LAND SUITABILITY ASSESSMENT FOR DISTRIBUTED SOLAR ENERGY

solar

MAYILADUTHURAI DISTRICT,
TAMIL NADU

OCTOBER 2022

AurovilleConsulting

LiLa
Earth Intelligence for Climate Action

LAND SUITABILITY ASSESSMENT FOR DISTRIBUTED SOLAR ENERGY

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ACKNOWLEDGEMENT

Authors:
Athithiyan. M.R
Martin Scherfler
Nilima Dharanipragada
Dr. Sukanya Randhawa

Designer:
Thiagarajan Rajendiran, Auroville Consulting

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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 (iiI) evaluates these lands in regards 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

S o l a r

KEY FINDINGS

TOTAL GEOGRAPHICAL AREA

1,186 km^2

UNUSED LAND

118 km^2

Mayiladuthurai district has a total geographical area of 1,172 km^2 of which 118 km^2 or 10% has been classified at unused or fallow lands.

SOLAR TARGET

The districts solar energy target by 2030 has been determined at 0.29 GW. Achieving this target with distributed and ground mounted solar energy system will require a land area of 1,151 acres.

0.29	GW solar PV
1,151	acres

TECHNICAL POTENTIAL

The suitability analysis revealed that 6,469 acres of unused land have a technical potential for solar energy development. The 6,469 acres are distributed over 392 plots and would be able to accommodate a 1.62 GW of solar. This would exceed the solar energy target by more than 5 times.

1.62	GW solar PV
6,462	acres
393	plots
561%	of target

HIGHEST POTENTIAL

Two land plots with a cumulative area of 698 acres are having the best commercial potential for solar energy development. A 0.17 GW of solar energy capacity can be deployed, this would help meeting 61% of the set solar energy target.

0.17	GW solar PV
698	acres
2	plots
61%	of target

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01 INTRODUCTION

The objective of this report is to identify unused lands for a selected district in the state of Tamil Nadu, India i.e. Mayiladuthurai district and evaluate to what extent these unused lands can be utilized to meet the state's solar energy target of 20 GW by the year 2030.

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.

As per its intended Nationally Determined Contribution under the United Nations Framework Convention on Climate Change, India is targeting 50 % of its cumulative power generation capacity from non-fossil fuel-based energy resources by 2030.

Tamil Nadu has announced that it aims at adding an additional 20 GW of solar energy capacity by the year 2030. This capacity addition is envisioned to be primarily achieved by distributed solar energy generation.

Distributed solar energy can avoid transmission losses and reduce distribution losses. Feeding power from the tail-end of the grid will further result in an improvement of voltage, as most distribution feeders in Tamil Nadu show an undervoltage. Distributed generation also means a distribution of risks and consequently an increase in grid resilience.

One of the key challenges in developing solar energy project is the identification of suitable lands and land acquisition. The complex land acquisition process can lead to project delays or even cancelation of proposed projects.

Unused or fallow lands can be of particular interest for solar energy development. Developing unused lands for solar energy avoids any conflict arising out of the uptake of agricultural or other lands. Local authorities can proactively facilitate solar energy development in the district by identifying unused lands and by undertaking a solar suitability assessing of these lands. This type of geospatial information, if provided to solar developers and electricity distribution companies, has the potential to spur local economic development and to create green jobs. Degraded lands could become key elements in rolling out climate adaptation and mitigation programs.

We have developed a geospatial digital tool LiLa (LifeLands) that uses satellite imagery, AI & GIS Mapping to create critical data-based insights and visualization that supports decision-making by proving detailed information on exactly "where" (location) and "why" (attributes of the location) to implement sustainable interventions. Such kind of rigorous information is derived by combining multidimensional data analytics on different kinds of data indicators, along with, in-depth subject expertise. This way the tool is able to "zero-in" on most suitable lands that fulfil the required criteria.

The tool is intended to help governments, development agencies and private sector in developing evidence-based climate adaptation and mitigation programs, program developers in optimal site selection and public and private landowners to regenerate and develop their lands as per the evaluated potential. Our tool identifies unused lands and evaluate its potential for distributed solar energy deployment to meet the state's solar energy capacity addition target.

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, reforestation 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 analyzing 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 w.r.t its ecosystem as well 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.

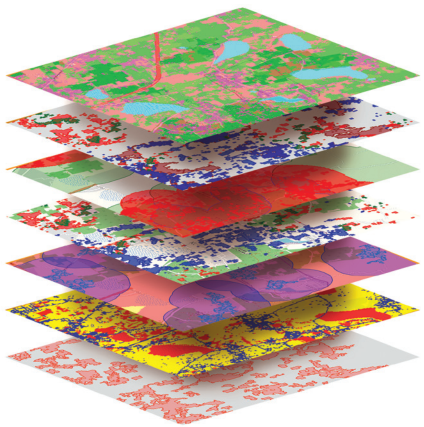
This can replace the current outdated ways of infrastructure expansion that involve long lead times and lack of reliable data for planning and impact measurement. By creating more transparency and delivering sustainable development goals (SDGs) faster in a more diligent and precise manner.

Analysing multiple dimensions and interlinkages & making the right decisions

Data Sources

- Multiple remote sensing data
- Ground data
- Public data sets

Data Layers



- Weather
- Land-Cover
- Soil
- Terrain
- Infrastructure
- Demographics
- Etc.

Data Analytics

- In-house algorithms
- Used defined criteria
- Demand modelling
- Suitability assessment
- Rating and pre-selection

↕

Experts

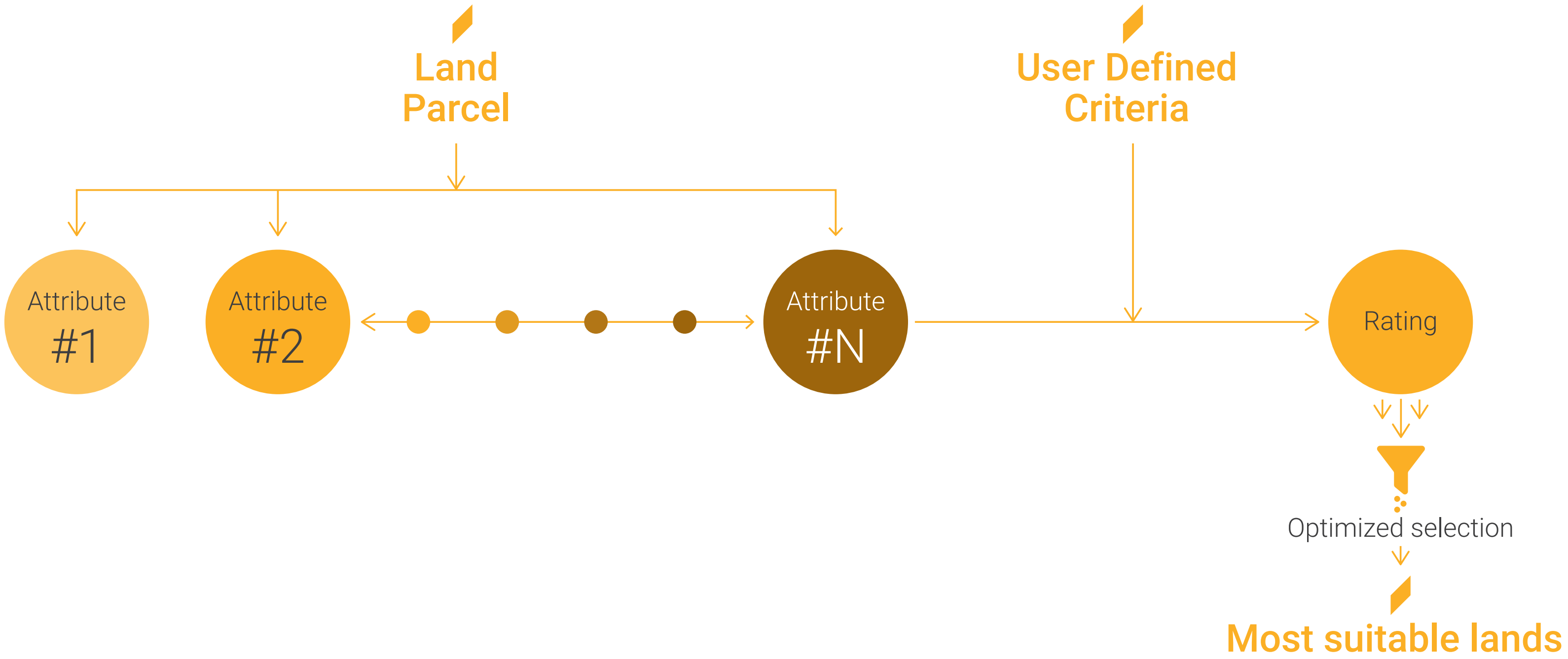
Results

- Recommendation report
- Visualization maps

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.

