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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation

Developing irrigation management system in the dry season for rice cultivation by utilizing remote sensing data
(リモートセンシング・データを利用した乾季の水田における灌漑管理に関する研究)

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Global climate change has impacts on rainfall patterns in some countries, including Indonesia. The change causes the shifting at the onset of the dry and rainy seasons. However, the shifting will affect water availability and rice production. Rice production in the dry season generally decreases due to insufficient water availability, inappropriate planting schedule, and changes in cropping patterns. Therefore, the objectives of this study were: (1) to determine the dry season's onset, end and duration, and predicted ones for the near future; (2) to develop a monitoring system for rice production in the dry season by utilizing Landsat 8 Operational Land Imager (OLI), with the impact of the dry season parameters on rice production; and (3) to develop a monitoring system for the response of rice plant canopy to soil water and meteorological conditions using the aerial photograph.

This study proposed a new approach for determining the present dry season parameters (i.e., the onset, the end, and the duration) by using annual cumulative rainfall for the past 35 years (1985 – 2019) in Agam District (West Sumatra, Indonesia). In addition, the Autoregressive Integrated Moving Average (ARIMA) model predicted future dry season parameters. After detecting the dry season parameters, this study examined the impact of the dry season on rice production using the Normalized Difference Vegetation Index (NDVI) of Landsat 8 OLI. Furthermore, this study discussed the response of rice plant canopy to soil water (before and after the irrigation process) and meteorological conditions.

This study showed that the dry season period in Agam District started on April 28 and ended on September 17, with a duration of 142 days. The ARIMA model successfully predicted the dry season with good performance for the onset (Nash-Sutcliffe efficiency (NSE); NSE = 0.747) and very good performance for the

end of the dry season (NSE = 0.769). The predicted dry season period in the next 5 years (2020 – 2025) would start between April 29 and May 5, and end between September 19 and October 4.

Rice cultivation area in the dry season in Ampek Angkek sub-district was successfully detected using NDVI of Landsat 8 OLI Level 2 with a good correlation with NDVI from the unmanned aerial vehicle (UAV) (r = 0.826). This study successfully predicted rice production in the dry season by a linear function of NDVI of Landsat 8 Level 2 with a significant correlation (r = 0.815). The total rainfall during the dry season showed a high correlation with rice production (r = 0.981). In addition, this study could explain that the amount of rainfall and the dry season parameters had an impact on the predicted rice production in this sub-district.

Irrigation water influenced the canopy temperature and plant conditions in the rice field, which were clearly detected by the camera of UAVs. NDVI values from UAV camera correlated successfully with the Soil Plant Analysis Development (SPAD) value at the same point (r = 0.982). In addition, thermal imagery by UAV successfully correlated with the hand-held temperature measurement at the same point (r = 0.914). Monitoring NDVI during the heading and flowering stages could represent the rice field's yield across the rice field.

This study suggested that water users' association and relevant departments of local government should prepare some countermeasures in irrigation management that can anticipate the water shortages problems during the dry season, as follows: (i) to reassess the distribution of agricultural water and the schedule for water use, (ii) to postpone the transplanting time to the first week of July in future dry seasons, (iii) to prepare additional irrigation water from a river, a small reservoir and artificial wells, (iv) to minimize water loss from the irrigation system, and (v) to strive for the application of water harvesting in the dry season. The new approach presented in this study would be applicable for predicting the dry season parameters for irrigation management in a region with dry and rainy seasons.