TRACK 2: MATHEMATICS, STATISTICS & NUCLEAR SCIENCE

A multi-criteria framework for locating sustainable wind energy plants in Sri Lanka

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In the modern world, renewable energy is considered the newest trend in the field of energy generation. Currently, increasing energy demand and rising energy costs are identified as major issues in the world, including in Sri Lanka. Renewable energy resources are seen as an impactful solution because of their availability, economic viability, and environmental friendliness. This study focuses on identifying the most significant locations for wind power generation in Sri Lanka by integrating environmental, technical, and economic considerations. Thirty regions across the country were selected for the analysis. Data were gathered from NASA POWER Access Viewer, Google Earth Pro, and QGIS. Five decision factors that are responsible for the sustainability of wind plants were considered in this study, namely, wind density, elevation, land use, distance from restricted areas, and proximity to road networks. Fast Fourier Transform was applied to assess wind density patterns, which revealed seasonal consistency in several regions, including Trincomalee, Hambantota, Kalmunai and Mannar. Fuzzy Analytic Hierarchy Process (FAHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) were applied to evaluate regional suitability, by incorporating expert judgment and literature-based criteria. The results were refined using clustering analysis, and cities were grouped based on overall suitability scores. The regions were categorized into different suitability levels based on the TOPSIS criteria, and among them, Kalmunai and Mannar were identified as the most significant locations for setting up wind energy plants, while the other areas were observed to have low potential. The importance of maintaining updated data and applying advanced methods is emphasized to improve the accuracy and reliability of wind energy planning. The approach of this study can be used to improve decision-making in the development of wind power systems in Sri Lanka.

Keywords: *Renewable energy, Wind power, Fast Fourier Transform, Fuzzy logic*