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Philippine Site Suitability Analysis for Biomass, Hydro, Solar, and Wind Renewable Energy Development Using Geographic Information System Tools

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Abstract : For the past few years, Philippines has depended most of its energy source on oil, coal, and fossil fuel. According to the Department of Energy (DOE), the dominance of coal in the energy mix will continue until the year 2020. The expanding energy needs in the country have led to increasing efforts to promote and develop renewable energy. This research is a part of the government initiative in preparation for renewable energy development and expansion in the country. The Philippine Renewable Energy Resource Mapping from Light Detection and Ranging (LiDAR) Surveys is a three-year government project which aims to assess and quantify the renewable energy potential of the country and to put them into usable maps. This study focuses on the site suitability analysis of the four renewable energy sources – biomass (coconut, corn, rice, and sugarcane), hydro, solar, and wind energy. The site assessment is a key component in determining and assessing the most suitable locations for the construction of renewable energy power plants. This method maximizes the use of both the technical methods in resource assessment, as well as taking into account the environmental, social, and accessibility aspect in identifying potential sites by utilizing and integrating two different methods: the Multi-Criteria Decision Analysis (MCDA) method and Geographic Information System (GIS) tools. For the MCDA, Analytical Hierarchy Processing (AHP) is employed to determine the parameters needed for the suitability analysis. To structure these site suitability parameters, various experts from different fields were consulted – scientists, policy makers, environmentalists, and industrialists. The need to have a well-represented group of people to consult with is relevant to avoid bias in the output parameter of hierarchy levels and weight matrices. AHP pairwise matrix computation is utilized to derive weights per level out of the expert's gathered feedback. Whereas from the threshold values derived from related literature, international studies, and government laws, the output values were then consulted with energy specialists from the DOE. Geospatial analysis using GIS tools translate this decision support outputs into visual maps. Particularly, this study uses Euclidean distance to compute for the distance values of each parameter, Fuzzy Membership algorithm which normalizes the output from the Euclidean Distance, and the Weighted Overlay tool for the aggregation of the layers. Using the Natural Breaks algorithm, the suitability ratings of each of the map are classified into 5 discrete categories of suitability index: (1) not suitable (2) least suitable, (3) suitable, (4) moderately suitable, and (5) highly suitable. In this method, the classes are grouped based on the best groups similar values wherein each subdivision are set from the rest based on the big difference in boundary values. Results show that in the entire Philippine area of responsibility, biomass has the highest suitability rating with rice as the most suitable at 75.76% suitability percentage, whereas wind has the least suitability percentage with score 10.28%. Solar and Hydro fall in the middle of the two, with suitability values 28.77% and 21.27%.

Keywords : site suitability, biomass energy, hydro energy, solar energy, wind energy, GIS
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