GIS Based Site Suitability Analysis for Establishing a Solar Power Park in Namakkal District, Tamil Nadu

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Abstract

Solar radiation is received as heat and light which can be converted into useful thermal energy or for the production of electricity through solar-thermal power production. Availability of purely reliable solar radiation data is vital for the success of solar energy installations in different sites of the country. Electricity has become a basic need for people, like air or water. So, it is a big task how to generate electricity with cheaper cost to fulfill the electricity demand of the consumers. This paper focuses on GIS analysis to select suitable site for solar power park in Namakkal District in Tamil Nadu. In Topography, Distance to Infrastructure and Area for organizing a park are the important parameters that have been considered in finding suitable location. It is also important to assess the incoming solar energy for tapping it assures the efficiency. Sector wise power consumption Peak demand and Cost factors are taken into consideration in the analysis. In this paper two interrelated steps have been applied. First, Remote Sensing including satellite data from LANDSAT 8 was used to derive land use/land cover map of the study area. Second, Digital Elevation Model (DEM) was used to model the aspect angles map and slope map for the study area. This findings show the possible site for optimum location for Solar Power Park.

Keywords: GIS, Solar power Park and Site suitability

I. INTRODUCTION

The study mainly focuses on the idea to encourage the sustainable development activities in Tamil Nadu. In sustainable development the concept of solar energy and technologies plays a vital role which is considered as the foremost important factor among all other sustainable development activities. India being located in the equatorial region, it has good solar energy potential. Solar Park is essentially a concentrated zone of solar development which may consist of a minimum of 250 MW generation capacities on a land area of over 600 hectare with minimum value of annual average global horizontal irradiance (GHI) greater than 5 kWh per sq.m. of area. The concerned State Government may designate and permit one or more blocks of land in close proximity as a Solar Park and prepare the transmission and other necessary infrastructure. Various blocks will be located within a radius of 10 km and such that no end points are separated more than 20 km. Private or public investors will lease the land and construct individual solar plants on the land in a clustered fashion and on a predictable timeline with an overall aim to reduce the development uncertainty through the sharing of common infrastructure including transmission. Solar Parks would include all required facilities for generation of solar power, which may include evacuation and transmission infrastructure, solar radiation monitoring station, water availability, access roads to the park, interior roads in the park, telecommunication facility, fire station, green belt and security.

A. Objectives:

1) To study the usage and shortage of electricity in the study area.
2) To analyze the climatic condition of the study area.
3) To analyze the Site Topography.
4) To identify the Suitable site selection.

II. STUDY AREA

Namakkal district is bounded by the districts Salem on north side, Karur on south side, Perambalur on east side and Erode on west side. It lies in the interior of Tamil Nadu between the North Latitudes 11° 00'00" to 11° 36' 10" and East Longitudes 77° 40' 00" to 78° 30' 00". The total geographical area of the District is 3404.3 sq. km. The district has been divided into four taluks namely, Namakkal, Thiruchengode, Paramathi and Rasipuram and fifteen administrative blocks. With a city population of 1,726,601 according to the 2011 census, it is the administrative capital of Namakkal district.

It has an average elevation of 218 meters above mean sea level. The climate is dry and hot, with rains during October/December. Temperatures during summer reach maximum of 38 and a minimum of 22 degree Celsius making it a perfect location for planning a solar power park. Winter temperatures range between 28.3 and 17 degrees Celsius. Namakkal district experiences

semi-arid tropical climate. The road transport system of this district is also well-developed. The location of the study area is shown in the Figure1.

