Machine Learning-Driven Solar Panel Site Selection and Rooftop Potential Estimation for Sustainable Development Goals

Rishitha N.[1*], Muthu Reshmi K.[1], Srishti Gulecha R.[1] and Dr Vani K.[1]

[1]Department of Information Science and Technology, College of Engineering Guindy, Anna University, India

*nrishitha58@gmail.com

ABSTRACT

Harnessing solar energy is a game-changer for sustainable development and alleviating poverty. Solar power not only combats climate change but also opens doors to economic opportunities and improves the quality of life in underserved areas. The installation of solar panels is essential for addressing global challenges such as poverty reduction and advancing Sustainable Development Goals. This work uses satellite and government data to map site suitability for solar panels, considering factors like Elevation, Wind speed, Surface temperature, Land use land cover, Normalized Differential Vegetation Index, Carbon Monoxide level, Solar irradiation, Population, Proximity to Residential areas, Water bodies, Power grids, and Roads. This study provides a comprehensive framework for evaluating solar panel site suitability, integrating environmental and infrastructural factors to optimize placement. Various machine learning models, like XGBoost, Random Forest Classifier, and Random Forest Regression, are trained and tested for the region of Rajasthan situated in India. The best model which is XGBoost resulted in an accuracy of 0.982, precision of 0.983, recall of 0.979, and F1 Score of 0.981 in training. Similarly, testing values were 0.934, 0.882, 0.985, and 0.931 for accuracy, precision, recall and F1 score respectively. The XGBoost model is selected to create a solar panel site suitability map. Using the pre-trained YOLOv8 model and Google Earth Pro images concrete roofs are detected. And then the rooftop images are clipped and processed to determine boundaries. Edge detection and contouring are used to calculate the rooftop area, estimating the number of solar panels and their potential power generation based on the available roof space. This study provides a clean and reliable energy solution that can reduce costs and improve life quality in underdeveloped and rural areas. By placing solar panels, the dependency on fossil fuels is decreased which helps in reducing greenhouse gas emissions and fostering environmental sustainability.

Keywords: Geospatial data, Image Processing, Machine learning, Solar Panel Site Suitability, Sustainable Development