Using Satellite-derived Parameters to assess the adoption of

ALTERNATE WETTING-DRYING (AWD) Practice:

A Case Study of Thailand's Rice Fields

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INTRODUCTION

The Alternate Wetting and Drying (AWD) method holds great promise for rice cultivation in Thailand. By alternating between periods of flooding and drying, this method offers a sustainable way to improve water efficiency, increase yields, and reduce greenhouse gas emissions (Bouman et al., 2007). There has recently been an increase in interest in carbon trading in rice cultivation in Thailand through the practice of AWD. However, implementing IoT devices to monitor AWD in all of Thailand's paddy fields may not be feasible. What Thailand needs is a cost-effective and efficient approach to monitor the implementation of AWD.

To address this challenge, the study explored the relationship between satellite-derived parameters and the status of paddy fields during the cultivation process. This approach allows for near real-time monitoring of the AWD method, using parameters such as the Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), Normalized Difference Moisture Index (NDMI), and the spectral bands of Sentinel-2 images.

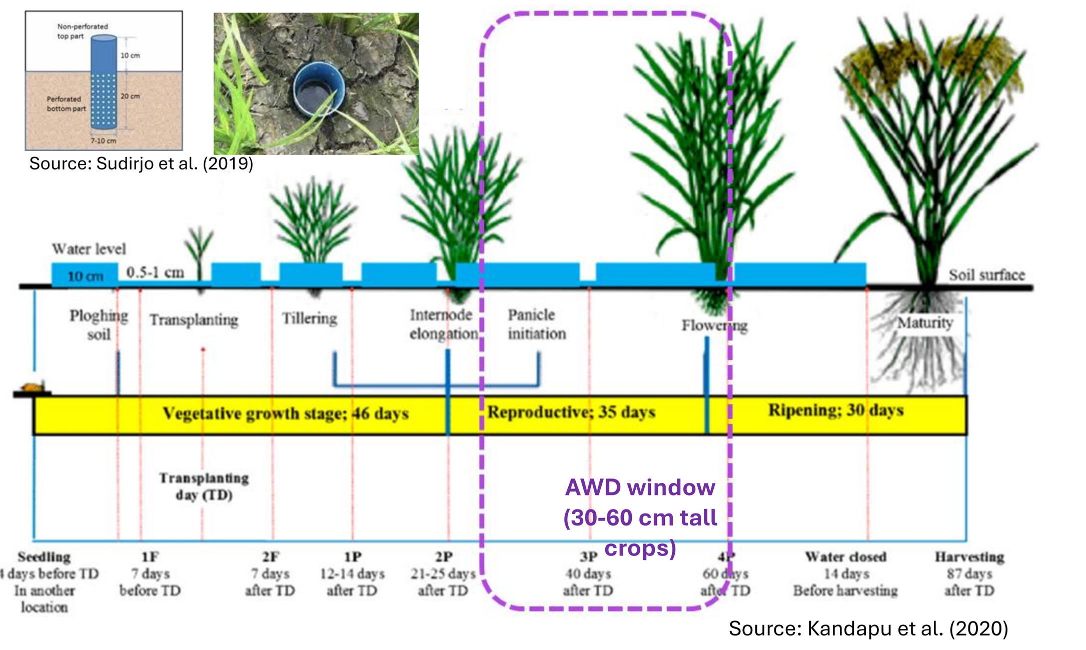

Figure 1. The window of practicing AWD method in paddy fields.
Note: AWD can be started a few days after transplanting (or with a 10 cm tall crop in direct seeding).

DATA & METHODS

The study focused on examining the early growth phase of 222 paddy fields in Ayutthaya province, Thailand, from day 1 to day 60. Among these fields, 7 implemented the AWD method while the remaining 215 used the conventional approach. For the AWD fields, a ground survey was conducted, as displayed in Figure 2. Meanwhile, the non-AWD fields were monitored biweekly using GISTDA's economic crops monitoring system, which relied on the analysis of Sentinel-2, THEOS, and Landsat 9 satellite imagery. Moreover, Sentinel-2 Surface Reflectance images via Google Earth Engine were used to extract NDMI, NDVI, NDWI, and spectral band values of the study plots.

Figure 2. Status of the observed AWD paddy field on different dates of growth.

Figure 4. (a) The mean and median of NDVI and NDMI of 215 non-AWD fields. (b) The NDVI, NDWI, and NDMI of observed AWD plots, including (b1) Maharaj, (b2) Bang Pra Han, and (b3) Bang Sai 12.

RESULTS & DISCUSSION

A study was conducted in Ayutthaya province, located in central Thailand, which discovered that certain satellite-derived parameters can differentiate between paddy fields that use AWD and those that do not. The study found that parameters such as NDMI and Band 9, which measure water evaporation, had lower values over AWD paddy fields than non-AWD fields. This trend was especially prominent between day 25 and day 60, as illustrated in Figures 3a and b. Additionally, these parameters, particularly NDMI, exhibited fluctuations in AWD fields due to the drying and re-flooding processes, as shown in Figure 4b. These fluctuations were not present in non-AWD fields, as depicted in Figure 4a. Consequently, the fluctuation patterns in NDMI and NDWI have the potential to recognize and differentiate between AWD and non-AWD paddy fields.

