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Uncovering Optimal Solar Site Locations in India using Unsupervised Learning Approaches

Introduction

The process of transitioning the global energy supply from fossil fuel-based sources to sustainable energy sources like wind and solar will be crucial for mankind to make in the 21st century. Solar energy is generated from photovoltaic cells which need a high amount of solar irradiance throughout the year to be profitable. Countries in tropical regions like parts of India tend to receive abundant sunlight throughout the year. However, many aspects need to be studied before identifying promising regions where solar farms could be built to tap into that region's solar potential, like the slope gradient of the terrain, proximity to urban centers, and nature, wildlife preserve areas.

Background Research or Context

There are several challenges in identifying and classifying sites favorable for solar energy predictions from data gathering to methodology for identification. Studies for solar site selections have been carried out by Colak et al.[1] and Al Garni et al.[2] for provinces in Turkey and Saudia Arabia respectively. Both authors used the Analytical Hierarch Process(AHP) a Multi-Criteria Decision Making(MCDM) the process where they would rank various aspects of geographical features and generate weights for the importance of aspects or features. Other MCDMs processes like the Fuzzy Logic model for site selection done by Zoghi et al.[3] in Iran. Finally, using GIS data and carrying out AHP for identifying solar and wind power sites in India was done by Saraswat et al. [4] in 2021.

Proposed Project

There has been a lot of research in this domain but all the studies more or less have used Multi-Criteria Decision-making processes to evaluate GIS information and make suggestions. This study aims to develop a novel unsupervised model for clustering potential sites for solar farms. Firstly, the gathering of GIS(geographical information systems) data for multiple layers of information like terrain type, solar irradiance, wildlife protected sanctuaries. Using GIS data to identify sites of concern has been done for studies like detecting landslide occurrences have been done by Chang et al. [5] using unsupervised learning approach, but it has been relatively absent in the identification of areas suitable for renewable energy farms. Secondly, after data gathering, it would be trained using clustering algorithms to identify sites based on selected features. Lastly, In the previous studies, it was hard to quantify the robustness and accuracy of the developed models, but here we can use unsupervised learning evaluation metrics like purity, and residual sum squares to evaluate our results. Additionally, auto-labeling of data could also be tried with set criteria, and then robust supervised learning methods could be used to develop models on the labeled data.

Timeline

- Literature review - April 31, 2023
- Project Proposal - June 30, 2023
- Project Implementation - July 30, 2023
- Thesis writeup - August 20, 2023
- Project Completion - August 31, 2023

References

[1] H. Colak, T. Memisoglu, and Y. Gercek, "Optimal site selection for solar photovoltaic (pv) power plants using gis and ahp: A case study of malatya province, turkey," *Renewable Energy*, vol. 149, pp. 565–576, 2020.

[2] H. Z. Al Garni and A. Awasthi, "Solar pv power plant site selection using a gis-ahp based approach with application in saudi arabia," *Applied Energy*, vol. 206, p. 1225–1240, 2017.

[3] M. Zoghi, A. Houshang Ehsani, M. Sadat, M. javad Amiri, and S. Karimi, "Optimization solar site selection by fuzzy logic model and weighted linear combination method in arid and semi-arid region: A case study isfahan-iran," *Renewable and Sustainable Energy Reviews*, vol. 68, p. 986–996, 2017.

[4] S. Saraswat, A. K. Digalwar, S. Yadav, and G. Kumar, "Mcdm and gis based modelling technique for assessment of solar and wind farm locations in india," *Renewable Energy*, vol. 169, p. 865–884, 2021.

[5] Z. Chang, Z. Du, F. Zhang, F. Huang, J. Chen, W. Li, and Z. Guo, "Landslide susceptibility prediction based on remote sensing images and gis: Comparisons of supervised and unsupervised machine learning models," *Remote Sensing*, vol. 12, no. 3, p. 502, 2020.