Correlation El Nino and La Nina with season variability in South Kalimantan, Indonesia

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Correlation El Nino and La Nina with season variability in South Kalimantan, Indonesia

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Key words: El Nino, La Nina, Dry season, Rainy season.

Abstract

Seasonal variability arising from Pacific ocean surface temperature anomalies known as El Niño and La Niña phenomena. El Nino and La Nina have an impact on the agriculture, forestry, health and transport sectors in the Indonesian province of South Kalimantan. The mapping of season variability associated with El Niño and La Niña was based on rainfall data from 1997-2016 using the season index method. In the year of the El Niño incidence the majority of ZOM experienced early onset dry season, longer season duration, rainy season onset retreat and less than normal rainfall. In the year of La Niña the majority of ZOM experienced earlier rainy season onset, longer rainfall duration and normal rainfall.

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Introduction

A Global circulation that greatly affects the variability of seasons in Indonesia is El Nino-Southern Oscillation (ENSO). ENSO is an atmospheric ocean interaction on the equatorial region of the Pacific Ocean (Aldrian, 2008) that causes global climate anomalies (Trenberth & Caron, 2000). ENSO consists of three phenomena namely Normal, El Nino and La Nina. The El Nino phenomenon is an increase of Sea Surface Temperature (SST) from its normal temperature in the Eastern Equatorial Pacific, while La Nina is a SST phenomenon in the Equatorial East Pacific Ocean region decreasing from its normal temperature (Seprianto,et.al, 2016). El Nino and La Nina events can be detected by the South Oscillation Index (SOI). La Nina might occurs when SOI show positive Fig. over a fairly long period (at least three months), while El Nino show negative SOI over a fairly long period (at least three months).

The influence of El Nino and La Nina in Indonesia is raises variations in the amount of rainfall (Tjasyono, 2006). In areas with monsoonal patterns season variability includes the beginning of the incident (onset), the condition is weak (break), ends (withdrawal), and the length of the season (period) of the rainy season and dry season. The geographical factor is one elements that trigger season variability, where season type in the mountainous area is different from coastal areas or lowlands as well the influence of global phenomena on the pattern of seasons the region is also different. (Wirjohamidjojo & Swarinoto, 2010).

One of the impacts of El Nino is drought in most part of Indonesia. For example, in 1997/1998 there was a strong El Nino when Indonesia suffered from a long drought. It affected 517.614 ha agricultural area and caused crop failure in 87.099 ha from 11.13 million ha total planting area. As a result of El Nino 1997, Indonesia imported 7.1 million tons of rice in 1998. El Nino in 2015, also caused the drought resulting in extensive forest fires in Kalimantan and Sumatra. According to data from the Ministry of Environment and Forestry in South Kalimantan the area of forest and land fires in 2015 of 1,714 ha increased 1350 compared to the previous year.

The number of acute respiratory infections on June 29 to October 5, 2015 due to heavy smoke from forest fires in South Kalimantan recorded 29,104 cases. The thick haze also disrupts flight activity at Syamsudin Noor Airport in South Kalimantan. For example, on Sunday, June 9, 2015 13 flights suffered due to limited visibility (<1000m).

La Nina resulted in increased rainfall that could cause flooding in the mainland and caused severe weather and high waves in the ocean (Supriatin & Martono, 2016). The La Nina event in 2010 caused a significant increase in rainfall during the dry season. As in 2010 when La Nina strong severe flooding occurred in several areas of South Kalimantan including Kab. Banjar, Barito Kuala District, Tapin, Hulu Sungai Selatan, Balangan, Tabalong, Hulu Sungai Utara, Kotabaru and Tanah Bumbu. The floods resulted in an area of 15.431 ha of flooded rice field area and harvest failure of 3.591 ha.

The El Nino and La Nina events are unavoidable natural phenomena. The impact of the El Nino and La Nina events is closely related to the rainfall conditions. Rainfall is one of the elements of weather and climate. That is very important because it affects human life activities in various sectors such as agriculture, forestry, health, environment, transportation and others. Based on the above facts it is necessary to study the influence of El Nino and La Nina on the variability of the rainy season and dry season in South Kalimantan region. The results of this study may provide information on season variability when El Nino and La Nina. The information obtained is expected to be expected to be utilized in planning and development in various sectors.

Materials and methods

Study Area

This research area is South Kalimantan Province of Indonesia which located at 114,19°E - 116,33°E and 1.2° S-4,10°S which wide area reach 38.744km². South Kalimantan consists of 12 Season Zones (ZOM) and 1 Non Zone Season (Non ZOM).

Seasonal zone is a grouping of regions in Indonesia based on the average rainfall pattern of the region. Areas with distinct differences between rainy and dry seasons are classified as ZOM areas, whereas areas with no clear distinction between rainy and dry seasons are categorized as non-ZOM areas.