User-based Prioritsation Ratings



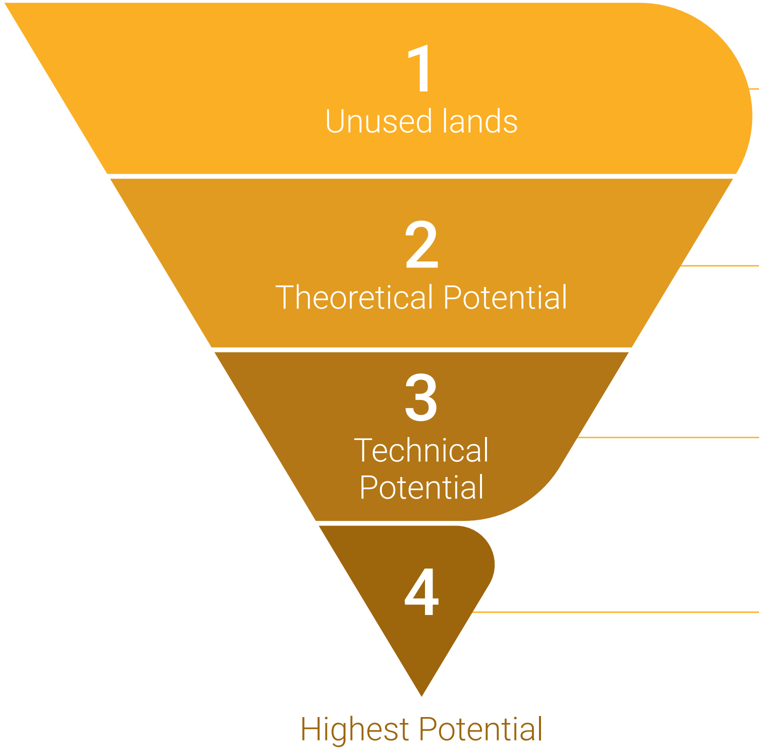
The criteria definition is overall a flexible process and serves as an adaptability measure, specifically designed to provide agility in terms of meeting the requirements of different projects and stakeholders for any geo-location. Further details w.r.t land evaluation and criteria for solar suitability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

Theoretical Potential:
All lands suitable for distributed solar PV generation.

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

Highest Potential:
Lands with the highest commercial potential for solar energy development.

Additionally, all lands with technical potential have been analyzed regarding its distribution by size and for its competing land-use for water harvesting and reforestation.

LAND DISTRIBUTION

Categories	Filter
Small area	>5 to 20 acres
Medium area	>20 to 100 acres
Large area	>100 acres

COMPETING USE FOR CLIMATE ACTION

Criteria	
Forest top rating	High, Medium
Water top rating	High, Medium

THEORETICAL POTENTIAL	
Criteria	
Slope	<8%
Distance to water body	>100 m
Distance to railway	>200 m
Distance from highways	>500 m

TECHNICAL POTENTIAL	
Criteria	
Min. land size	5 acres
Distance to evacuation infrastructure	<10 km
Distance to road access	<2 km

HIGHEST POTENTIAL			
Criteria	**High**	**Medium**	**Low**
Plot size (acres)	>100	>20	>5
Distance to substation (km)	<2	<5	>10
Distance from road (km)	<1	<2	<2

To contribute in meeting Tamil Nadu's target of 20 GW, the Mayiladuthurai district would need to target 0.29 GW of solar energy capacity addition. A cumulative area of 1,151 acres of land is required for this.

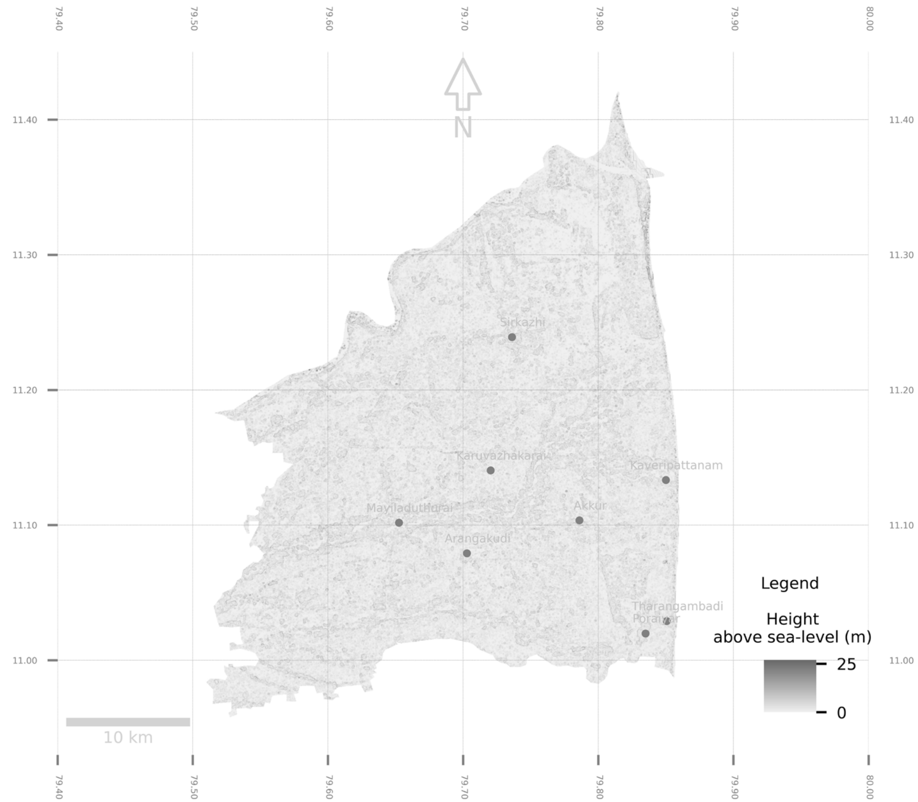
TARGET SETTING

Tamil Nadu is planning to add 20 GW of solar energy capacity to its generation fleet by 2030. This is expected to be done through distributed solar systems in all districts of the State. If Mayiladuthurai district would contribute its equal share to the 20 GW solar energy capacity addition target based on its share of population of the State's total population, then a 0.29 GW of solar energy capacity addition and a cumulative area of 1,151 acres of land is required.

SOLAR TARGET		
	State	**District**
Population	7,21,47,039	10,37,860
Solar Target (GW)	20	0.29
Land requirement (acres)	80,000.00	1,151

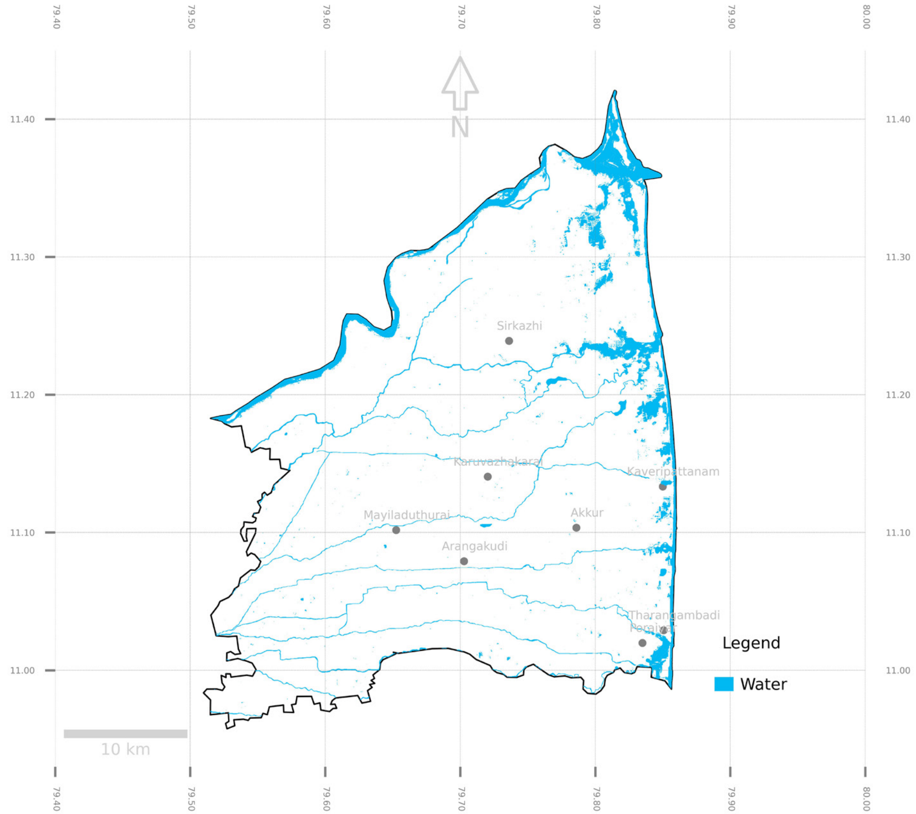
HEIGHT-ABOVE SEA LEVEL

Lands with a slope larger than 8% may increase the capital cost of the project and thereby are excluded from the lands with technical potential. The height of the land above sea-level is indicative of the slope and topography of the area.



