IEEE Student Hackathon on Geospatial Technology for Sustainable Development (GTSD) 2023

Team Name: Tri-Geo

Team Number: 28

Team Members: Vineet Balkrishna Chavan

Suraj Ravasaheb Mane

Aniket Kishor Sonawane

Multi-Criteria Analysis for befitting Solar Farm Locations using Geospatial Technology

Introduction

The global energy demand is increasing, and utilizing clean energy sources has become a primary challenge in the 21st century. Fossil fuels are the primary energy source, but renewable energy sources are being explored to reduce greenhouse gas emissions and combat global warming. Solar energy is a clean, abundant, and free source of energy that can meet the increasing energy demand and provide social and economic benefits without harming the environment. Solar energy has had a significant impact on India's energy sector, meeting the energy needs of millions of people in rural areas and emerging as a significant player in the grid-connected power generation capacity. India ranks fourth globally in solar PV deployment, and the government has implemented various policy measures to promote the use of solar energy.

Study Area

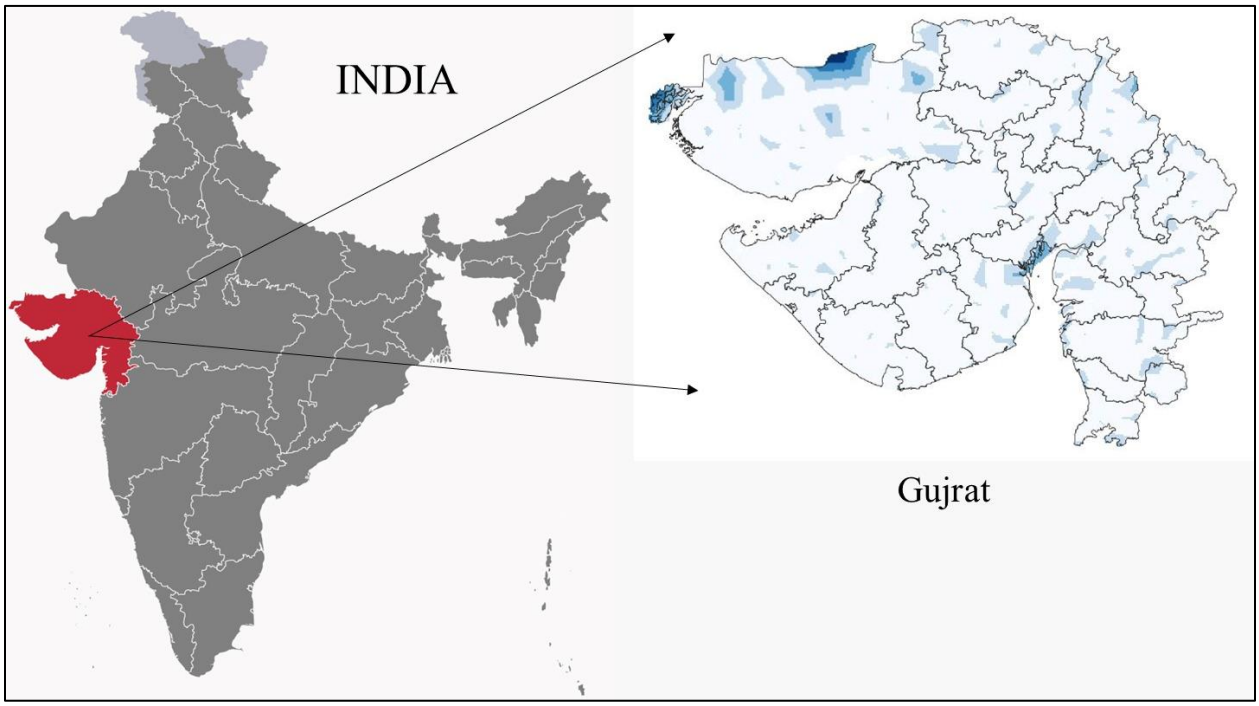
Gujarat is a state located on the western coast of India, and its weather and climate are influenced by the Arabian Sea and the Thar Desert. The state experiences hot and dry summers, with temperatures reaching up to 45°C, while winters are mild and pleasant. The monsoon season in Gujarat lasts from June to September, bringing heavy rainfall to the region.