Data and Method

The data used are the normal data of each ZOM season, 10-days accumulated rainfall data of each ZOM and SOI data. Normal season data include the beginning of the dry season (dry season onset), the beginning of the rainy season (rainy season onset) and the amount of rainfall during the rainy and dry seasons. This study uses 20 years of data (1997-2016). Normal season data and 10-days accumulated rainfall data is obtained from the Class I Banjarbaru Climatology Station and SOI data obtained from the Australian Meteorological Agency/Bereau of Meteorology (BOM). 10-days accumulated rainfall data converted into index 1-36 where 1 representing January 1 and 36 is the December 3rd. Rainy season onset determined based on the amount of rainfall 10-days ≥ 50mm and followed by next two 10-days in a row. Dry season onset determined based on the amount of rainfall 10-days ≤ 50mm and followed by next two 10-days in a row. Determination of variability using a comparison between onset, length of season, rainfall characteristic seasonal conditions in the year of the El Nino and La Nina events with the normal year conditions.

Analysis of the relationship between SOI and rainfall in South Kalimantan using correlation method. Correlation analysis to investigate the existence of the relationship of two variables in this case monthly rainfall and SOI obtained by using equation 1. The correlation method used is (Pearson product moment correlation coefficient) in equation:

$$r_{(x,y)} = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}} \quad (1)$$

r = Correlation value

x = SOI

y = Rainfall

n = amount of data (Suprapto, 2009).

From this correlation analysis yields correlation coefficient which shows high degree of relationship of two variables. Level relation magnitude correlation coefficient can be seen in table 1. Data processing using SPSS 22 software and making spatial appearance in the form of map using ArcView 10.3 software with ZOM base map of South Kalimantan region renewal of BMKG at 2010.

Table 1. Guidance of Correlation Coefficient Intrepetation.

Coefficient Interval	Relationship Level
0 - 0.19	Very low
0.2- 0.39	Low
0.4-0.59	Strong enough
0.6-0,79	Strong
0.8-1,0	Very Strong

Results and discussion

Season variability is associated with rainy and dry seasons during the El Niño and La Niña periods based on rainfall anomalies. The determination of the rainy season and the dry season using 50mm limits where each ZOM has its own characteristics so that the beginning of the season, the length of the season and the nature of the season is different. Therefore, the presentation of seasonal variability distribution maps is temporal in comparing the normal conditions of the ZOM region to the conditions at the time of the El Niño and La Niña.

When El Nino, with a negative SOI (-) indicates that air pressure in the Indonesian region is higher than normal; High pressure means a little cloud, low rain and low humidity. On the other hand, when La Nina positive SOI value (+) indicates that air pressure in Indonesia is lower than normal (Prabowo, 2008).

The re-occurrence of El Nino phenomena ranges from 1-5 years. During the period 1997 to 2016 there have been 4 occasions of medium intensity El Nino events (2002, 2003, 2006, 2014/2015) and 3 times El Nino strong intensity (1997/1998, 2009/2010, 2015/2016). El Nino 1997 was the strongest and longest El Nino period of 14 months. El Nino is shortest with a duration of 5 months occurred in 2003. The re-occurrence of the La Nina phenomenon ranges from 1-7 years.