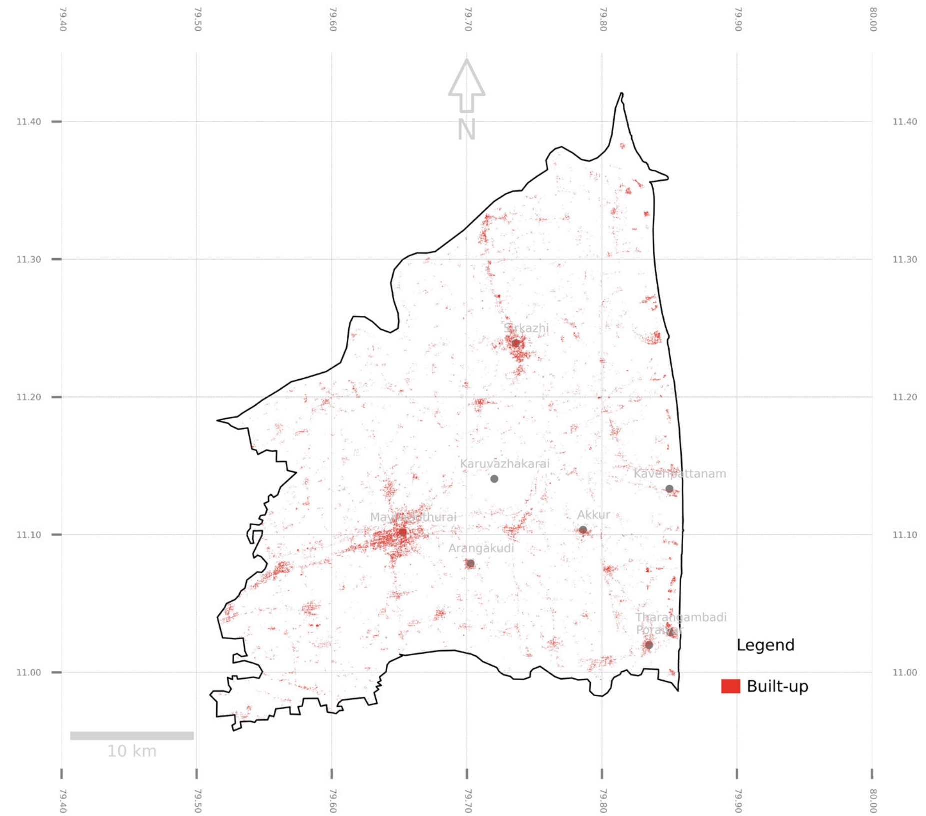
WATER BODIES

Large water bodies, if available, could be utilized for floating solar plants.



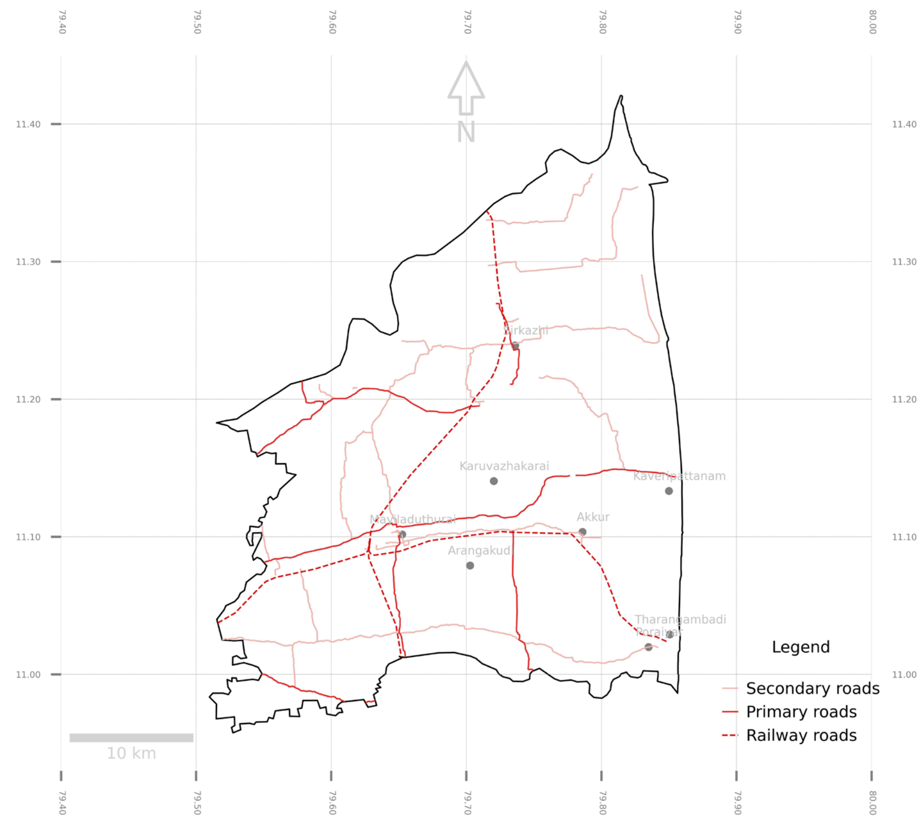
BUILT-UP AREA

Built-up area can indicate high load centers and rooftop solar potential.



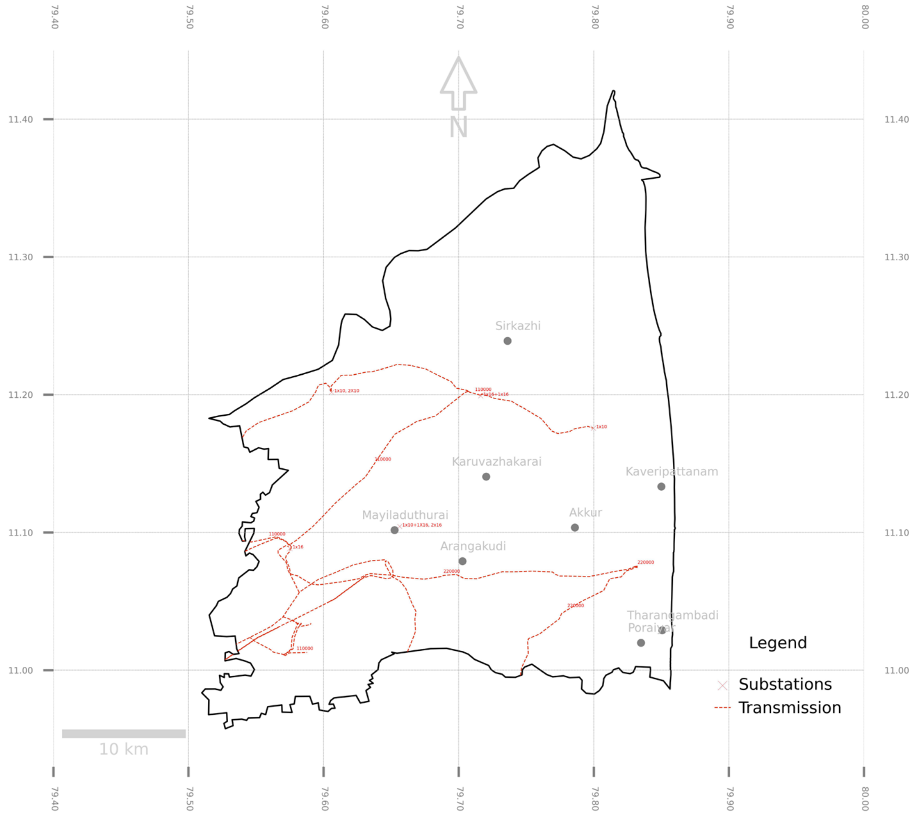
MAJOR ROADS

Vicinity to a road that can accommodate load carriers is essential for the deployment of a solar system.