Agriculture is an important sector of Gujarat's economy, contributing to around 17% of the state's gross domestic product (GDP). The state is known for its production of cotton, groundnuts, and sugarcane, among other crops.

Renewable energy has been a focus area for the state of Gujarat, with several initiatives taken to promote its development. Gujarat has significant potential for solar and wind energy, and the state has made significant progress in harnessing these resources. Recently, India stands 4th in solar PV

deployment across the globe as on end of 2021. Solar power installed capacity has reached around 61.97 GW as on 30th November, 2022.

Gujarat's climate and weather conditions, coupled with its agricultural sector's challenges, have made the development of renewable energy resources a priority for the state. Gujarat has made significant strides in harnessing solar and wind energy, and the state's efforts in this direction have helped promote sustainable development and energy security.



Objectives

The following are the objectives of the study,

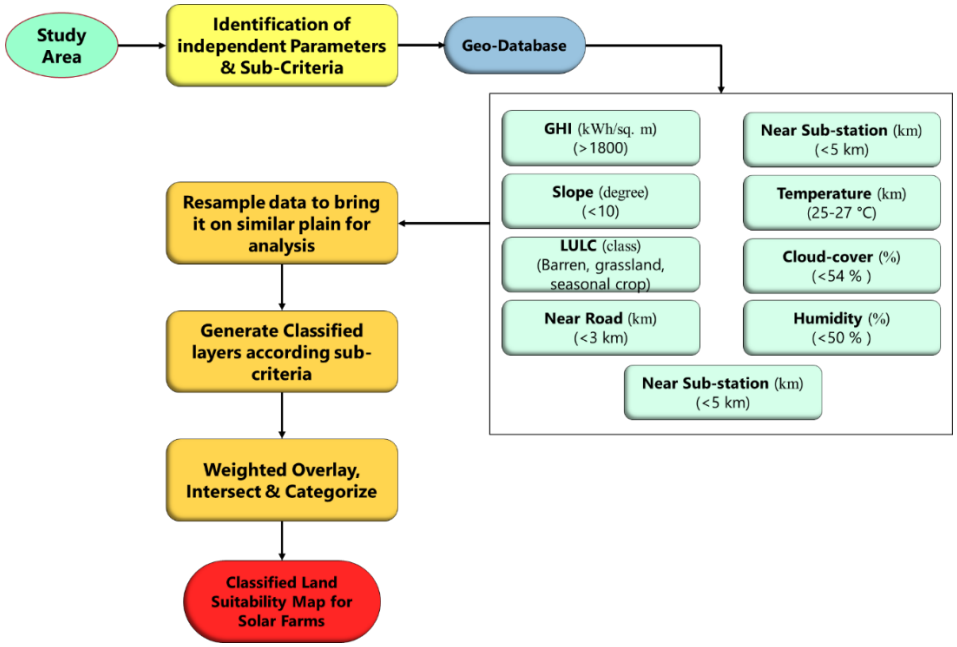
1. To evaluate the region's solar energy potential to get the feasibility of establishing solar farms.
2. To identify the potential locations that fulfill the criteria for efficient performance through solar farms.

Methodology

The methodology for the project can be broken down into the following steps:

1. **Identification of independent parameters and sub criteria:** The independent parameters for the project are Global Horizontal Irradiance (GHI), Land Use Land Cover (LULC), Connectivity, Substations, Temperature, Cloud Cover, and Humanity. These parameters are further divided into subcriteria such as terrain slope, land cover type, distance from substations, etc.