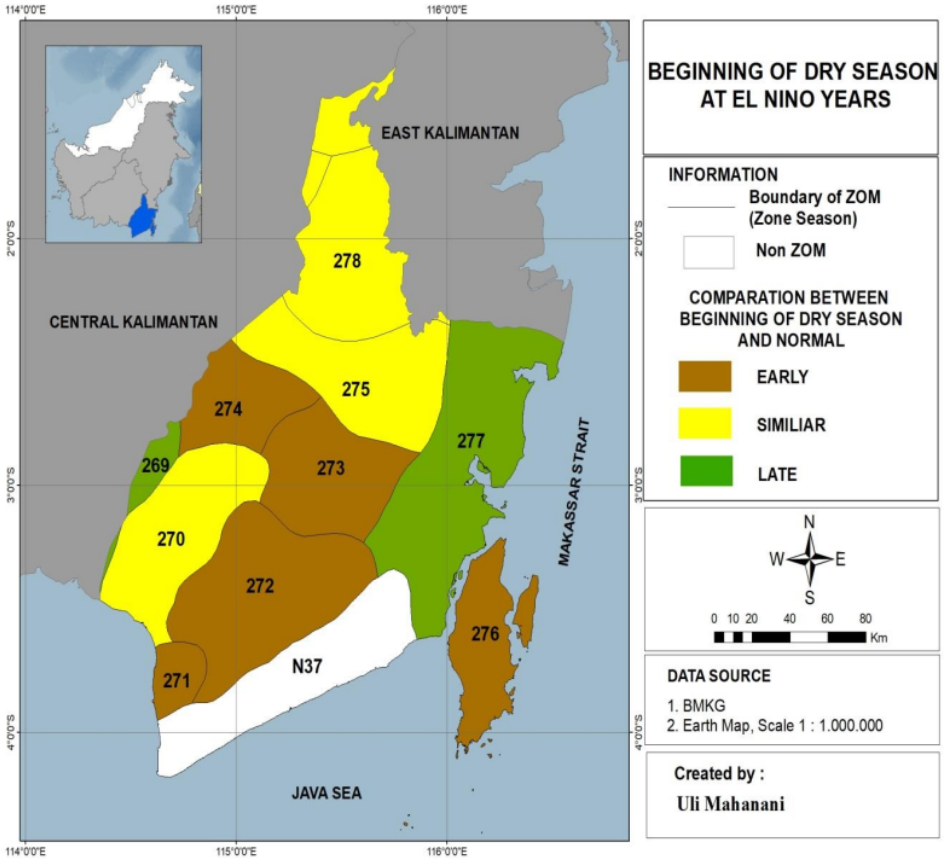
There are 5 times the incidence of medium La Nina sedang (1999/2000, 2000/2001, 2007/2008, 2011/2012, dan 2013) and 3 times strong El Nino. (1988/1999, 2008/2009, dan 2010/2011). In detail the year of El Nino and La Nina is shown in Table 2.

Table 2. Year of El Nino and La Nina phenomena.

El Nino	La Nina
1997 (March 1997 - April 1998)	1998 (June 1998 - April 1999)
2002(May – December)	1999 (October 1999 - April 2000)
2003 (February - June)	2000 (September 2000 - March 2001)
2006 (May - October)	2007 (October 2007 -March 2008)
2009 (October 2009 - March 2010)	2008 (August 2008 - February 2009)
2014 (August 2014 - January 2015)	2010 (July 2010 - April 2011)
2015 (May 2015 - February 2016)	2011(September 2011 - January 2012)
	2013 (May - July)

Based on the results of the seasonal trend maps in Fig.s 1 and 2, prove that the El Nino and La Nina phenomena affect the seasonal pattern in South Kalimantan. In general, El Nino affects dry season onset more advanced than normal (Fig. 1a), longer dry season (Fig. 1b), dry season characteristic less than normal (Fig. 1c), early rainy season onset (Fig. 1d), duration of rainy season longer than normal (Fig. 1e), and rainy season characteristic is above normal (Fig. 1f). The results of rainfall data processing in South Kalimantan, there is a tendency that after the dry season in the El Nino period is usually followed by increased rainfall in the rainy season.

This is evident in the pattern of SMH when El Nino is predominantly above normal. Rainy season characteristic above normal during the El Niño period is not actually a result of El Nino. This is due to the end of the active period of the El Nino period.