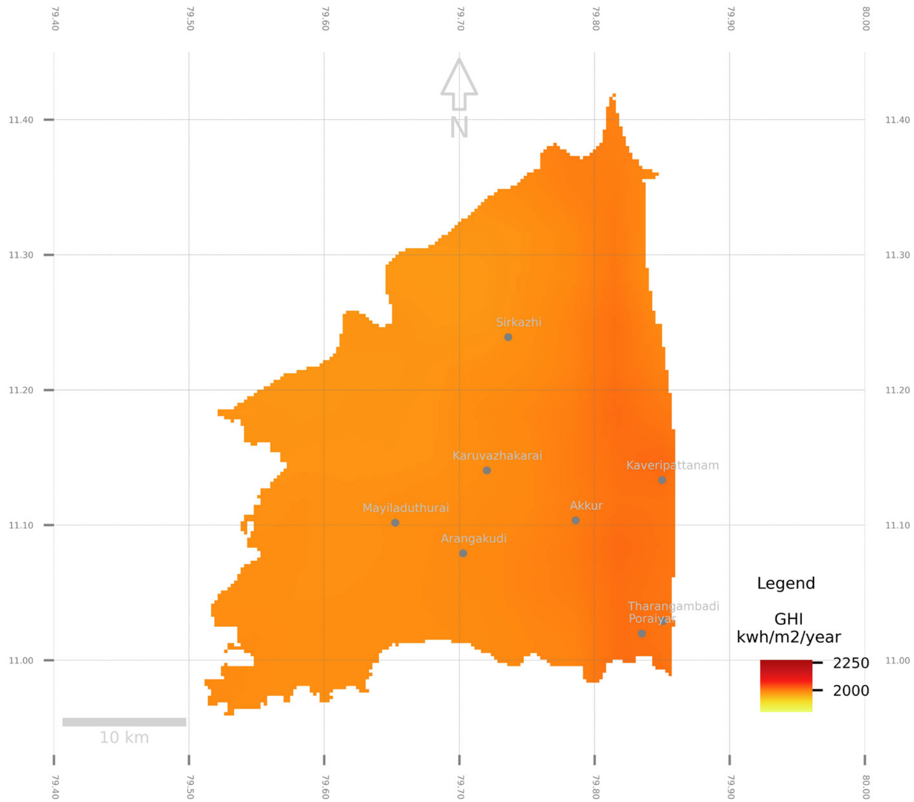
POWER EVACUATION

Availability and accessibility of adequate power evacuation infrastructure is one of the key criteria for deciding on the location of a solar plant.



GLOBAL HORIZONTAL IRRADIATON (GHI)

The GHI of a site is a key determining factor for the energy generation potential of a solar plant.



To view the interactive map with these features: Click here

"Conserving, restoring, and using our land resources sustainably is a global imperative, one that requires action on a crisis footing... Business as usual is not a viable pathway for our continued survival and prosperity."

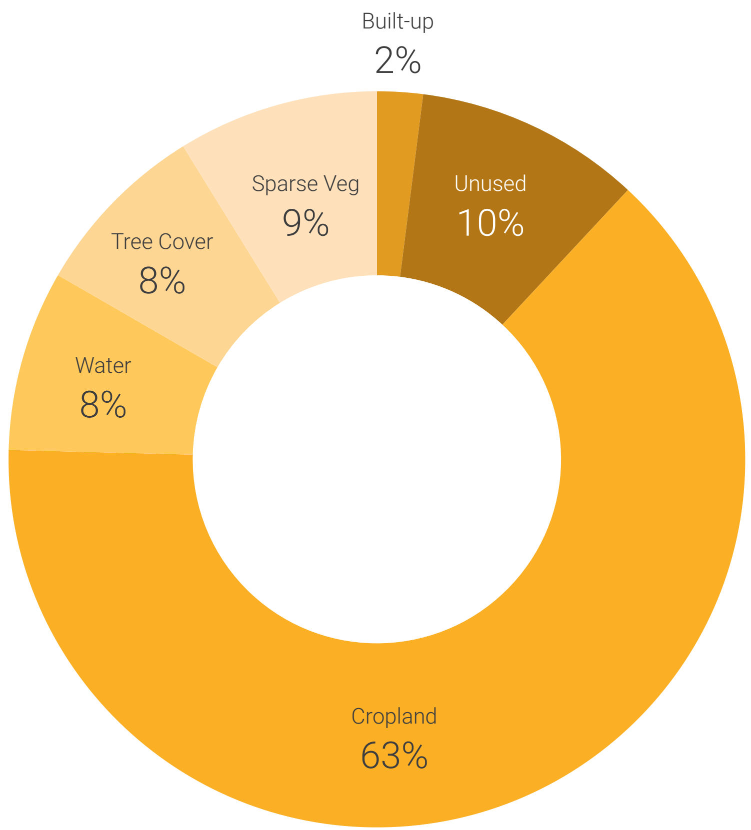
Source: United Nations Convention to Combat Desertification, 2022

03 LAND COVER

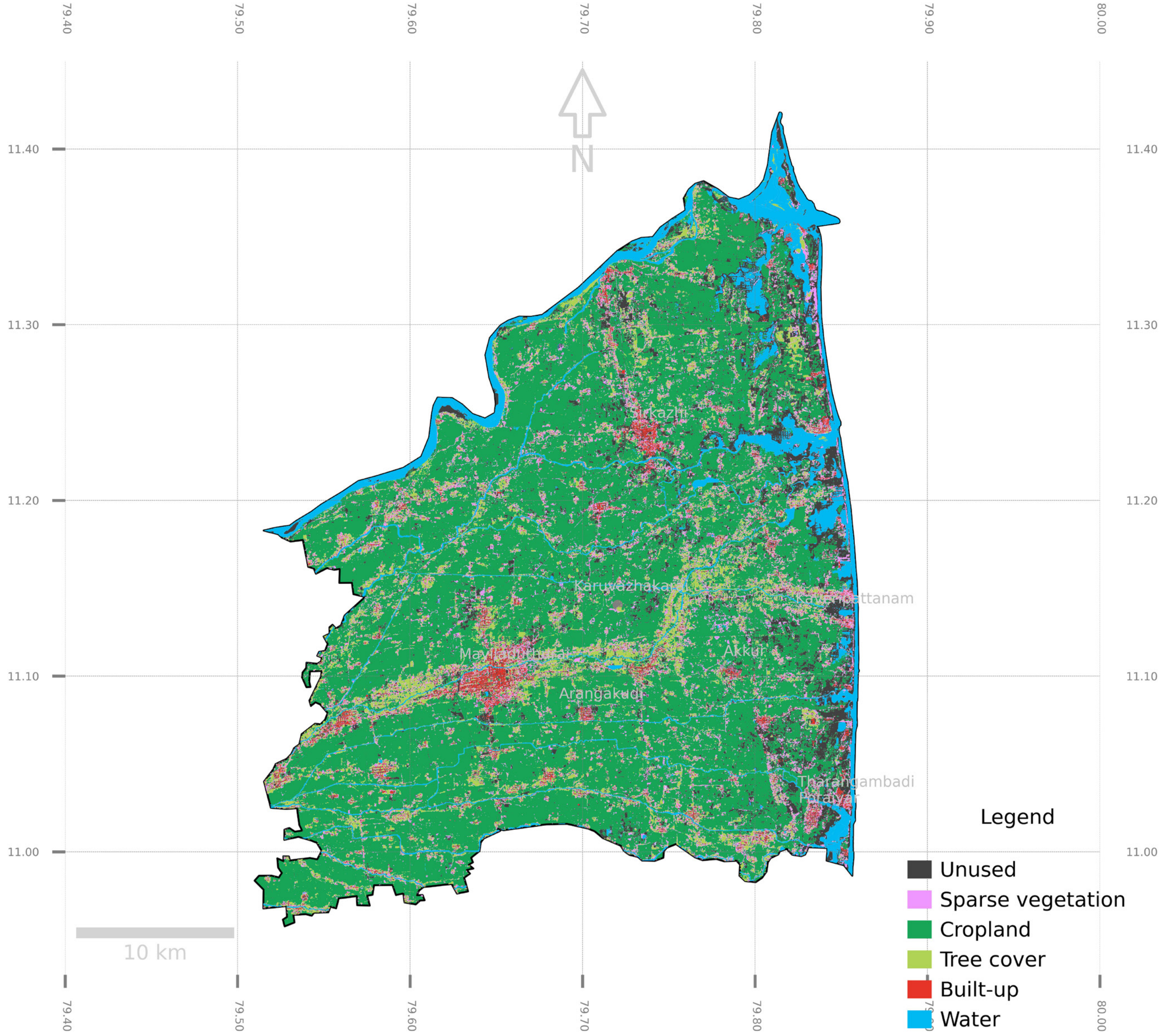
The districts land cover has been identified as per details below:

Land Cover	Km^2
Built-up	23.83
Unused	117.78
Cropland	753
Water	94.16
Tree Cover	93.07
Sparse Vegetation	104.59
Total	**1,186**

Unused or fallow lands account for the second highest recorded land-use in the district, with 10% of TGA or 117.81 km^2 . These lands will be assessed for its suitability for distributed solar energy deployment.



