PENGEMBANGAN MODEL ESTIMASI KADAR LENGAS TANAH BERBASIS CITRA SATELIT SENTINEL-1 DAN 2 DENGAN PENDEKATAN EMPIRIS DAN *MACHINE LEARNING* UNTUK MENDUKUNG PERTANIAN LAHAN KERING DI KAWASAN KARST: STUDI KASUS KAWASAN KARST KENDENG DAN SEMANU

INTISARI

Oleh:

AFINAFGHANI DUTA PRATAMA

20/460572/TP/12782

Kadar lengas tanah merupakan cerminan kondisi neraca air di lapisan atas permukaan tanah. Kondisi tersebut mampu memberikan informasi yang berhubungan dengan pola penanaman hingga kesehatan tanaman. Kawasan Karst merupakan salah satu jenis lahan yang memerlukan perhatian lebih untuk dibudidayakan karena sifatnya yang tidak mampu menyimpan air permukaan dalam waktu yang lama. Kawasan Karst Kendeng dan Semanu merupakan dua kawasan karst yang memiliki potensi sebagai pertanian lahan kering serta cadangan air bagi masyarakat sekitar. Pengamatan kadar lengas tanah di kedua kawasan karst tersebut tidak dapat dilakukan secara langsung karena kondisi topografi yang variatif. Oleh karena itu, penelitian ini bertujuan untuk mengembangkan model estimasi kadar lengas tanah berbasis teknik penginderaan jauh dengan memanfaatkan citra Sentinel-1 dan 2 serta mengkombinasikannya dengan DEM.

Pengembangan model estimasi didasarkan pada tiga metode, yaitu model empiris kombinasi DuboisTopp, model matematis *Stepwise Multi Linear Regression* (SMLR) serta model *machine learning Artificial Neural Network* (ANN). Sampel kadar lengas tanah diambil di Kawasan Karst Kawasan Karst Kendeng dan Semanu pada 15 dan 23 Oktober 2023 (musim kemarau) dan 14 dan 26 Maret serta 7 dan 23 April 2022 (musim hujan) yang didasarkan pada level kelerengan dan penutupan lahan. Akurasi model diuji dengan koefisen determinasi (R^2 dan *Adj* R^2), korelasi *pearson coefficient* (r), serta uji *error Mean Square Error* (MSE) dan *Nash Sutcliffe Efficiency* (NSE).

Hasil menunjukkan model *training* ANN mampu memberikan uji akurasi kuat (r = 0,689; R^2 = 0,467; *Adjusted* R^2 = 0,475; MSE = 0,183, dan NSE = -60,26) menjadikannya sebagai model terbaik yang dikembangkan. Selain itu, ketiga model telah mampu melakukan visualisasi sebaran spasial dengan SMLR sebagai model yang mampu menunjukkan heterogenitas sebaran kadar lengas tanah berdasarkan variabel elevasi.

Kata kunci: kadar lengas tanah, kawasan karst, *machine learning*, model estimasi, penginderaan jauh

DEVELOPMENT OF SOIL MOISTURE CONTENT ESTIMATION MODEL BASED ON SENTINEL-1 AND 2 SATELLITE IMAGERY WITH EMPIRICAL AND MACHINE LEARNING APPROACHES TO SUPPORT DRYLAND AGRICULTURE IN KARST AREAS: CASE STUDY OF KENDENG AND SEMANU KARST AREAS

ABSTRACT

By:

AFINAFGHANI DUTA PARATAMA

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Soil moisture content is a reflection of the water balance conditions in the upper layers of the soil surface. This condition can provide information related to cropping patterns and plant health. Karst area is one type of land that requires more attention for cultivation because it is not able to store surface water for a long period of time. Kendeng and Semanu Karst Areas are two karst areas that have potential as dryland agricultural land and water reserves for the surrounding community. Observation of soil moisture content in both karst areas cannot be done directly due to varying topographic conditions. Therefore, this research aimed to develop a model for estimating soil moisture content based on remote sensing techniques by utilizing Sentinel-1 and 2 imagery and combining them with DEM.

The development of the estimation model is based on three methods, the DuboisTopp combination empirical model, the Stepwise Multi Linear Regression (SMLR) mathematical model and the Artificial Neural Network (ANN) machine learning model. Soil moisture samples were taken in Kendeng and Semanu Karst Areas on October 15 and 23, 2023 (dry season) and March 14 and 26 and April 7 and 23, 2022 (wet season) based on slope and land cover levels. Model accuracy was tested with coefficient of determination (R^2 and Adj R^2), Pearson correlation coefficient (r), and Mean Square Error (MSE) and Nash Sutcliffe Efficiency (NSE) error tests.

The results showed that the ANN model was able to provide a very strong accuracy test (r = 0,689; R^2 = 0,467; *Adjusted* R^2 = 0,475; MSE = 0,183, dan NSE = -60,26) it the best model developed. In addition, the three models have been able

to visualize the spatial distribution with SMLR as the model that is able to show the heterogeneity of soil moisture distribution based on elevation variables.

Keywords: *soil moisture content, karst area, machine learning, estimation model, remote sensing*