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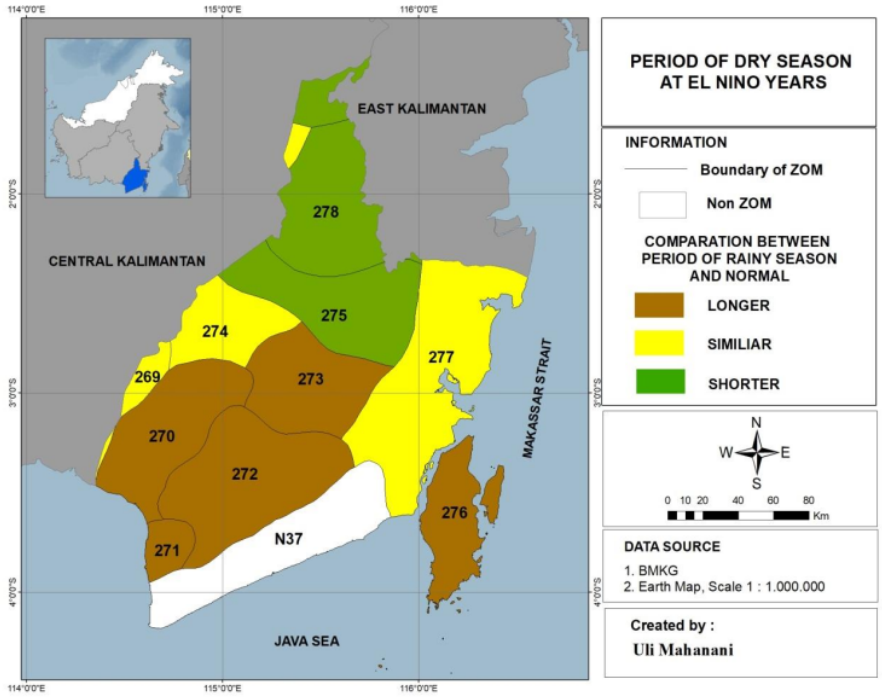
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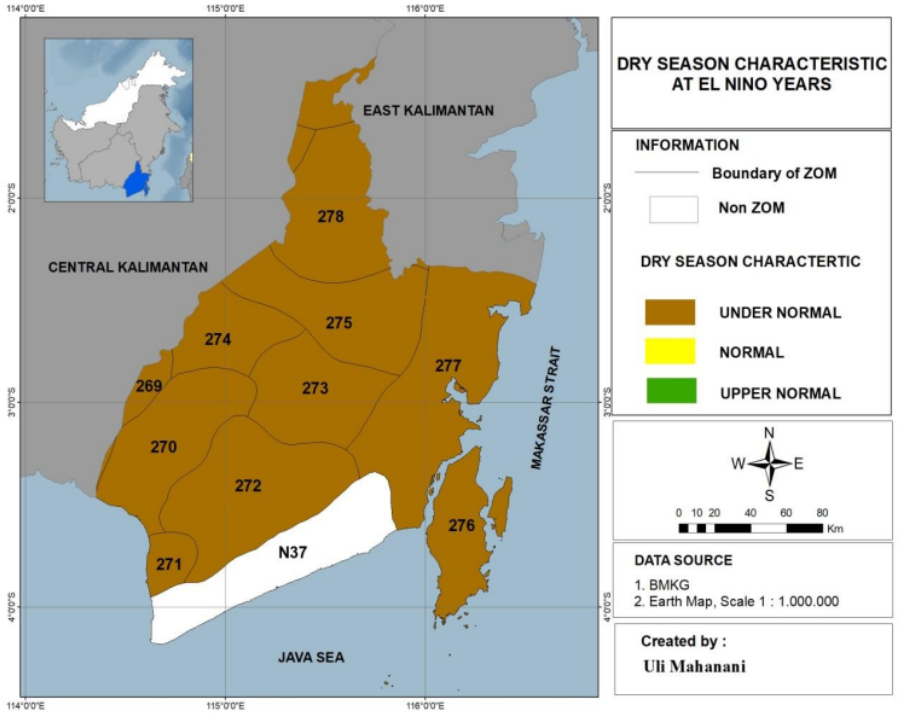
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