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GIS-based approach for optimal siting and sizing of renewables considering techno-environmental constraints and the stochastic nature of meteorological inputs

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Following the legislative EU targets and taking advantage of its high renewable energy potential, Greece can obtain significant benefits from developing its water, solar and wind energy resources. In this context we present a GIS-based methodology for the optimal sizing and siting of solar and wind energy systems at the regional scale, which is tested in the Prefecture of Thessaly. First, we assess the wind and solar potential, taking into account the stochastic nature of the associated meteorological processes (i.e. wind speed and solar radiation, respectively), which is essential component for both planning (i.e. type selection and sizing of photovoltaic panels and wind turbines) and management purposes (i.e. real-time operation of the system). For the optimal siting, we assess the efficiency and economic performance of the energy system, also accounting for a number of constraints, associated with topographic limitations (e.g., terrain slope, proximity to road and electricity grid network, etc.), the environmental legislation and other land use constraints. Based on this analysis, we investigate favorable alternatives using technical, environmental as well as financial criteria. The final outcome is GIS maps that depict the available energy potential and the optimal layout for photovoltaic panels and wind turbines over the study area. We also consider a hypothetical scenario of future development of the study area, in which we assume the combined operation of the above renewables with major hydroelectric dams and pumped-storage facilities, thus providing a unique hybrid renewable system, extended at the regional scale.