2. **Resampling of data:** Since the data for different parameters is collected at different spatial resolutions, it is important to resample the data to bring it to a common spatial resolution. This is done to ensure that all data layers can be analyzed together and compared accurately.
3. **Generation of classified layers**: The data for each subcriteria is classified and converted into a raster layer. For example, the LULC data can be classified into different land cover types such as agricultural land, forest, urban areas, etc.
4. **Weighted overlay**: A weighted overlay analysis is performed to combine the classified layers and assign weights to each layer based on their relative importance in determining the suitability of an area for solar farms. The weighted overlay analysis combines the different layers and generates a composite score for each pixel in the study area.
5. **AHP Technique for Weighted Overlay**: The Analytic Hierarchy Process (AHP) technique is used to assign weights to the subcriteria. This technique involves pairwise comparisons of the subcriteria to determine their relative importance.
6. **Classified land suitability map**: Based on the composite scores generated through the weighted overlay analysis, the study area is classified into different classes of suitability for solar farms. These classes can range from highly suitable to not suitable for solar farms.



The Execution model for the proposed study

Data Sources

Data	Source	Unit
Solar Irradiance	Solargis, World Bank Group	kWh/sq. m

Temperature	Solargis, World Bank Group	°C
Slope	SRTM, USGS	Degree
LULC	Sentinel-2, LULC	NA
Sub-stations	Maharashtra State Electricity Transmission Co. Ltd.	Number
Roads and Railway Network	Diva GIS	km
Protected Areas	Wildlife Institute of India	Km^2
Humidity	power.larc.nasa.gov	%
Cloud Cover	power.larc.nasa.gov	%

Analytical Hierarchy Process (AHP)

Factor	Weight	Optimum Range	Unit
GHI	0.2982	> 1900	kWh/sq.m
Slope	0.0173	< 5	Degree
LULC	0.13748	NA	NA
Near roads	0.02424	< 5	km
Sub-station	0.05605	< 5	km
Protected zones	0.05164	> 3	km
Temperature	0.21121	> 25	Degree Celsius
Humidity	0.10944	< 54	%
Cloud cover	0.09398	< 50	%