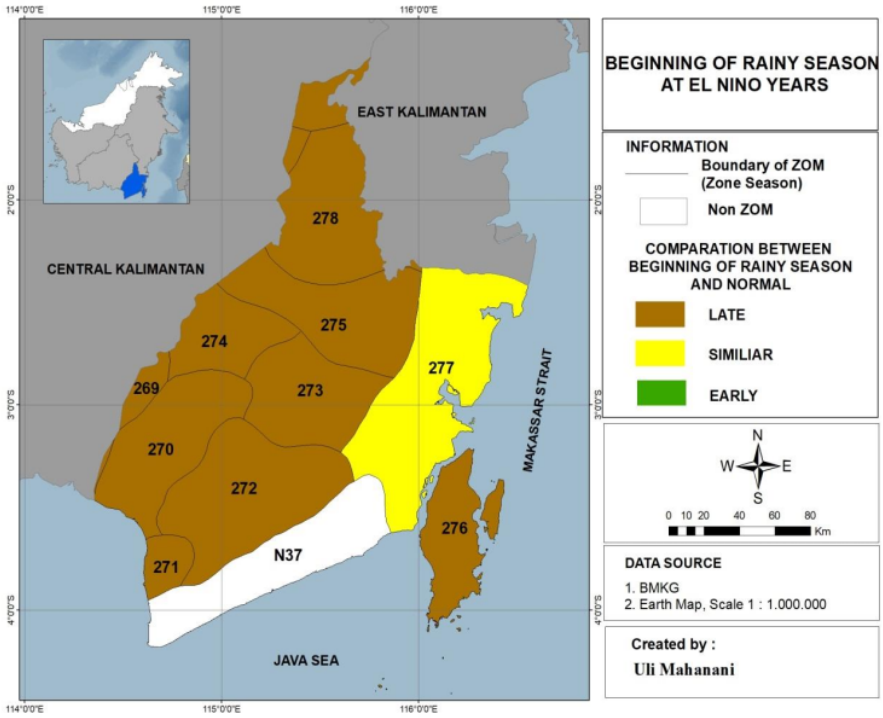
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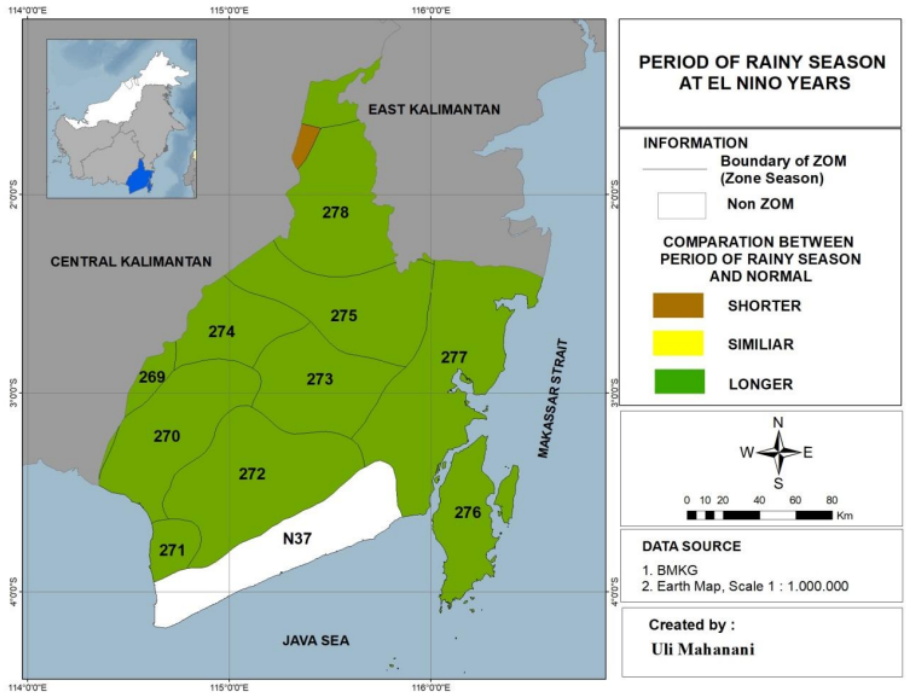
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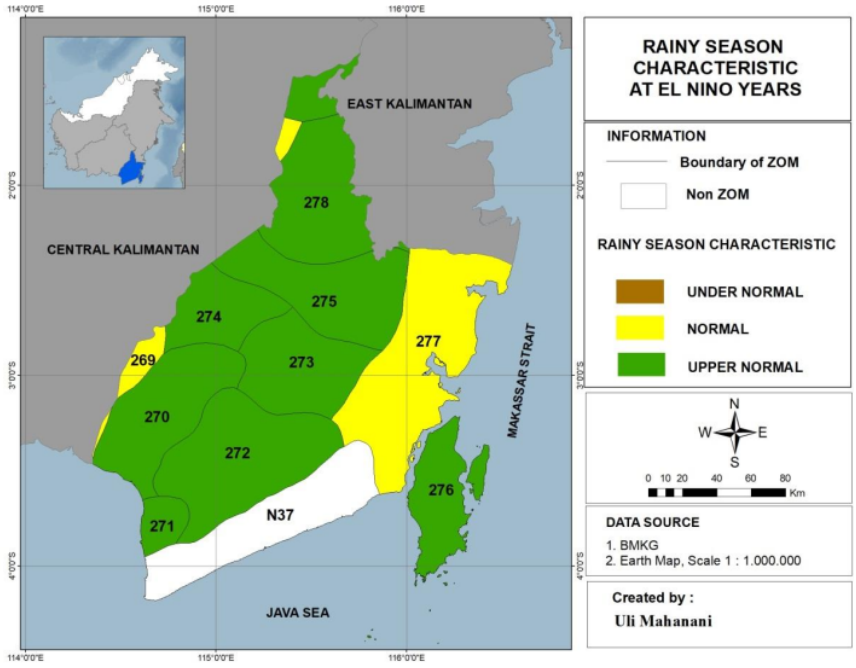


