

PREDIKSI KEBAKARAN HUTAN DAN LAHAN DI PROVINSI KALIMANTAN TIMUR BERDASARKAN PARAMETER METEOROLOGIS

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INTISARI

Kalimantan Timur, sebagai lokasi Ibu Kota Negara baru, memiliki tingkat bahayatinggi terhadap kebakaran hutan dan lahan (karhutla) akibat perubahan iklim, degradasi lingkungan, dan aktivitas manusia. Penelitian ini bertujuan mengidentifikasi nilai ambang batas parameter fisik dan meteorologis serta membangun model prediksi kebakaran menggunakan algoritma *Random Forest*. Parameter yang dianalisis meliputi total presipitasi, temperatur permukaan, *dewpoint temperature*, kelembapan relatif, kecepatan angin, *volumetric soil water layer*, dan *Leaf Area Index* (LAI). Data *hotspot* MODIS NASA tahun 2014–2023 digunakan sebagai indikator kebakaran, sedangkan data prediktor berasal dari ERA5 Land.

Nilai ambang batas (*threshold*) ditentukan berdasarkan klasifikasi *Fire Weather Index* (FWI) menjadi tiga tingkatan yaitu *high*, *very high*, dan *extreme*. Hasilnya menunjukkan bahwa total presipitasi memiliki *threshold* 0,71 mm/hari (*high* dan *very high*), turun drastis menjadi 0,002 mm/hari pada *extreme*. Suhu udara ketinggian 2 meter menunjukkan ambang batas 26,62°C (*high* dan *very high*), serta meningkat menjadi 29,29°C (*extreme*). Suhu titik embun memiliki *threshold* 16,32°C (*high* dan *very high*) dan 18,23°C (*extreme*). Kecepatan angin ketinggian 10 meter berada pada 1,47 km/jam (*high* dan *very high*), meningkat menjadi 3,66 km/jam pada *extreme*. Kelembapan relatif memiliki *threshold* 52,5% (*high*), 53,5% (*very high*), dan menurun menjadi 51,5% (*extreme*). *Volumetric soil water layer 1* memiliki nilai ambang 0,25 m³/m³ (*high* dan *very high*) dan 0,12 m³/m³ (*extreme*). LAI menunjukkan *threshold* 4,13 (*high* dan *very high*) dan meningkat menjadi 4,52 (*extreme*).

Model prediksi dikembangkan dalam tiga skenario yakni *baseline*, SMOTE, dan SMOTE dengan *Hyperparameter Tuning*. Skenario terbaik diperoleh dari metode ketiga dengan akurasi sebesar 99,15%. Model ini terbukti efektif dan stabil dalam mendeteksi kejadian kebakaran berdasarkan data aktual, sehingga dinilai paling sesuai untuk diterapkan dalam sistem peringatan dini. Penelitian ini menegaskan pentingnya pemantauan parameter lingkungan secara komprehensif serta menunjukkan potensi penerapan *machine learning* dalam mendukung upaya mitigasi dan pencegahan karhutla di wilayah rawan seperti Kalimantan Timur.

Kata kunci : Kebakaran Hutan dan Lahan, Kalimantan Timur, Ambang Batas, *Fire Weather Index*, *Random Forest*.

PREDICTION OF FOREST AND LAND FIRES IN EAST KALIMANTAN
PROVINCE BASED ON METEOROLOGICAL PARAMETERS

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ABSTRACT

East Kalimantan, as the location of Indonesia's new capital city, has a high level of danger to forest and land fires (karhutla) due to climate change, environmental degradation, and human activities. This study aims to identify threshold values of physical and meteorological parameters and develop a fire prediction model using the Random Forest algorithm. The analyzed parameters include total precipitation, surface temperature, dew point temperature, relative humidity, wind speed, volumetric soil water layer, and Leaf Area Index (LAI). MODIS hotspot data from NASA (2014–2023) was used as an indicator of fire events, while predictor data was obtained from ERA5 Land.

Threshold values were determined based on the Fire Weather Index (FWI) classification into three levels: high, very high, and extreme. The results show that total precipitation has a threshold of 0.71 mm/day (high and very high), decreasing sharply to 0.002 mm/day under the extreme class. Air temperature at 2 meters was 26.62°C (high and very high), increasing to 29.29°C (extreme). Dew point temperature thresholds were 16.32°C (high and very high) and 18.23°C (extreme). Wind speed at 10 meters was 1.47 km/h (high and very high), rising to 3.66 km/h (extreme). Relative humidity was 52.5% (high), 53.5% (very high), and dropped to 51.5% (extreme). Volumetric soil water layer 1 had thresholds of 0.25 m³/m³ (high and very high) and 0.12 m³/m³ (extreme). LAI showed values of 4.13 (high and very high) and increased to 4.52 (extreme).

The prediction model was developed using three scenarios: baseline, SMOTE, and SMOTE with Hyperparameter Tuning. The best performance was achieved in the third scenario with an accuracy of 99.15%. This model proved to be effective and stable in detecting fire events based on actual data, making it highly suitable for early warning systems. This study emphasizes the importance of integrated environmental monitoring and demonstrates the potential of machine learning in supporting mitigation and prevention efforts for forest and land fires in vulnerable regions such as East Kalimantan.

Keyword : Forest and Land Fires, East Kalimantan, Threshold, Fire Weather Index, Random Forest.