Assigned weights for considered criteria by AHP

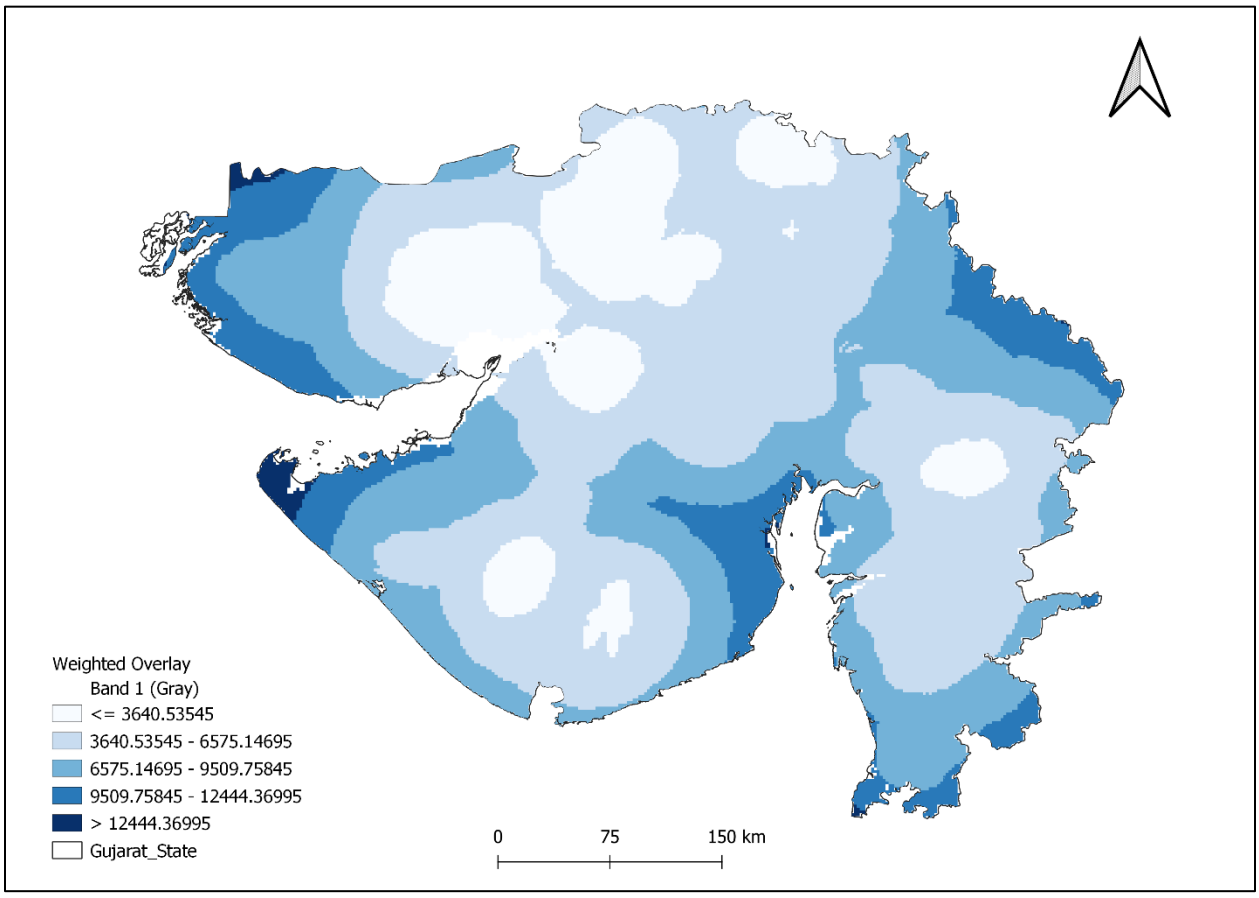
Results

The study can observe the following things,

1. The monthly potential scenario concludes that economic potential throughout the year is the most suitable criterion for solar farms.

2. The most suitable locations are Kachchh, Morbi, Surendranagar, Dwarka, Porbandar, Rajkot districts. The remaining sections also have potential sites, but the extent needs to be improved to achieve economy.

3. The suitable areas are distributed throughout the state, which is significant for energy circulation & accessibility.



Conclusion

The study results provide befitting locations for energy source establishment that will be the ground solution. The data generated can be significant for policymakers to design things according to an efficient manner. The government also feels ease in revenue distribution to fulfill policies that are ultimately intended to contribute to the growth & self-sufficiency of the state. In the preceding era, power self-sufficiency is critical to the future & can be more rewarding if sustainable.

References

[1] Solar energy potential assessment: A framework to integrate geographic, technological, and economic indices for potential analysis, Yuhu Zhang, Jing Ren, Yanru Pu, Peng Wang, College of Resource Environment & Tourism, Capital Normal University, Beijing, 100048, China.

[2] SOLAR PV POWER PLANT SITE SUITABILITY ASSESSMENT BY GIS-BASED MCDM METHODOLOGY IN BEYPAZARI-ANKARA, Dikmeoğlu, Berrak Master of Science, Geological Engineering Supervisor: Prof. Dr. Mehmet Lütfi Süzen.

[3] GIS-Based Assessment of the Technical and Economic Feasibility of Utility-Scale Solar PV Plants: Case Study in West Kalimantan Province, Alfeus Sunarso, Kunhali Ibrahim-Bathis, Sakti A. Murti, Irwan Budiarto & Harold S. Ruiz.

[4] Spatial mapping of renewable energy potential, T.V. Ramachandran, B.V. Shruthib, Centre for Sustainable Technologies, Indian Institute of Science, Bangalore, India.

[5] The Effect of Cloud on the Output Performance of a Solar Module, J. A. Amusan, E. B. Otokunefor, Department of Physics University of Port Harcourt, Rivers State, Nigeria.