

Prediksi Radiasi Matahari Menggunakan Metode Weather Research and Forecasting di Wilayah Provinsi Jawa Barat = Prediction of Solar Radiation Using the Weather Research and Forecasting Method in West Java Province

Khansa Mutia Hanauli, author

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Abstrak

Indonesia memiliki potensi energi surya yang besar karena posisinya di sekitar garis khatulistiwa, dengan intensitas radiasi matahari rata-rata mencapai 4,8 kWh/m² per hari. Salah satu wilayah potensial adalah Provinsi Jawa Barat, yang memiliki estimasi kapasitas hingga 9.099 MW. Namun, pemanfaatan energi surya di wilayah ini masih terkendala oleh kondisi atmosfer dan topografi yang kompleks. Untuk menjawab tantangan ini, prediksi radiasi matahari yang akurat diperlukan guna mendukung perencanaan dan optimalisasi sistem energi terbarukan. Penelitian ini bertujuan untuk menganalisis pola spasial dan variasi temporal prediksi radiasi matahari di Provinsi Jawa Barat selama tahun 2023, serta menguji akurasi model Weather Research and Forecasting (WRF) dalam memprediksi radiasi matahari hingga 72 jam ke depan berdasarkan musim dan ketinggian wilayah. Data prediksi dihasilkan dari simulasi model numerik WRF dan dibandingkan dengan data observasi dari BMKG. Secara spasial, dataran rendah menerima radiasi lebih tinggi daripada dataran tinggi, dengan korelasi negatif kuat antara ketinggian dan intensitas radiasi matahari. Hasil uji akurasi menunjukkan bahwa model memberikan akurasi lebih tinggi pada musim kemarau dengan rRMSE 36–85% dan R² 0,44–0,77. Temuan ini menunjukkan bahwa musim, ketinggian, dan lokasi memengaruhi akurasi prediksi radiasi matahari menggunakan model WRF. Penelitian ini dapat menjadi dasar bagi penelitian lanjutan di wilayah tropis, khususnya di Provinsi Jawa Barat, dalam meningkatkan akurasi pemodelan maupun pemanfaatan energi surya.

.....Indonesia possesses substantial solar energy potential due to its strategic location along the equatorial belt, receiving an average solar irradiance of approximately 4.8 kWh/m² per day. Among the most promising regions is West Java Province, which is estimated to have a potential capacity of up to 9,099 MW. Nevertheless, the deployment of solar energy in this region remains constrained by complex atmospheric dynamics and heterogeneous topographical features. To overcome these challenges, accurate solar radiation forecasting is imperative for the effective planning and optimization of renewable energy systems. This study aims to examine the spatial distribution and temporal variability of solar radiation forecasts across West Java throughout 2023 and to evaluate the predictive performance of the Weather Research and Forecasting (WRF) model for up to 72-hour lead times, with consideration of seasonal cycles and elevational gradients. Forecast outputs were derived from WRF numerical simulations and validated against observational data from the Indonesian Meteorological, Climatological, and Geophysical Agency (BMKG). The spatial analysis reveals that lowland regions consistently receive higher solar irradiance compared to highland areas, exhibiting a strong negative correlation between elevation and solar radiation intensity. Accuracy assessments indicate that the model yields improved performance during the dry season, with relative Root Mean Square Error (rRMSE) ranging from 36% to 85% and coefficient of determination (R²) values between 0.44 and 0.77. These findings underscore the significant influence of seasonal variation, topography, and geographic location on the accuracy of WRF-based solar radiation forecasts. This research

contributes to the advancement of solar energy modeling in tropical environments and provides a scientific foundation for enhancing the precision and applicability of solar energy utilization in West Java and similar regions.