(1f)

Fig. 1. Map of the season variability in El Niño events, (a) dry season onset, (b) dry season duration, (c) dry season characteristic rainfall, (d) rainy season onset, (e) rainy season duration and (f) rainy season characteristic rainfall.

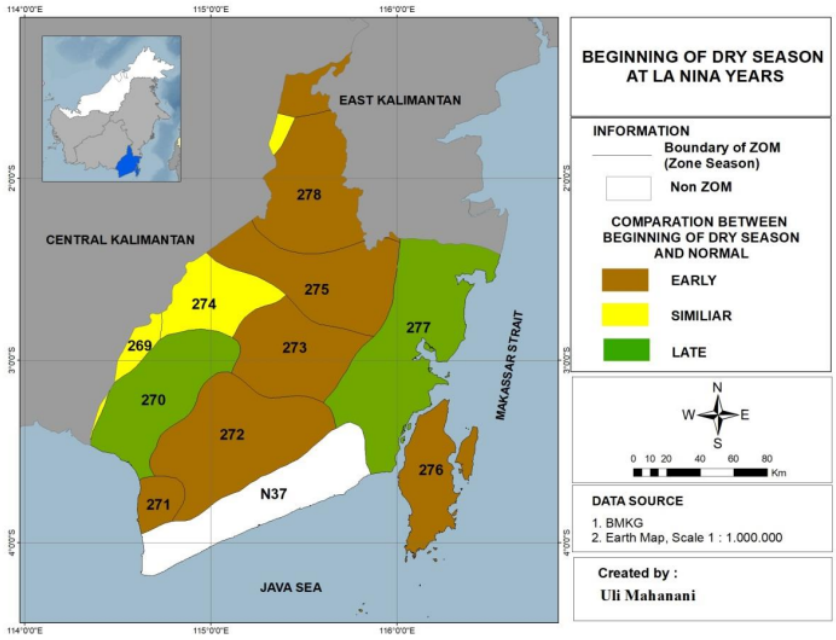
Some cases show that after a strong El Nino event it must be accompanied by a powerful La Nina phenomenon, such as El Nino 1997 accompanied by strong La Nina 1998 and strong El Nino 2009/2010 accompanied La Nina 2010/2011. Theoretically it can be understood. Kadarsah (2007) argues that it happens based on the classic energy balance concept, including steam will always strike a balance after experiencing certain extreme conditions, will turn to other extreme conditions. With the same pattern, most likely the strong El Nino period is always accompanied by the La Nina period. The influence of La Nina on the pattern of seasons in South Kalimantan in Fig. 2. La Nina has an effect on dry season onset more advanced than normal (Fig. 2a), shorter dry season (Fig. 2b), dry season characteristic less than normal (Fig. 2c), early rainy season onset (Fig. 2d), duration of rainy season longer than normal (Fig. 2e), and rainy season characteristic is normal (Fig. 2f).

The trend of climate patterns that have changed from their normal state over the past few years has had many negative impacts on people and the environment. The impact of El Nino in South Kalimantan is the decrease of rainfall in the dry season and longer season length so that it can cause drought. The process of drought begins with a decrease in the amount of rainfall below normal in one season. Low amounts of rainfall will lead to a reduction in groundwater reserves (meteorological drought) that are important in people's lives.

In the long run, conditions in the region will also be disrupted, such as decreasing water levels such as rivers and reservoirs (hydrologic drought), to the depletion of water reserves for crops (agricultural drought) causing crop failures, potentially even fire (WMO 2012). Likewise El Nino, La Nina can also be disastrous. La Nina influenced the pattern of the season in South Kalimantan, the shorter duration of

the dry season and the longer duration of the rainy season than normal. This resulted in abundant rainfall during the La Nina period.

Wetter conditions than usual, there are even ZOM areas that do not experience the dry season can be a disaster in South Kalimantan.



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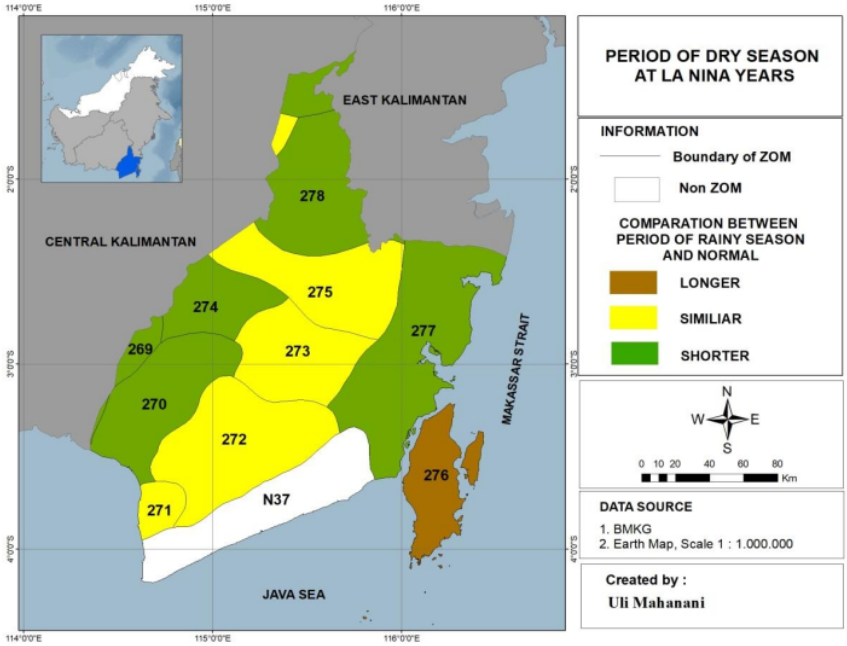