Mayiladuthurai district is dominated by agriculture. 63% of TGA is under crop land. The district has a tree cover of 8%, considering the state average of 23.80% (MOEF 2017) this is a low tree cover. Unused or fallow lands account for the second highest recorded land-use in the district, with 10% of TGA or 117.81 km^2. This possibly presents amble opportunities for climate mitigation and adaptation actions including distributed solar energy deployment.



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

04 SOLAR RESULTS

Technical suitability

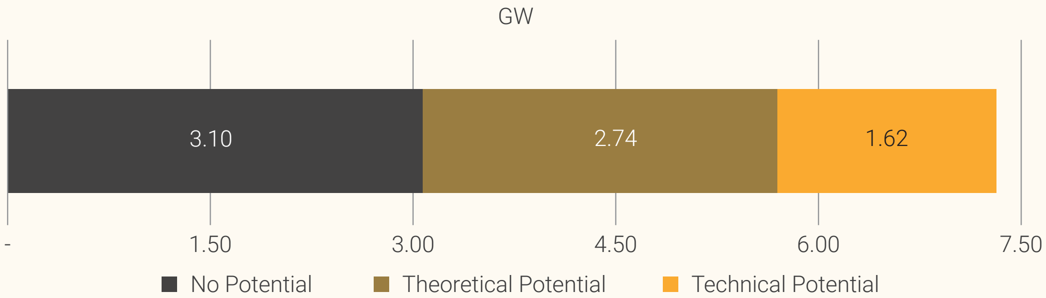
KEY RESULTS

Suitable land	6,462	acres
Share on total area	2.2	%
Share of unused area	22	%
Share of solar target	561	%

RESULTS

Category	Plots (nos)	Area (acres)	Capacity (GW)
No Potential	8,071	12,040	3.10
Theroetical Potential	25,106	10,966	2.74
Technical Potential	393	6,462	1.62

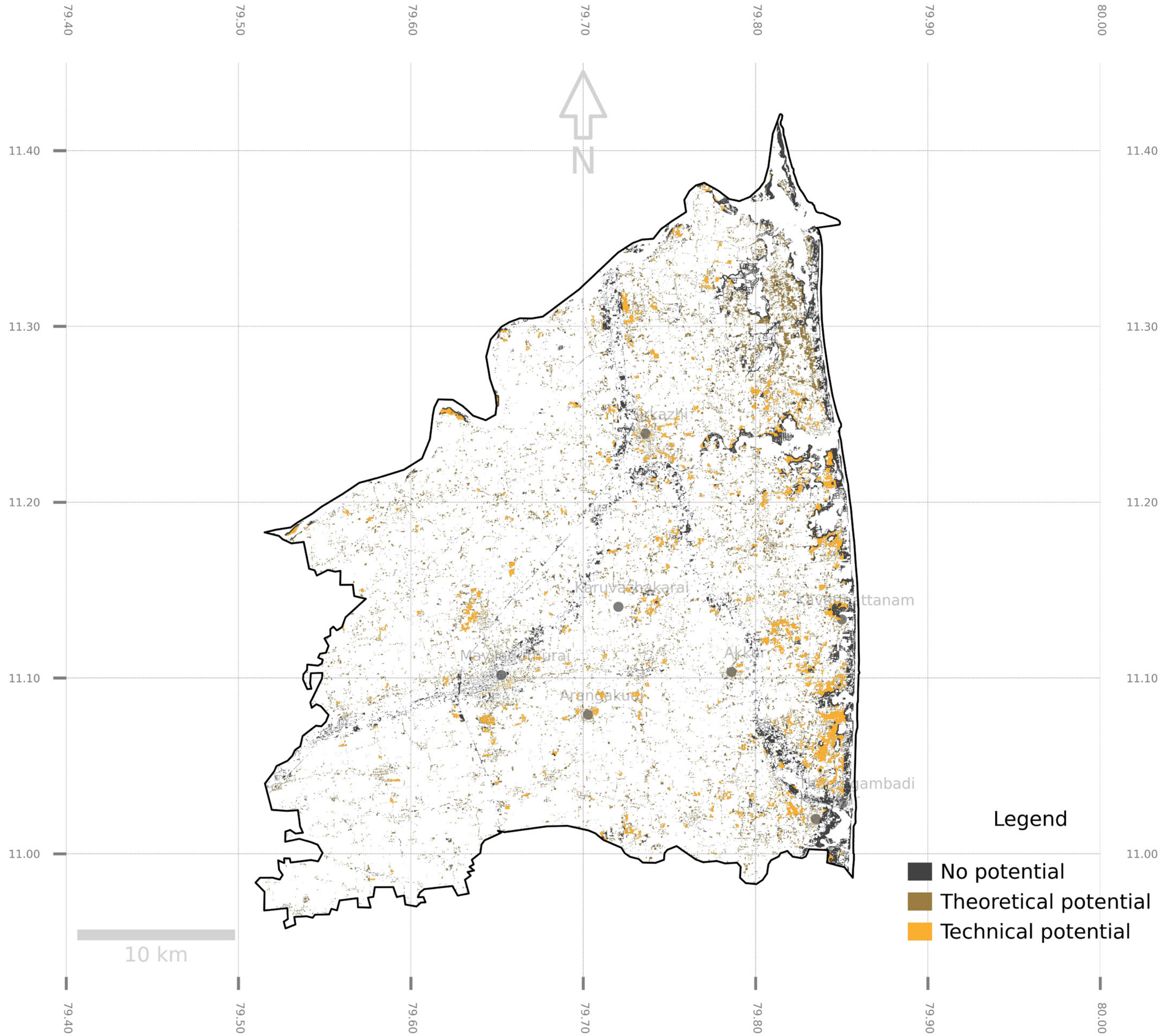
Cumulative Capacity



No Potential
12,040 acres

Theroetical Potential
10,966 acres

Technical Potential
6,462 acres



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

Distribution by plot size

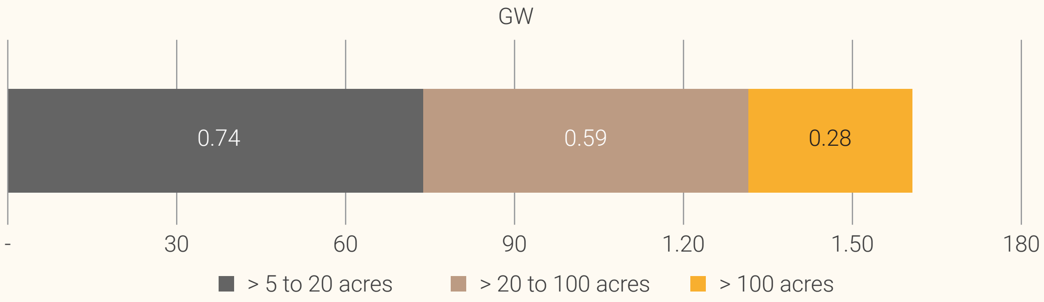
KEY RESULTS

Largest plot	543	acres
Plots>100 acres	5	%
Sum of capacities >20 acres	0.87	GW
Sum of capacities >100 acres	0.28	GW

RESULTS

Plot sizes	Plots (nos)	Area (acres)	Capacity (GW)
Small area	320	2,969	0.74
Medium area	68	2,363	0.59
Large area	5	1,130	0.28

