Drought monitoring in watershed containing terraced paddy fields
棚田が多く含まれている流域における干ばつのモニタリング

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1. Introduction

Intensifying extreme El-Nino events in the past few decades pose a threat for agricultural activities that depends heavily on the nature in the affected area. The warmer atmosphere the more concern raised for the disruption that can be caused by El-Nino not only on the downstream area that literally far from water resources but also on the upstream area like mountainous watershed where water resources mostly generated. In Asian region where the main staple food is rice, terraced paddy fields can be found easily in the mountainous region. Local people mainly depend their economic activities on the rice production therefore the sustainability of terraced paddy need to be maintained to sustain economy of the locals as well as its ecosystem services.

Since the complexity of mountainous terrain and distinguished water management of terraced paddy, the influence of extreme El-Nino can be different from that of the plain or lowland terrain. To understand the influence of climate variability to mountainous watershed containing terraced paddy, an analysis of drought distribution on the watershed was conducted using remote sensing data.

2 Study area and methods

Keduang watershed was located in Wonogiri Regency, Central Java, Indonesia with the range altitude of 400 – 600 m ASL. Terraced paddy occupy around 30% of the total land use in this watershed and the cropping schedule for rice almost uniform in the watershed.

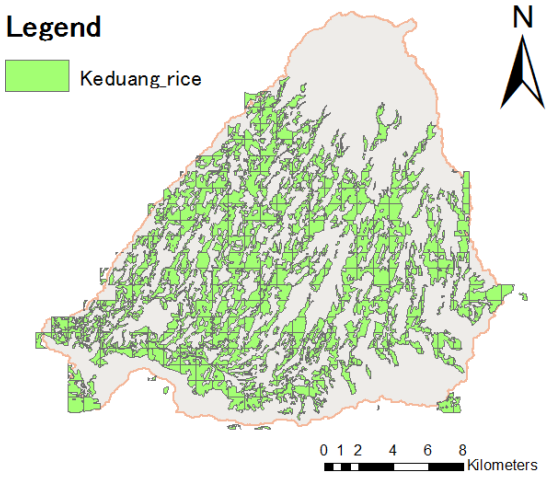

Fig.1 Terraced paddy distribution in Keduang watershed

Drought monitoring was conducted using remote sensing data obtained by using MODIStsp in R model package developed by Busetto and Rangheti (2016). Remote sensing data used including: 1) 16 days composite Normalized difference vegetation index (NDVI) (MOD13A2); 2) while 8 days composite land surface temperature (LST) (MOD11A1) and 3) 8-days composite ET (MOD16A2) with 1 km resolution. There are many indices that was studied to monitor drought using remote sensing data. In this study there were two drought indices that was used, they are TVDI (Temperature vegetation dryness

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index) and CWSI (Crop water stress index). These two indices were used previously to study drought occurrence in Guangzhou plain, China. TVDI is calculated using NDVI-LST triangle with equation as follows:

$$\text{TVDI} = \frac{LST - LST_{min}}{a + bNDVI - LST_{min}}$$

Where a and b are the intercept and slope of the dry edge (the upper straight line in the triangle) calculated from the NDVI-LST space regression with small intervals of NDVI (LSTmax=a+bNDVI), LSTmax is the maximum surface temperature observation for a given NDVI value. The lower horizontal line of the triangle represents the wet edge (LSTmin), which was calculated by averaging a group of points in the lower limits of the scatterplots.

While CWSI was calculated using evapotranspiration data that was derived from MODIS with equation as follows

$$\text{CWSI} = 1 - \frac{ET}{PET}$$

3. Ongoing Result and discussion

Initial study was conducted to monitor climate variability on the influence of land surface temperature. Since ENSO is closely related to precipitation and air temperature, rise of the temperature and decrease of the rainfall would very likely raise land surface temperature while La-Nina affect otherwise. From Fig.2 there was distinct difference in the normal year (2012-2014), La-Nina (2011 and 2016), and El-Nino (2015) year. In El-Nino year it showed clearly that land temperature higher than normal year especially in dry season where rain was rarely fell while in La-Nina the land surface temperature is colder than normal year but the pattern in each year was different. This could be influenced by the precipitation pattern on those year because in 2016 it showed colder temperature in dry season but in 2011 it was warmer in rainy season. The land surface temperature is only one of the many components influencing drought therefore to study further analysis using drought indices is being conducted. The outcome is expected to show the ENSO influence on watershed containing terraced paddy. Since the water management in terraced paddy quite different with the general agriculture, it has the possibility of having more resilience during drought period.

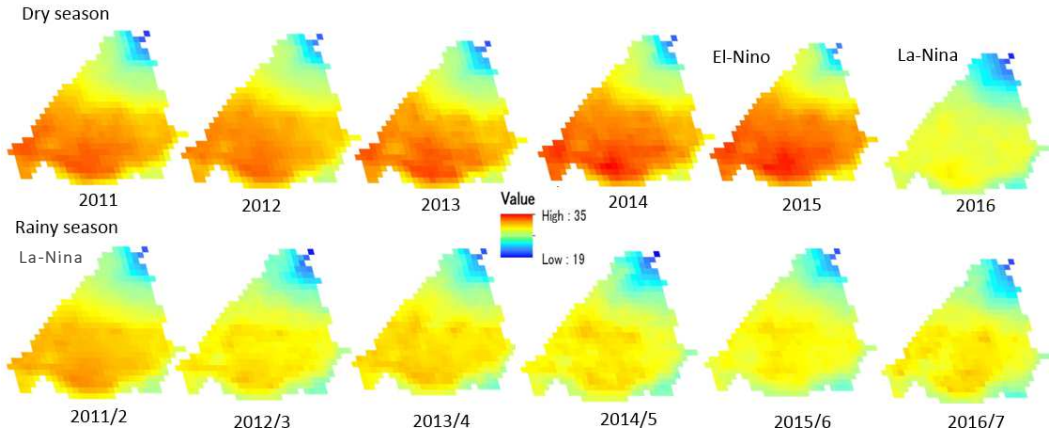

Fig. 2 Land surface change during dry and rainy period in 2011-2017