24	1.80	1	0.00	0	-	SW

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Tiruchampalli	79.75	11.09	1,992	1,160	5.52	7.00	0.48	4.63	6	0.89	2	0.01	both
Tiruchitrambalam	79.54	11.18	668	806	-	-	-	-	0	0.00	0	25.66	nothing
Tiruvaduthurai	79.54	11.05	1,512	588	3.26	7.00	0.56	0.10	1	3.16	6	3.17	both
Tiruvalangadu	79.55	11.07	2,348	281	1.39	1.00	0.49	-	0	1.39	1	3.44	GW
Udayayarkoil Pathy	79.79	11.10	5,434	928	7.54	13.00	0.81	7.54	13	0.00	0	3.31	SW
Uluthakuppai	79.68	11.14	3,700	867	-	-	-	-	0	0.00	0	0.05	nothing
Umayalpathy	79.77	11.26	376	793	8.02	5.00	1.01	8.02	4	0.00	0	0.14	SW
Uthirangudi	79.77	11.03	3,697	635	15.42	4.00	2.43	13.64	4	1.78	1	-	both
Vadanattam	79.55	10.97	19	16	-	-	-	-	0	0.00	0	0.26	nothing
Vadarengam	79.65	11.28	589	798	1.98	2.00	0.25	1.98	2	0.00	0	17.91	SW
Vaitheeswarankoil	79.71	11.21	10,055	2,030	6.35	15.00	0.31	6.35	14	0.00	0	1.34	SW
Valluvakudi	79.68	11.25	355	819	2.17	1.00	0.27	2.17	1	0.00	0	0.90	SW
Valuvur	79.63	11.06	2,114	1,047	2.27	3.00	0.22	2.27	2	0.00	0	3.02	SW
Vanadirajapuram	79.59	11.11	975	955	1.70	2.00	0.18	1.70	1	0.00	0	1.50	SW
Vanagiri	79.85	11.12	9,307	1,923	249.24	41.00	12.96	230.40	29	18.84	13	18.06	both
Vannikudi	79.55	11.16	100	12	-	-	-	-	0	0.00	0	37.76	nothing
Vannikudi	79.55	11.13	-	21	-	-	-	-	0	0.00	0	26.40	nothing
Varadampattu	79.63	11.20	2,446	834	1.89	5.00	0.23	1.89	5	0.00	0	-	SW
Varisaipathuvadagal	79.78	11.25	2,362	524	4.25	4.00	0.81	4.25	2	0.00	0	0.04	SW
Vayalur	79.52	10.97	143	49	-	-	-	-	0	0.00	0	2.24	nothing
Veerasolapuram	79.61	11.23	-	12	-	-	-	-	0	0.00	0	95.36	nothing
Vellalar agaram	79.66	11.13	3,324	960	23.68	13.00	2.47	23.68	12	0.00	0	-	SW
Vellur	79.65	11.27	-	41	-	-	-	-	0	0.00	0	98.12	nothing
Velur	79.55	11.11	67	120	-	-	-	-	0	0.00	0	5.36	nothing

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Vettangudy	79.81	11.28	7,672	4,242	413.14	73.00	9.74	130.15	20	282.99	24	9.98	both
Vilagam	79.73	11.01	726	743	89.40	33.00	12.03	89.40	15	0.00	0	2.09	SW
Villandhidasa Samuthiram	79.72	11.26	3,491	1,000	93.54	72.00	9.35	93.54	24	0.00	0	0.04	SW
Villiyanallur	79.63	11.18	2,927	1,497	2.83	3.00	0.19	2.83	3	0.00	0	4.33	SW
Villiyanallur	79.56	11.10	2,700	1,004	5.44	5.00	0.54	5.24	5	0.20	1	0.19	both
Visalur	79.78	11.03	1,594	770	4.03	9.00	0.52	4.03	8	0.00	0	0.01	SW

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