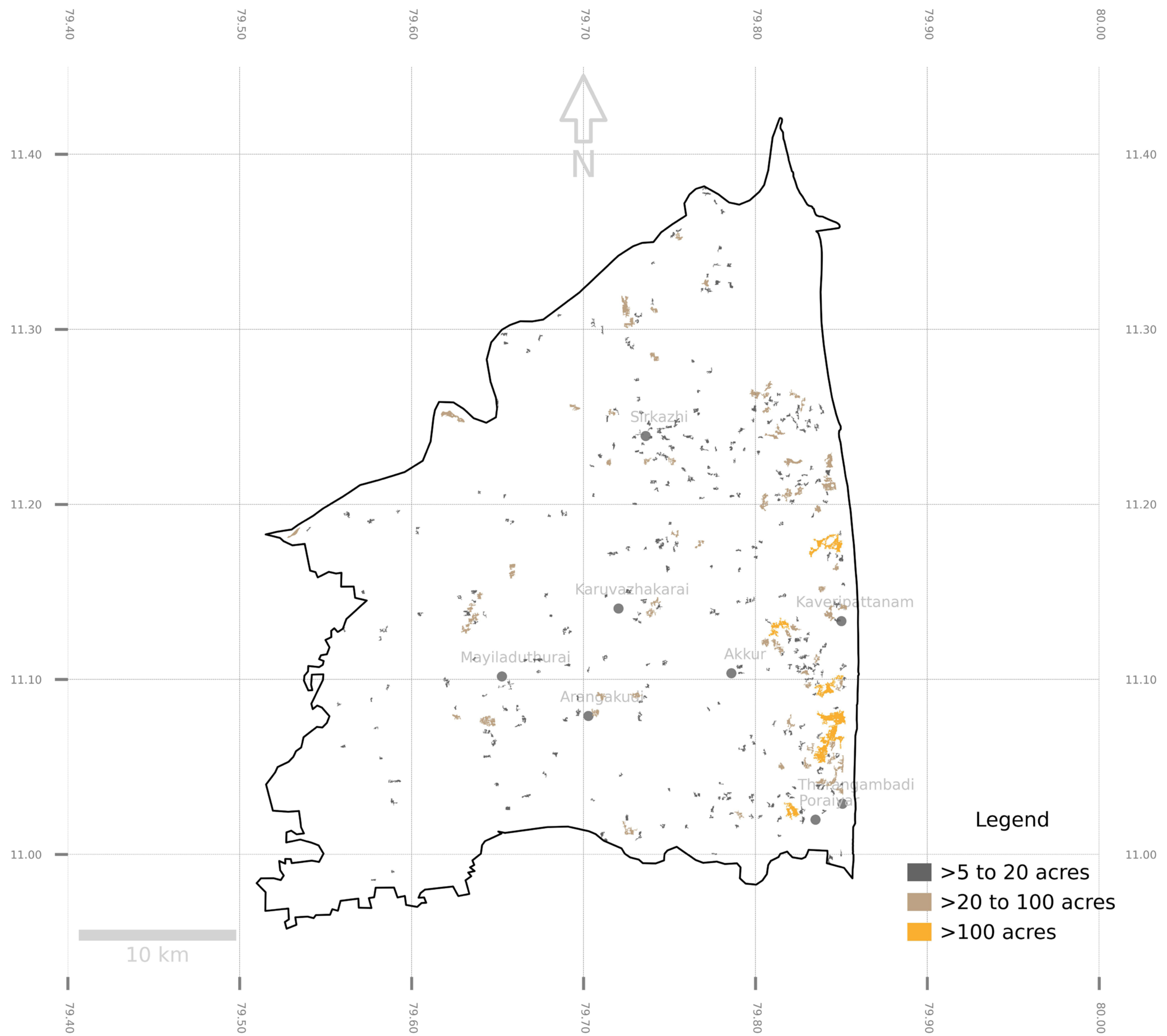
Cumulative Capacity



Small area
2,969 acres

medium area
2,263 acres

Large area
1,130 acres



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

High Potential

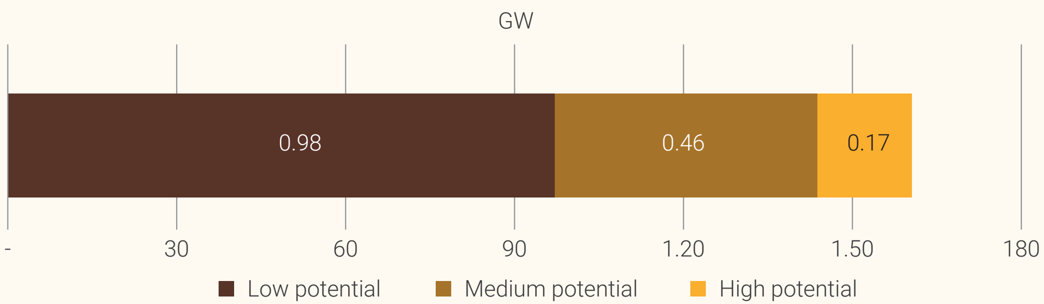
KEY RESULTS

Total area	698	acres
Plots	2	nos
Solar	0.17	GW
Share of target	61	%

RESULTS

Potential	Small area	Medium area	Large area
Low	2,956 acres	948 acres	0 acre
Medium	12 acres	1,416 acres	432 acres
High	0 acre	0 acre	698 acres

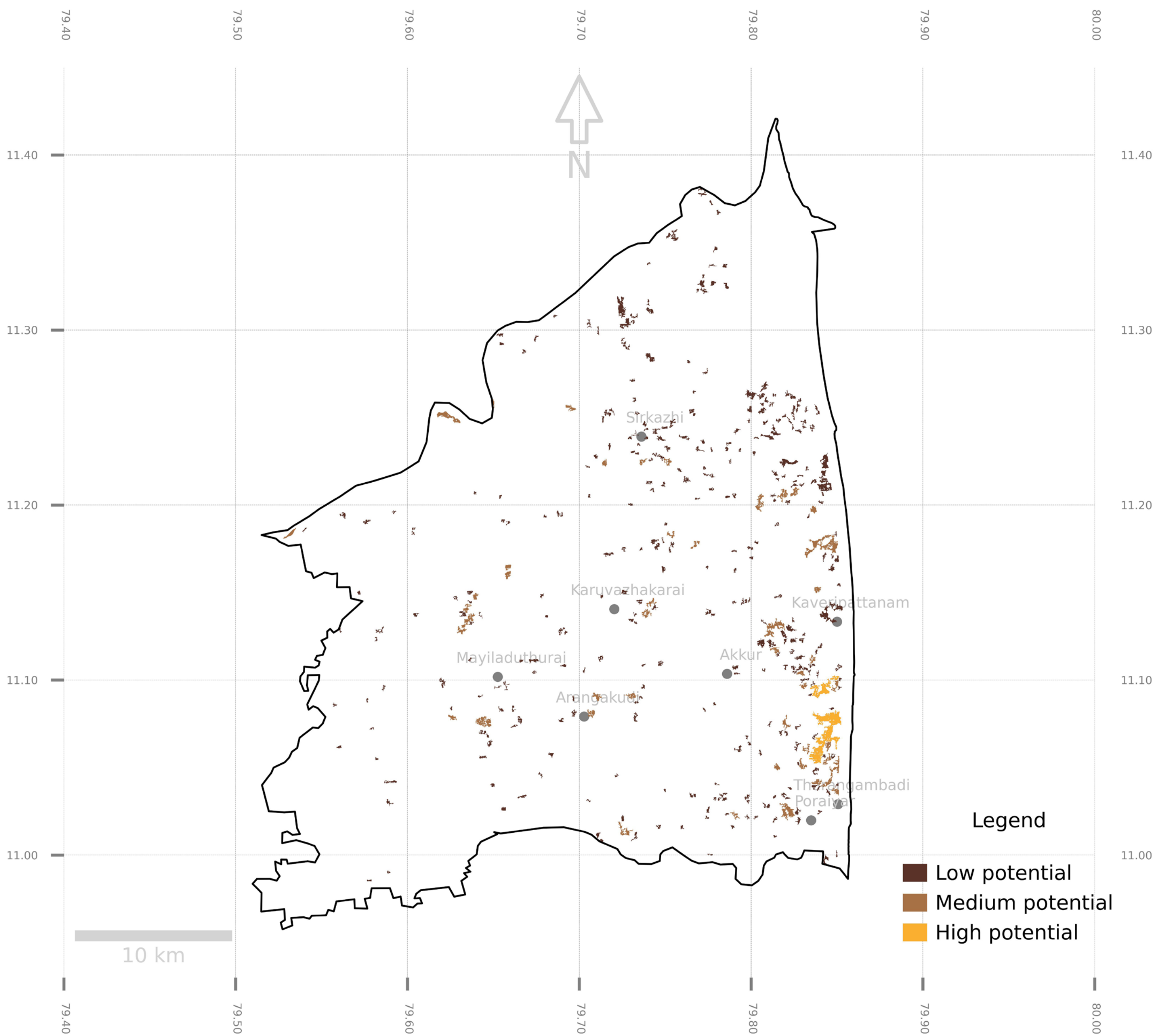
Cumulative Capacity



Low
3,904 acres

Medium
1,860 acres

High
698 acres



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

Competing use for Climate Action

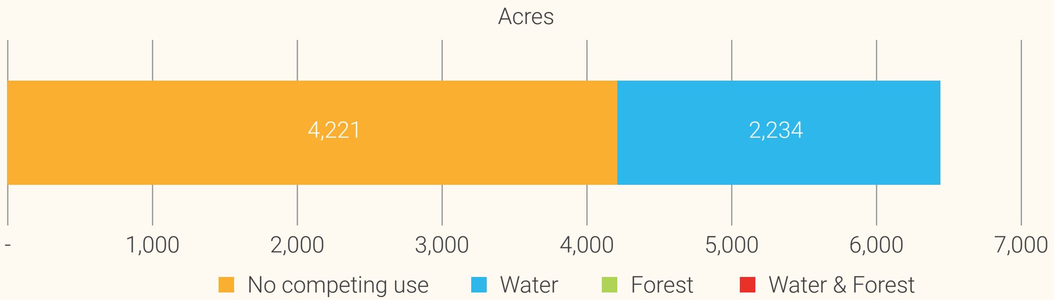
KEY RESULTS

Competing use	2,241	acres
Share of suitable area	65	%
Water use	2,234	acres
Forest use	7	acres