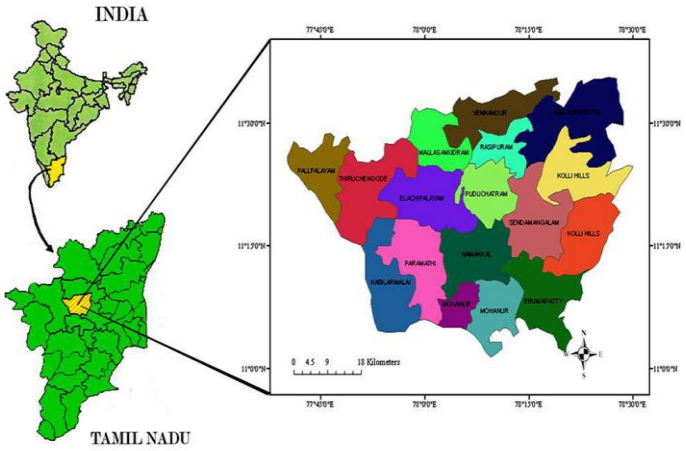

Fig. 1: study area

III. METHODOLOGY

Survey of India maps (58 E/15, 58 E/16, 58 I/2, 58 I/3, 58 I/4, 58 I/6, 58 I/7, 58 I/8) on the scale of 1:50000 were acquired from Survey of India, Bangalore center. Landsat satellite imagery was used for classifying the Land Use/Land Cover for identify the empty lands. Parameter consideration, analysis of nearest substations and consumer requirement in the study area was studied.

A. Software Used

- Arc GIS
- ERDAS Imagine

B. Imageries

- Landsat 8
- ASTER DEM Imageries
- Google Earth Imageries

IV. ELECTRICITY ANALYSIS FOR THE STUDY AREA

A. Power Demand Details

Table - 1
Peak Demand and Energy Output (2012-2013) Source: District Electricity Board, Namakkal.

S.NO	*Power Demand*	*Power Demand Details in MVA*
1	*Instantaneous peak demand*	*459*
2	*Sustained peak demand*	*370*

The Instantaneous (direct) peak demand of the study area is 459 MVA (Mega Volt Ampere) and the Sustained peak demand is 370 MVA. Thereby this is the electricity demand per day in the study area according to TNEB Namakkal Ltd.
Power demand details in MVA is shown in figure 2

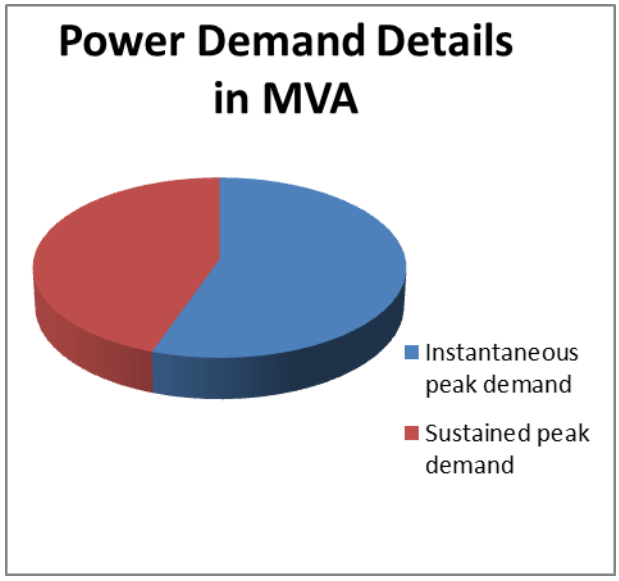

Fig. 2: Power demand details in MVA

B. Electricity Travel Analysis:

According to ohms law
Power loss (Q) = I^2 ^ R
Power loss (Q) =I^2 ^ ρL/A
A Copper wire (Density (ρ) = 8.96 g/ cm^3 has a diameter
A = 11.684 mm = 0.011684 m
L = Depend upon the from station – to station
For Example

1) The Electricity from Kalpakam to Namakkal, the power loss is

Power loss (Q) = I^2 ^ R
Powerloss (Q) = $(5)^2$ ^ 0.0896*345/0.011684
Q = 66141.732 v

2) The Electricity from Neyveli to Namakkal, the power loss is

Power loss (Q) = I^2 ^ R
Power loss (Q) = $(5)^2$^ 0.0896*208 / 0.011684
Q = 39876.755

3) The Electricity from Aralvaimozhy to Namakkal, the power loss is

Power loss (Q) = I^2 ^ R
Powerloss (Q) = $(5)^2$ ^ 0.0896*394/0.011684
Q=75535.775 v

4) The Electricity from Mettur to Namakkal, the power loss is

Power loss (Q) = I^2 ^ R
Power loss (Q) = $(5)^2$^0.0896*104/0.011684
Q=19938.377v

According to Ohm's law, the electricity travel waste was calculated. When the distance increases the travel waste also increases. This is the main thing we select the site near by the existing infrastructure.

