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Incorporation of Crowdsourcing Techniques in Geographic Information Systems for Site Selection of Offshore Wind Farms

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ABSTRACT

Offshore wind energy corresponds to vast, clean and eco-friendly energy source. It is a technologically mature and economically competitive energy choice that has, nowadays, managed to gather the interest of both the scientific community and the investors. Offshore Wind Farms (OWFs) constitute the "new generation" in wind farms' development, presenting significant advantages in contrast to the onshore ones. The limited land area and the lower wind intensity on the surface of the land due to the impact of the relief are going to be confronted by this new trend, which offers a more efficient "harvest" of the available energy. Moreover, the exploitation of the offshore wind energy through OWFs is directly related to the long-term strategic priorities and energy policies of the European Union. Therefore, many large-scale, commercial OWFs have been already installed, mainly in the countries of the northern Europe (North and Baltic Sea).Motivated by this, the present thesis focuses on the site selection of OWFs in Greece, through the combined use of Geographic Information Systems (GIS), Multi Criteria Decision Analysis methods (MCDA) and Crowdsourcing techniques ('open invitation' to an Online Questionnaire). In the 1st phase of the analysis, unsuitable areas for the sitting of OWFs are identified through the development of a GIS database that produces thematic maps representing exclusion criteria related to utilization restrictions, economic, social and technical constraints. At the same time marine areas not satisfying the examined exclusion criteria are determined, candidate areas (eligible areas) for further evaluation (alternatives) are identified. In the 2nd phase, and through the answers given in the online questionnaire, the weights of the evaluation criteria are determined and the spatial representation of the social acceptance criterion is carried out by the crowd. In the 3rd phase, the eligible areas, as obtained from the 1st phase of the site selection process, are evaluated and are ranked. Based on this ranking, the "optimum" area for the sitting of OWFs in the Greek marine environment is defined and proposed. For this purpose, two MCDA are applied, the Analytic Hierarchy Process (AHP), which is supported by GIS, and the Weighted Sum Model, whose implementation is through GIS.The results of the AHP evaluation demonstrate the existence of a predominantly "optimal" position in the Greek marine environment, which is located in the Southwest of Rhodes, while in the Weighted Sum Model three are the alternatives that show the highest significance score.Finally, a sensitivity analysis in the results of AHP is carried out, which aims mainly to the investigation of the sensitivity's degree of the final result with regard to the changes in the criteria's significance. For this purpose, in addition to the baseline scenario, five scenarios with different criteria weights are being formed and studied. In all of the above scenarios,

the final hierarchy of the alternative areas for the sitting of OWFs remains the same, as it is obtained from the baseline scenario.

KEYWORDS

Offshore Wind Farms, Geographic Information Systems (GIS), Analytic Hierarchy Process (AHP), Weighted Sum Model, Crowdsourcing