RESULTS

Plot sizes	Forest (acres)	Water (acres)	F&W (acres)
Small area	4	831	0
Medium area	3	868	0
Large area	0	536	0

Cumulative Capacity

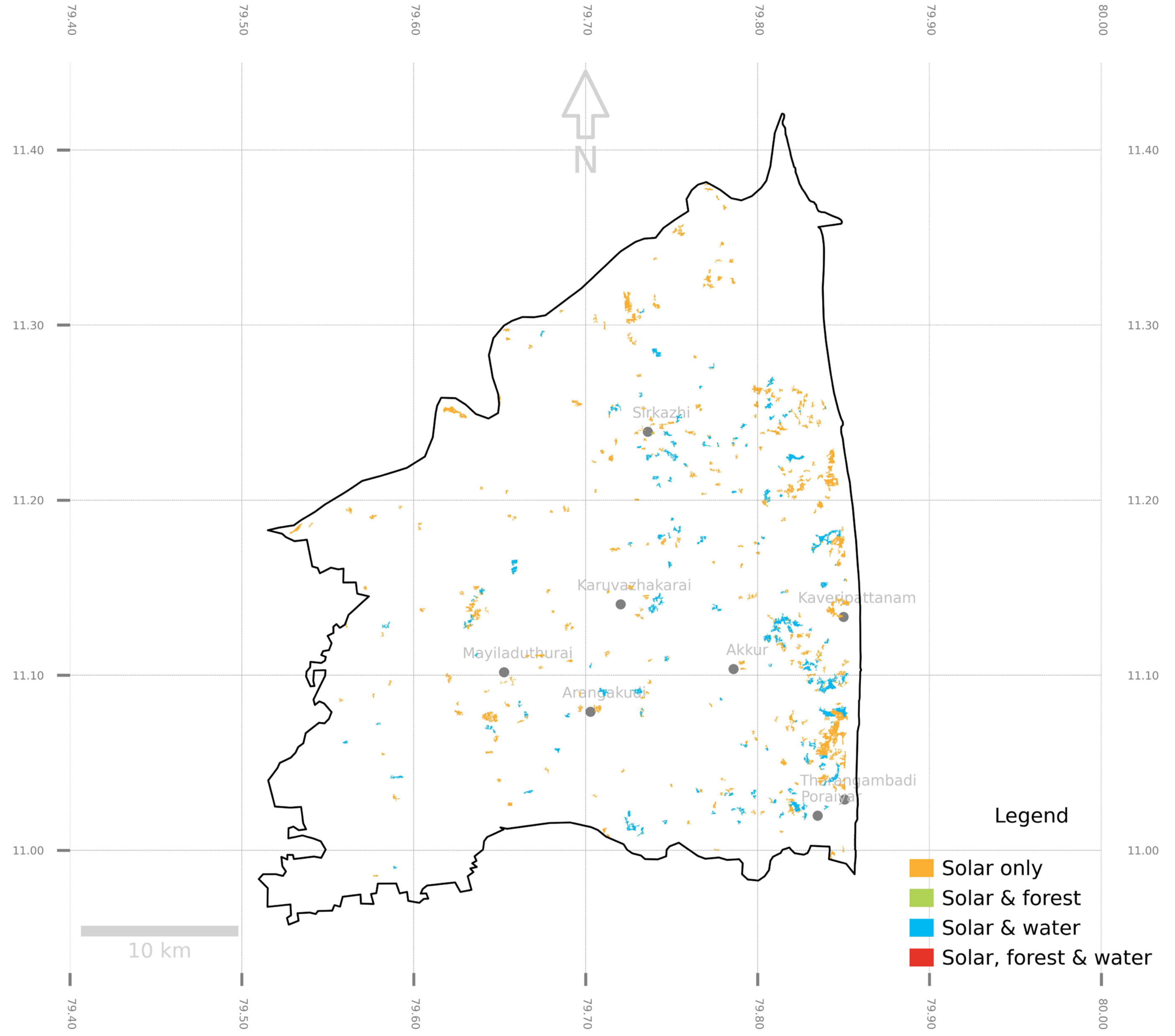


No competing use
4,221 acres

Water
2,234 acres

Forest
7 acres

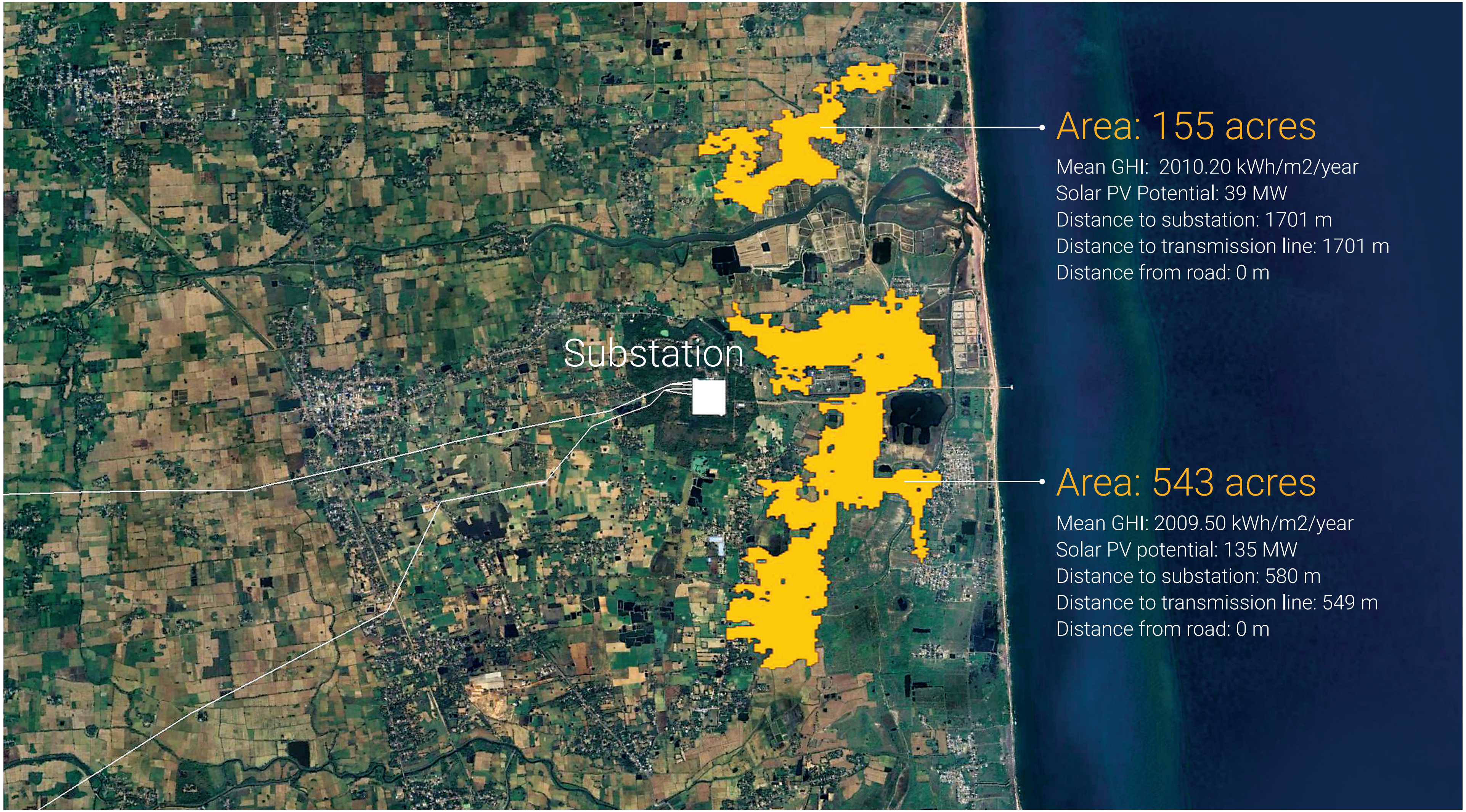
F & W
0 acres



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

High potential sites

This section indicates lands that have the technical potential for the deployment of solar plants but also do have high or medium suitability for reforestation and/or water harvesting. This can inform policy maker, land-use planers, and developers on how to utilize such lands adequately.