C. Examples

1) Kalpakkam Thermal power plant,
2) Neyveli NLC plant
3) Aralvoimozhi Pass
4) Mettur dam

V. RESULT AND DISCUSSION

A. Land Use Land Cover Analysis:

To locate a Solar power park, according to IEA (International Energy Agency) and NREL (National Renewable Energy Limited, USA), that location which we identify needs to have some Topographic elements. They are,

1) Plain Area.
2) Without shadow.
3) Non Agriculture land such as Waste land or Barren land.

Land use Land cover map of the study area is shown in Figure 3.

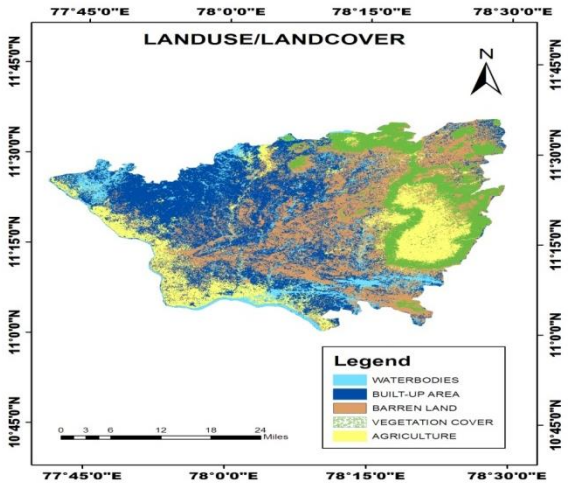

Fig. 3: LULC

B. Generation of Slope, Aspect & Dem:

ASTER GDEM of 20m resolution is obtained for the whole study area and were extracted exactly for the region of study using the boundary shape file in ArcGIS. Later this extracted DEM data is used to obtain slope, aspect and Dem map for the region by using surface toolbox of Spatial Analyst tools in ArcGIS.

Slope, aspect and Dem maps were generated by providing appropriate values in the toolbox to produce accurate result. These maps are later used to select a suitable site for solar power park.

C. Aspect Map:

Aspect is simply the measure of the direction of slope. It begins with 0° at the north, and then in a clockwise direc-tion ends at 360° again at the north. Aspect is often clas-sified into four major directions namely; north, east, south, and west. The prepared aspect map describes the direction in azimuth for land slope angles for the study area. Aspect map produced from ASTER DEM digital elevation model is shown in Figure 4.

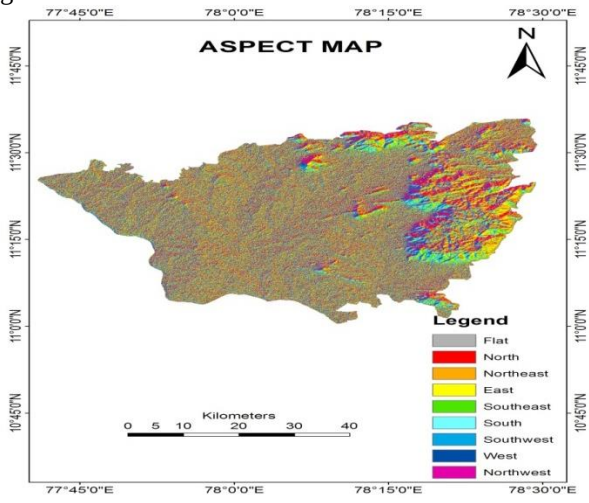

Fig. 4: ASPECT MAP

D. Slope Map:

Slope refers to the measures of the rate of change of elevation of surface location. It describes the rise or fall of the land forms and also percentage of slope. Here a slope map was created through the interpretation of DEM that covers the study area. In this study the lower degree of slope is highly suitable than the higher degree of slope. Slope map of the study area is shown in Figure5.