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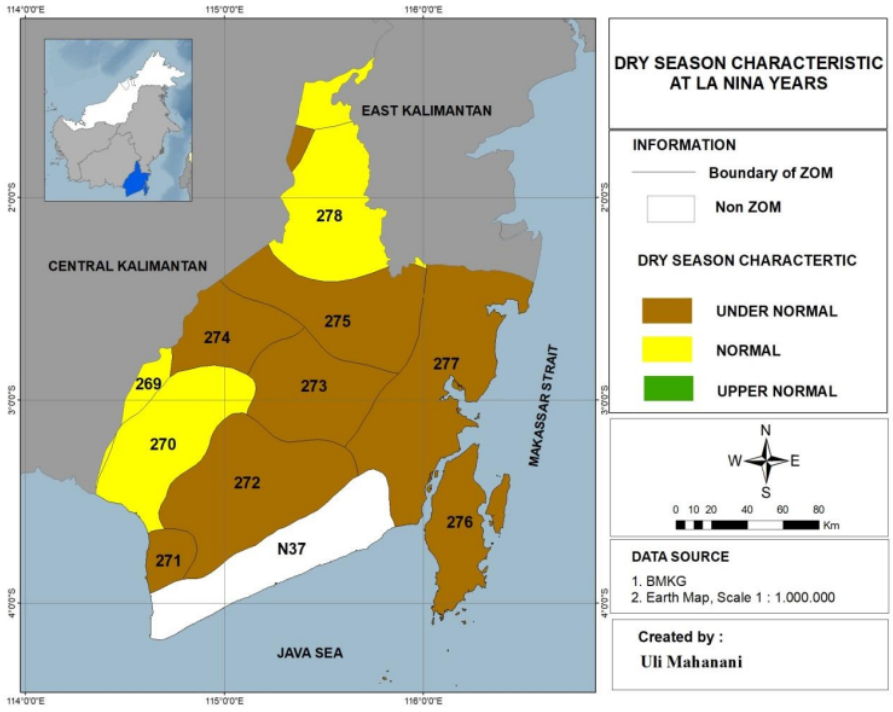
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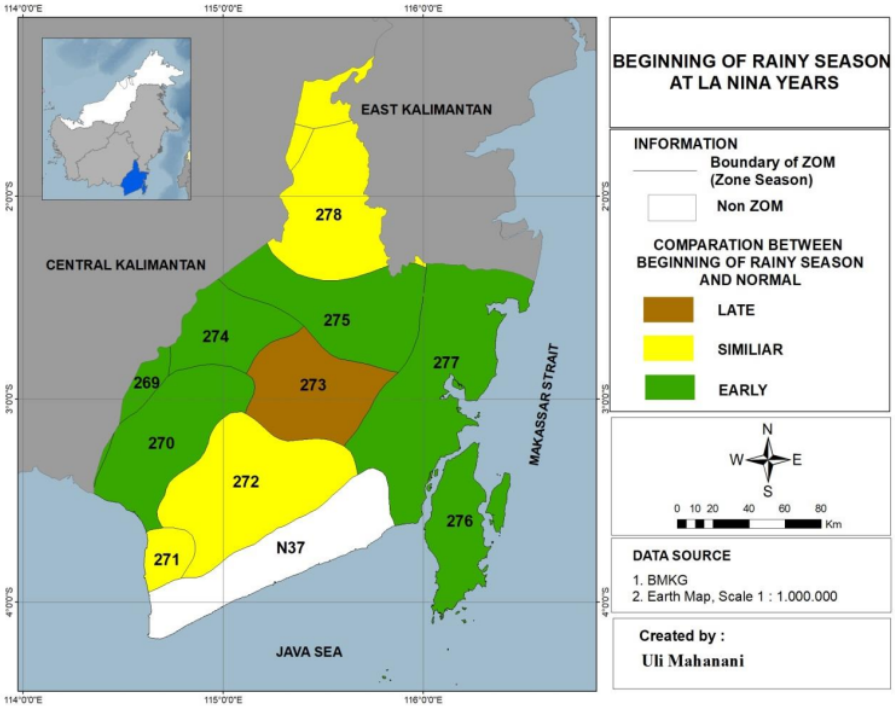
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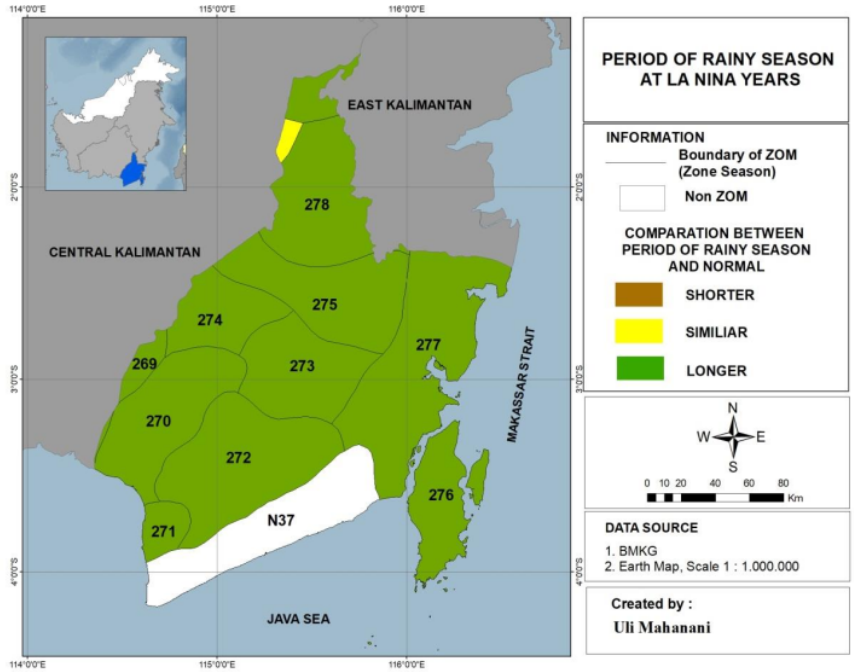