Top 15 Lands Identified

ID	Location		Area	GHI	Solar potential	Height above sea-level		Distance to evacuation		Substation capacity	Transmission voltage	Accessibility			Competing use	
	Long (°)	Lat. (°)	(acres)	(kWh/ m2/ year)	(MW)	Min (m)	Max (m)	To sub-station (m)	To trans-mission (m)	(MW)	(kV)	Minimum distance to road(m)	Road type	Number of roads	Type	(acres)
1	79.84	11.06	543	2009	135	0.00	7.47	580	594	-	220000	0	Tertiary Residential Path Unclassified	8 4 4 1	Water Forest F&W Total	136 0 0 136
2	79.84	11.09	155	2010	38	0.01	8.01	1701	1701	-	220000	0	Tertiary Residential Unclassified	5 3 3	Water Forest F&W Total	121 0 0 121
3	79.84	11.17	214	2008	53	0.00	6.05	N/A	-	N/A	-	0	Track Unclassified	1 4	Water Forest F&W Total	123 0 0 123
4	79.81	11.12	115	2009	28	0.00	7.57	N/A	-	N/A	-	0	Tertiary Unclassified	1 5	Water Forest F&W Total	103 0 0 103
5	79.82	11.02	103	2012	25	0.01	8.71	N/A	3258	N/A	220000	0	Residential Unclassified	1 3	Water Forest F&W Total	54 0 0 54
6	79.64	11.07	90	1982	22	0.00	6.75	N/A	-	N/A	110000	0	Primary Residential Unclassified	3 2 7	Water Forest F&W Total	0.30 0 0 0.30
7	79.63	11.13	85	1980	21	0.01	5.11	N/A	596	N/A	220000	0	Unclassified	6	Water Forest F&W Total	27 0 0 27
8	79.62	11.25	84	1977	21	0.02	9.99	N/A	14755	N/A	220000	0	Unclassified	5	Water Forest F&W Total	0 0 0 0

ID	Location		Area	GHI	Solar potential	Height above sea-level		Distance to evacuation		Substation capacity	Transmis-sion voltage	Accessibility			Competing use	
	Long (°)	Lat. (°)	(acres)	(kWh/ m2/ year)	(MW)	Min (m)	Max (m)	To sub-station (m)	To trans-mission (m)	(MW)	(kV)	Minimum distance to road(m)	Road type	Number of roads	Type	(acres)
9	79.80	11.20	61	2007	15	0.01	8.42	N/A	2358	N/A	110000	0	Residential Unclassified	1 5	Water Forest F&W Total	39 0 0 39
10	79.72	11.01	50	1988	12	0.01	3.14	N/A	2081	N/A	220000	0	Unclassified	3	Water Forest F&W Total	49 0 0 49
11	79.84	11.04	49	2009	12	0.01	3.50	N/A	3122	N/A	220000	57	Unclassified	1	Water Forest F&W Total	48 0 0 48
12	79.81	11.20	48	2011	12	0.01	7.42	N/A	3505	N/A	110000	0	Unclassified	3	Water Forest F&W Total	0 0 0 0
13	79.85	11.05	40	1965	10	0.01	3.37	N/A	2783	N/A	220000	0	Residential Unclassified	12 2	Water Forest F&W Total	0 0 0 0
14	79.73	11.13	35	1988	8	0.01	4.20	N/A	-	N/A	-	465	Unclassified	1	Water Forest F&W Total	35 0 0 35
15	79.82	11.20	35	2008	8.70	0.01	8.09	N/A	-	N/A	-	0	Unclassified	2	Water Forest F&W Total	0 0 0 0

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

05 RECOMMENDATIONS

INVITE SOLAR DEVELOPER

A total of 6,469 acres of unused lands were assessed as technically suitable for solar energy development. This represents a solar energy potential of 1.62 GW. A higher concentration of suitable lands in the eastern parts of the district can be observed. Most of the suitable plots are between 5 and 20 acres allowing a solar energy capacity of 1 to 5 MW, which is a suitable capacity to directly connected to existing high voltage distribution feeders. There are 2 plots that meet the high potential criteria for solar. Solar energy deployment on these lands maybe fast tracked, this would result in a solar energy capacity addition of 170 MW.

The district authorities may actively invite solar developers to set up solar energy plants in the district. A listing of unused lands, that are suitable and available for solar energy development can be published and made available as an open-source resource.

Another option is to develop smaller solar parks on these identified lands. Sola parks provide land and evacuation infrastructure and thereby offering a 'plug and play model' for solar energy developers. The solar energy produced from these plants could be supplied via the 'Open Access route' to local industries, businesses, and municipal services.

CO-LOCATE SOLAR & WATER HARVESTING

The competing land-suitability analysis identified that 2,234 acres of unused lands with suitability for solar energy generation have a high or medium potential for water harvesting.

Developers may be encouraged to install rainwater harvesting structures along with the solar system to ensure water availability. Land-use regulations that mandate the co-location of water harvesting and solar energy generation can make a significant contribution to the districts water security.

PRESERVE LANDS FOR FORESTS

Unused land that have a good potential for both reforestation and solar energy development may need to be flagged. The final recommended land use maybe decided based on the district level policy priorities. In the case of Mayiladuthurai District the current tree cover is only 8% of the TGA, Tamil Nadu is aiming at a tree cover of 33% by 2030. Therefore, it is recommended that the district prioritizes the utilization of unused lands for reforestation instead of solar energy development.

PROMOTE ROOFTOP SOLAR

The district has a total built up area of 23.57 km2. Some of the structures can be utilized for rooftop solar. Rooftop solar has no requirement for land as such, as the installation at it will be deployed on existing structures. Rooftop solar can make a major contribution to the districts and the State's energy supply security. Assuming a 10m2 space requirement for kW of rooftop solar capacity, and a suitability of 25% of the total build up area, then a 589 MW or rooftop solar could be deployed.

The district authorities can actively promote rooftop solar system and take the leadership by installing rooftop solar on all public buildings including government schools. The district government can also play a facilitating role by aggregation demand for rooftop solar from MSMEs and households in the district and by facilitating the price discovery.

06 SUMMARY

The land assessment for the Mayiladuthurai district, Tamil Nadu indicated a total of 29,468 acres of unused land. Of this, 6,462 acres (392 plots) have been identified to meet the technical criteria for solar development This is sufficient land area to meet five times the district's solar target of 0.29 GW. With the 73 plots that are greater than 20 acres and meet the technical criteria, a cumulative capacity of 0.87 GW can be achieved. Narrowing the choice down further to the highest potential lands, 47 plots of 1,860 acres in total are ranked medium, and 2 plots of 698 acres in total are ranked high. Medium ranked lands can count towards a cumulative capacity of 0.46 GW, which is 159% of the solar target, and the high ranked lands can meet 61% of this target, with a cumulative capacity of 0.17 GW.

Some of the lands with technical potential for solar energy are also highly suitable for water harvesting and reforestation initiatives. These competing land use opportunities include a total of 2,241 acres, of which 2,234 acres compete with the use of land for water harvesting, and 7 acres compete with the use for reforestation initiatives. While the competing land-use for water harvesting could be addressed by mandating co-location solar energy generation with water harvesting, the competing land-use between forest and solar energy generation does not provide such an opportunity of co-location. As the district has already a comparatively low tree cover of 8% of TGA prioritizing reforestation for land suitable for both solar energy and tree plantations, is recommended.

07 REFERENCES

1. 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)

2. United Nations Convention to Combat Desertification (UNCCD) 2022. Chronic land degradation: UN offers stark warnings and practical remedies in Global Land Outlook 2. Sustainable Land Management & Restoration, Press Release 26 APRIL 2022. Available at: https://www.unccd.int/news-stories/press-releases/chronic-land-degradation-un-offers-stark-warnings-and-practical (accessed on 12th October 2022)

Links to interactive maps:

- https://www.aurovilleconsulting.com/wp-content/uploads/Lila/Mayiladuthurai/Solar/Features.html
- https://www.aurovilleconsulting.com/wp-content/uploads/Lila/Mayiladuthurai/Solar/Landcover.html
- https://www.aurovilleconsulting.com/wp-content/uploads/Lila/Mayiladuthurai/Solar/Landsuitability.html
- https://www.aurovilleconsulting.com/wp-content/uploads/Lila/Mayiladuthurai/Solar/Competinguse.html
- https://www.aurovilleconsulting.com/wp-content/uploads/Lila/Mayiladuthurai/Solar/top15lands.html

Kalpana Community, Crown Road, Auroville, TN - 605101, India.
www.aurovilleconsulting.com | www.thelila.org

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