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Drought detection of West Java's paddy field using MODIS EVI satellite images (case study : Rancaekek and Rancaekek Wetan)

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Abstract

Nowadays, drought phenomenon occurred in several area in Indonesia. The length of the dry season, especially in the southern equatorial allegedly caused by El Nino phenomenon. This causes crop failures in many center area of agriculture. West Java Province as one of the centers of agricultural activities in Indonesia experienced a severe drought within a period of 6 months (April-September in 2003). The monitoring of drought is useful to understanding the characterization of drought itself. In the next period, we can decide what should we do to decreased the impact of this phenomenon. The study aimed to implement Breaks for Additive Seasonal and Trend (BFAST) algorithm for detecting and monitoring paddy field areas experiencing drought in The West Java during the period 2000-2015. This study used remote sensing data to study the response of vegetation on the drought phenomenon. MODIS EVI time series were decomposed into seasonal, trend, and remainder component using BFAST which enables the detection of trend changes within the time series. The result of study shows that BFAST able to detect drought in MODIS EVI time series. The result also compared to a new drought index, called SPEI.

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Keywords: BFAST; drought; dry season; MODIS EVI; paddy field; West Java.

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1. Introduction

The agricultural sector is one of the leading sectors that can fulfill our primary needs every day. Especially rice for Indonesian people. Rice produced from paddy where the paddy can be cultivating in paddy field area. According to Data and Information Center, Ministry of Agriculture 2010, West Java Province consist of paddy field area with a number are 925,565 hectare divided into 673,991 hectare of irrigated paddy field area and 251,574 hectare of non-irrigated paddy field area. The paddy field area and its productivity year to year has decreased caused by several factors. One of the factors that affect to agricultural sector productivity is drought phenomenon.

Drought phenomenon is the impact of global climate change, El Nino, and La Nina. In Agricultural sector, the main factor of agricultural production sustainability is managing climatic variability. Because it's critical condition, drought must be seriously managed in order to make stable production. The main cause of climatic variability is the El Nino Southern Oscillation (ENSO). During El Nino, some regions encounter lack of precipitation and vice versa during La Nina. Both El Nino and La Nina are natural phenomena. It is a normal condition and periodically occurred in a certain pattern [1].

Based on above explanation, the drought's phenomenon must be anticipated in order not to affect agricultural production sustainability. One way to anticipate this problem is monitoring drought at regional to global scales. This task is not easy because the characteristics of drought in each region is not the same and has different consequences [2]. Remote sensing is one of the most appropriate methods to do observations on the wide area and provide consistent data and frequency of data which are relatively quick and appropriate to capture the result of many processes that caused disturbances [3]. It is a powerful tool to produce land-use and land cover maps to identify the real-time process of change, and their locations, either in global or regional scale [4].

Remotely sensed data obtained from satellite sensor such as MODIS. MODIS satellite imagery provides data in moderate resolution. MODIS product that was used is Enhanced Vegetation Index (EVI) datasets to see the response of vegetation on drought phenomenon. It this study, we selected MOD13Q1 with 250 m spatial resolution and 16-days temporal resolution. MOD13Q1 can provide near-real-time data over large areas in relatively high resolution, has been widely used for vegetation condition monitoring, and also provide the seasonal dynamic for the paddy field patterns [5]. The algorithm that was used to detect drought in this research is Break For Additive Season and Trend (BFAST). BFAST can estimate the change in time series data and decomposed it into three components (seasonal, trend, and remainder components). The result of BFAST change detection furthermore will be adjusted to drought index known as The Standardized Precipitation-Evapotranspiration Index (SPEI). The SPEI fulfills the requirements of a drought index since its multi-scalar character can be used by different scientific disciplines to detect, monitor and analyze droughts.

2. Methods

2.1. Study area

The study focused in West Java Province that geographically located in latitude 5°50'- 7°50'S and longitude 104°48' - 108°48' E and the detailed of location that suffering drought at two locations: Rancaekek and Rancaekek Wetan, Bandung District. West Java Province has a good potential in agriculture, almost all area has a same potential agriculture. The main agricultural products in this area is paddy. Paddy field area in Bandung District was measured 88,667 hectare in 2013 [14]. Bandung District has high rainfall intensity [6] between 2000-4000 mm/year.