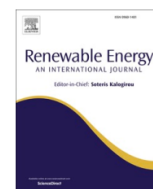




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# Optimal siting of large photovoltaic solar farms at Basrah governorate, Southern Iraq using hybrid GIS- based Entropy-TOPSIS and AHP-TOPSIS models

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## ABSTRACT

This study employed the entropy weight method (EWM) and analytical hierarchy process (AHP) with the technique for an order of preference by similarity to ideal solutions (TOPSIS) to identify optimal locations for photovoltaic (PV) solar farms using geographic information systems. Ten siting factors were considered, with solar radiation ( $PV_{out}$ ) being the most critical. Other key factors included land use/land cover (LULC), elevation, slope, aspect, and proximity to infrastructure and water sources. EWM assigned higher weights to  $PV_{out}$ , elevation, slope, and groundwater storage, while AHP prioritized  $PV_{out}$ , LULC, aspect, and slope. Ranked outputs from EWM-TOPSIS and AHP-TOPSIS were interpolated using inverse distance weighted (IDW), ordinary kriging (OK), and empirical Bayesian kriging (EBK), with EBK showing slightly higher accuracy. Using EBK, suitability maps classified areas into five levels: very low to very high. Validation against less suitable LULC categories confirmed EWM-TOPSIS as the optimal siting method, revealing that 38 % (4555 km<sup>2</sup>) of the study area is highly suitable for PV farms. These regions are primarily located in Basrah's southern Al-Fao district and northeastern Shatt Al-Arab district, demonstrating the area's potential for solar energy development.

## 1. Introduction

Basrah Governorate is distinguished as a region rich in fossil fuels, with many giant and large oil and gas fields. This gives the governorate a significant and unique economic role in the life of the Iraqi people and the country's future, potentially becoming the economic capital of the country. It is Iraq's only governorate with access to the Arabian Gulf, through the Shatt al-Arab waterway, making it the country's primary gateway to maritime trade. This strategic location has historically made Basrah a crucial center for commerce and trade, facilitating economic exchanges not only within Iraq but also with neighboring countries and beyond [1]. The governorate's location has also given it geopolitical significance, often placing it at the heart of regional conflicts and strategic negotiations.

The economy of Basrah Governorate is heavily reliant on the oil and

gas industry, which accounts for a significant portion of Iraq's overall oil production [2]. The region's vast oil fields, including Rumaila, West Qurna, and Zubair, are among the largest in the world. The oil sector provides the bulk of employment and revenue, making Basrah a critical contributor to the national economy. But because of this reliance, the area is also more susceptible to changes in the price of oil globally and unstable political environments.

However, the world is facing the challenges of global warming, necessitating a shift toward alternative energy sources in line with official international measures for energy transition. The transition from fossil fuels to renewable energy sources in Basrah Governorate has gained appeal as a practical approach to achieving environmental and economic stability. As a major city, Basrah could significantly benefit from diversifying its energy portfolio towards renewables. First, this shift could play a crucial role in reducing environmental pollution,

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