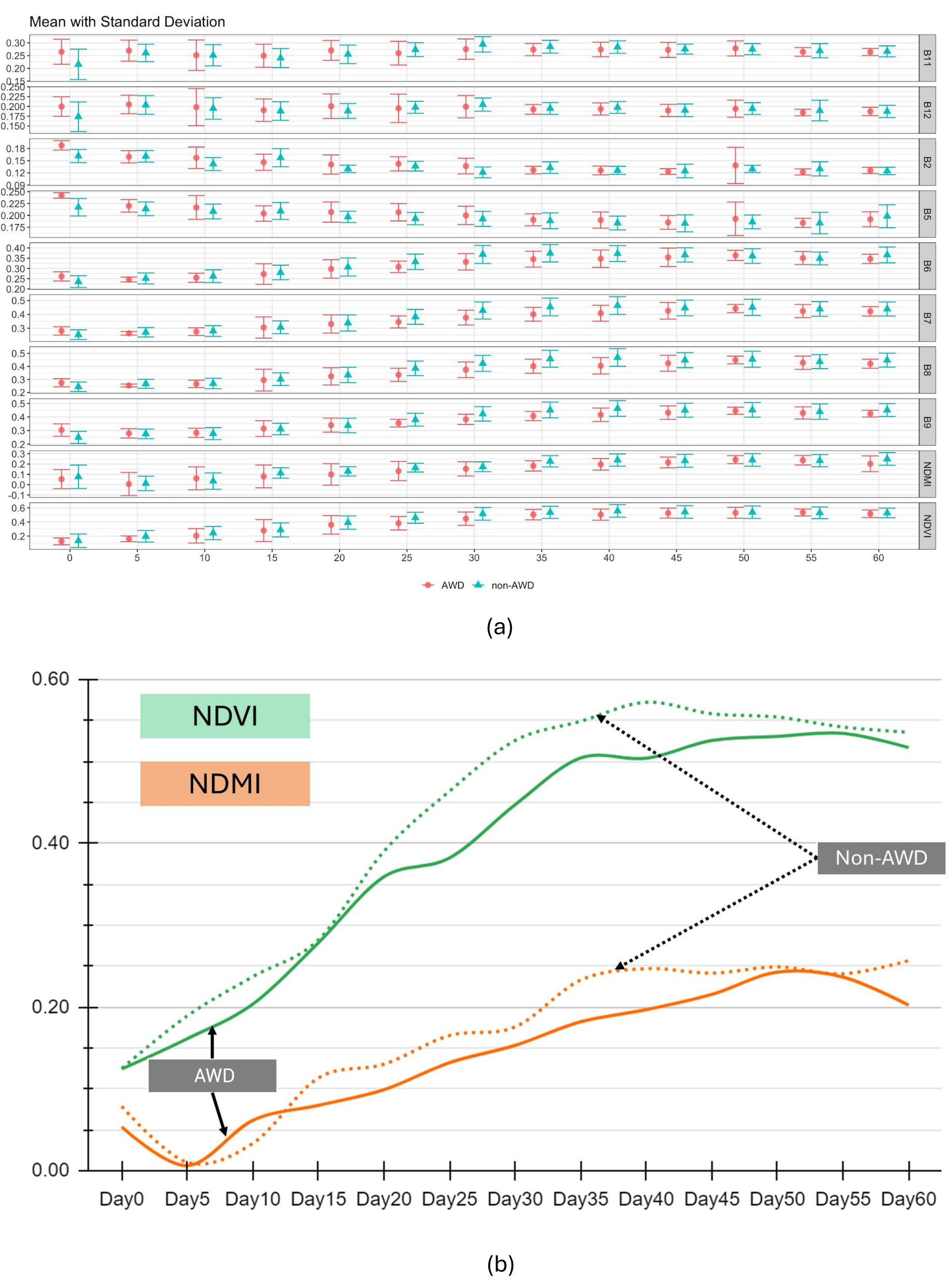

Figure 3. (a) The mean and standard deviation (SD) of Sentinel-2 spectral bands of study plots. (b) The comparison of mean NDVI and mean NDMI of AWD paddy fields and non-AWD paddy fields.

CONCLUSION

According to the results, monitoring the AWD method in paddy fields can be achieved through satellite-derived parameters. However, challenges may arise during the rainy season due to cloud cover. Future research will focus on assessing the feasibility of using radar satellites and exploring the relationship between satellite data and flux towers. Such an approach could increase transparency in carbon credit trading, provide a cost-effective monitoring method, and financially benefit farmers. This could lead to wider adoption of the AWD method and a significant reduction in greenhouse gas emissions in the future.

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