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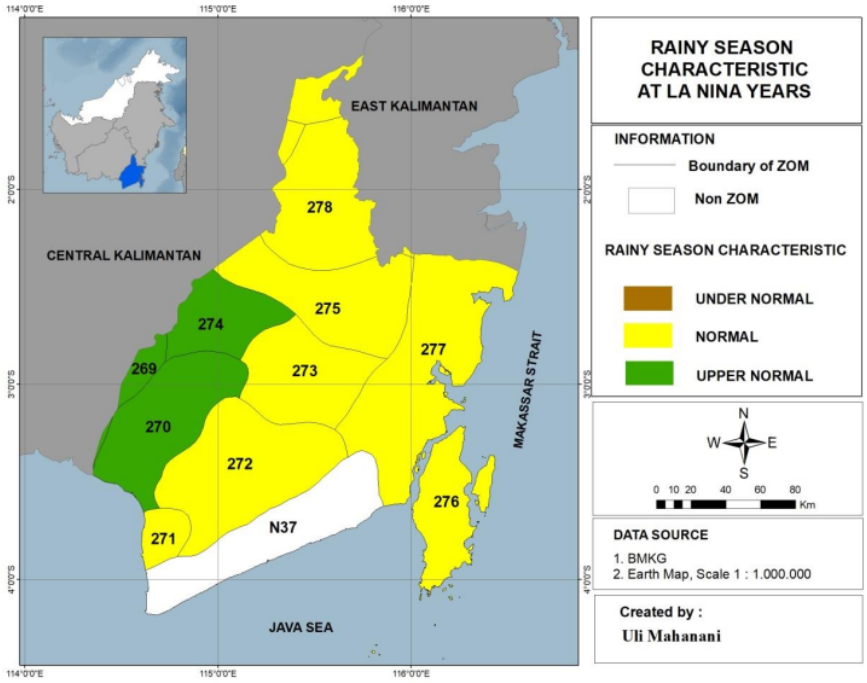

(2f)

Fig. 2. Map of the season variability La Nina events, (a) dry season onset, (b) dry season duration, (c) dry season characteristic rainfall, (d) rainy season onset, (e) rainy season duration and (f) rainy season characteristic rainfall.

SOI and ZOM rainfall relationships in South Kalimantan can be seen in table 3. The correlation coefficient (r) value between SOI and rainfall in South Kalimantan from 1997 to 2016 ranged from 0.319 to 0.530 which means the relationship between the two variables is considered low to strong enough and directly proportional. The positive correlation (+) result shows that if SOI is positive then rainfall value also increases. Based on the value of significance, if the significance value <0.01 then the relationship contained in the correlation coefficient (r) is considered significant. Significance value of data processing obtained <0,01 which means there is significant correlation between SOI and rainfall.

Table 3. Correlation SOI and rainfall.

ZOM	Correlation coefficient
268	0,355
269	0,319
270	0,472
271	0,414
272	0,463
273	0,530
274	0,498
275	0,459
276	0,430
277	0,472
278	0,472

Conclusion

El Nino and La Nina have varied influences on season variability in the South Kalimantan region. In general, El Nino affects the variability of the dry season with the start of the normal season, longer dry season with below normal rainfall whereas the beginning of the rainy season is likely to retreat, with longer wet season and above normal rainfall. La Nina has an effect on season variability in which early dry season progress, with shorter winters and less than normal rainfall. Beginning of the rainy season advancing, the duration of the rainy season is longer than normal and characteristic of normal rainy season.

Acknowledgements

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