Development of Estimation Method of Canopy Water Content of Rice Plant Using Hyperspectral Data

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ABSTRACT

Biomass is one of the key variables of concern in the study of plants, either cultivated or plants non-cultivated crops. The term biomass refers to fresh weight or dry weight of plants. Canopy water content of leaf (CWC) is the difference between fresh weight and dry weight become the attention of many applications. Rice is the most important cultivated plants in human civilization, rice is the staple food for 90% of Indonesia's population. Therefore, the fulfillment of rice production is an important issue for the Indonesian nation. One of the important things in rice production is monitoring the water condition of the paddy. Lack of water on paddy plant will affect the growth and decline in rice production. Remote sensing technology has an opportunity for monitoring the paddy water status in quickly and cover wide areas.

Paddy leaf canopy reflectance measurements with a field spectrometer are done at some point in upland rice in Indramayu, West Java Province. The field spectrometer is using a wavelength range from 350-2500 nm and with a spectral resolution of 1 nm. The measurement was performed at a distance of 10 cm (FS10) and 50 cm (FS50) of paddy leaf canopy surface. The sample points are selected such that represent different stages of rice growth such as vegetative, reproductive and ripening stage. At the same time an airborne survey which is using a Hyperpsectral Mapper (HyMap) sensor is done at the same areas. The HyMap sensor has specification of 128 channels, 10-20 nm spectral resolution, wavelength range 350-2500 nm, and spatial resolution of 4.5 meters. Clumps of paddy that has been measured withdrawn separated into the leaf, stem and grains and then weighed. Furthermore, the sample of leaf, stem and grains are dried in the laboratory until the temperature of 60 °C and to be weighed. The difference in fresh weight and dry weights were considered as canopy water content (CWC). Linear regression analysis was conducted to find the relationship between the CWC and spectral indices such as water index / WI = R_{0.900}/R_{0.970} (Peñuelas,
1993) and normalized difference water index / NDWI = (R_{0.860}-R_{1.240})/(R_{0.860}+ R_{1.240}) (Gao, 1996). Furthermore, linear regression analysis are done to obtain the optimal combination of channels for the prediction of CWC and spectral indices such as ratio of spectral indices (RSI=R_2/R_1), normalized difference spectral indices (NDSI=(R_2-R_1)/(R_2+R_1)), renormalized difference spectral indices (RDSI=(R_2-R_1)/\sqrt{R_2+R_1}) , soil adjusted spectral indices (SASI=(R_2-R_1)*1.5/(R_1+R_2+0.5)). Multi-linear regression analysis (MLR) between the CWC with the leaf canopy reflectance was also conducted to find the optimal combination of channels to predict CWC. Furthermore, the regression model obtained and applied to the HyMap data.

The analysis showed that the best method for detection of CWC is the spectral index method with the optimal band combination of \( R_1 = 1152.5 \) nm and \( R_2 = 1079.3 \) nm. The results of correlation coefficient \( r^2 \) for RSI = 0.78, SASI = 0.76, NDSI = 0.74, RDSI = 0.73, NDWI = 0.67, and WI = 0.65.

**Key words:** Soil Moisture Content, Hyperspectral, Remote Sensing, Multi Linear Regression, Spectal Indices, WI, NDWI, RSI, NDSI, RDSI, SASI, Paddy, Indramayu, West Java.