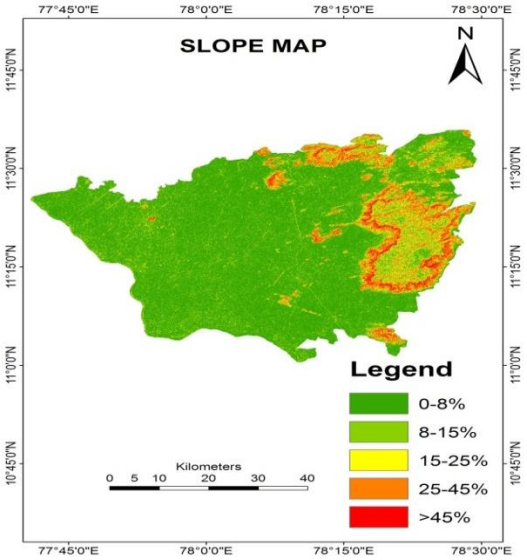

Fig. 5: SLOPE MAP

E. Digital Elevation Model Map:

Dem is a digital model of a terrain surface. Dem of the study area is shown in figure 6.

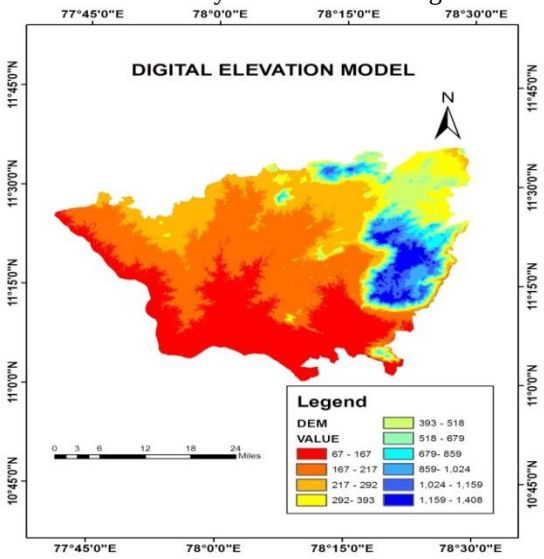

Fig. 6: DEM MAP

F. Suitable Site Location:

Before creating suitable site, the Settlements, River, Agriculture land, Roads, Hills zones have to buffer. Suitable site location map is shown in figure7. Based on all the thematic vector layers created and by integrating them into the software a suitable site was identified for planning a solar power park. The selected site receives a maximum solar insolation which is the first and foremost criteria for this site selection. And also the site selected is a barren land in which the setting up of the park is made easier. Also from the slope and land use land cover map created it is evident that the site must be located on a low slope and a plain area.

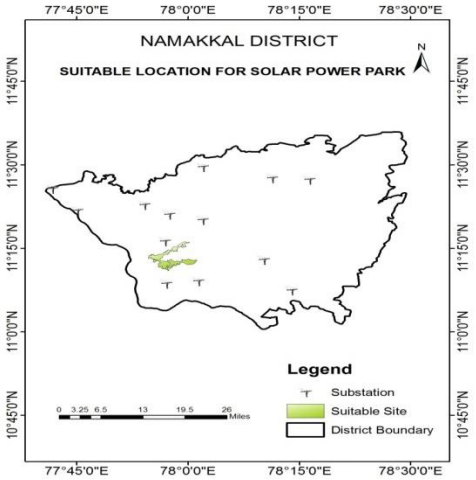

Fig. 7: SUITABLE SITE LOCATION

VI. CONCLUSION

Using the GIS tools we select the correct location to locate a transmission power park in Namakkal district concluded from the above data. Power consumption, energy output from monthly and quarterly electric schedules & schemes as per cost analysis (unit) distribution of transformers from various output resource such as delivering and receiving the signals, conductance are done. For finding suitable site slope map, land use / land cover classification has been done. Using GIS, suitable location for Establishing a Solar Power Park has been identified. Selected site has suitable climatic condition, topography, and also this was located nearby substation. Total area of the location is 22 SqKm, so it is possible to generate average220 MW electricity from this park.

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