International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 38 No. 2 May 2023, pp. 431-440

Rainfall Variability In East Kalimantan From Impact Of El Nino And La Nina To Effort Disaster Prevention To Support National Security

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Abstract – Rainfall has an important influence on human life. One of the global influences that have an impact on rainfall conditions in Indonesia is the El Nino and La Nina phenomena which can result in disasters. Efforts to reduce disaster risk require good disaster management to protect the entire nation from all threats, especially non-military threats in the disaster aspect in East Kalimantan. One effort is to recognize East Kalimantan's rainfall variability in La Nina and El Nino conditions. This study uses rainfall data for 1991 – 2020 at three locations at the Sepinggan Meteorological Station, Balikpapan, Samarinda and Kalimarau Berau, East Kalimantan. El Nino conditions in East Kalimantan show the influence of rainfall during the dry season, rainfall is less than normal conditions. Reduced rainfall from normal conditions can result in drought. La Nina conditions in East Kalimantan show the influence of the dry season, there is an increase in rainfall compared to normal conditions. Increased rainfall from normal conditions can cause flooding. La Nina and El Nino conditions affect rainfall in East Kalimantan which can have an impact on disasters. This condition must be anticipated in order to reduce the risk of an impending disaster. Anticipation efforts can guarantee the safety and welfare of citizens, communities, La Nina and El Nino conditions affect rainfall in East Kalimantan which can have an impact on disasters. This condition must be anticipated in order to reduce the risk of an impending disaster. Anticipation efforts can guarantee the safety and welfare of citizens, communities, La Nina and El Nino conditions affect rainfall in East Kalimantan which can have an impact on disasters. This condition must be anticipated in order to reduce the risk of an impending disaster. Anticipation efforts can guarantee the safety and welfare of citizens.

Keywords – component; rainfall, LaNina, ElNino, disaster, national security.

I. INTRODUCTION

Rainfall has an important influence on human life. Rain is used as the main factor for studying various natural disasters such as floods, landslides, and drought in an area. Various research methods are carried out to predict rain as a preventive measure. One of the global influences that have an impact on rainfall conditions in Indonesia is the El Nino and La Nina phenomena.

El Nino is defined as a global phenomenon of a system of interaction between the sea and the atmosphere which will be marked by an increase in sea surface temperature (SST) or commonly called SST (Sea Surface Temperature) from its average value around the Central and Eastern Pacific regions along the equator. Whereas La Nina is a condition where sea surface temperature decreases in the eastern equator in the Pacific Ocean from its average value, the opposite of the El Nino event (Aldrian, 2002; Aldrian & Susanto, 2003; Hendon, 2003; Meyers et al., 2007) . El Nino events will make a negative contribution, East Kalimantan is a province in Indonesia that has been designated by Indonesia as the capital of the new State of Indonesia, located in the eastern part of the island of Borneo.

East Kalimantan has a land area of 127,267.52 km^2 and a marine area of 25,656 km2, located between 113°44' East Longitude and 119°00' East Longitude and between 2°33' North Latitude and 2°25' South Latitude. The topography of the region

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varies from lowlands to mountains and many rivers cross it. (Kaltimprov,….) Most of East Kalimantan still consists of tropical rain forest which has an equatorial rain pattern where rain occurs throughout the year. Given the magnitude of the influence of El Nino and La Nina as global phenomena that affect weather conditions in Indonesia, it is necessary to carry out studies related to these phenomena to see how much influence they have on decreasing and increasing rainfall. The impact of increased rainfall due to La Nina caused flooding in the East Kalimantan region (2020), while reduced rainfall due to El Nino caused widespread forest and land fires to occur (2015). To reduce the impact due to the influence of El Nino and La Nina which can cause disasters in the East Kalimantan region is to know the characteristics of rain in an area. Each region has its own characteristics of rain. In order to assess the characteristics, it is necessary to analyze the rainfall conditions by determining normal rain conditions and rain conditions when la nina and elnino occur.

II. LITERATURE REVIEW

2.1. Definition of rain and the process of rain

The definition of rainfall is the height of rainwater that collects in a flat place, does not evaporate, does not seep, and does not flow. Rainfall of 1 (one) millimeter means that in an area of one square meter on a flat place one millimeter of water is accommodated or one liter of water is accommodated. Rainfall can be interpreted as the height of rainwater that collects in a flat place, does not evaporate, does not seep and does not flow. Indonesia is a country that has varied rainfall because its areas have different altitudes. Rainfall in 1 (one) millimeter can mean one square meter on a flat place where water is collected as high as one millimeter. Rain is the process of condensing water vapor in the atmosphere into enough water droplets to fall and usually arrive on the earth's surface. Rain falls can not be separated from the influence of air humidity which boosts the amount of water contained in the air. Rainfall is the amount of water that falls on the surface of the earth for a certain period of time which is measured in millimeters (mm) on a horizontal surface. (BMKG,…)

Rain occurs due to solar radiation causing sea, river and surface water to evaporate to form water droplets. Water droplets gather to form clouds in the atmosphere. The clouds move because they are blown by the wind. In clouds, water droplets collide with each other and are saturated so that they fall to the ground as rain. After falling to the ground surface, it will experience runoff, some of which will flow into the sea, some will enter the soil (infiltration) and continue to move downward (percolation) into the saturated zone below the water surface. The water in this area will move slowly to the river or directly into the sea. Thus the water cycle on earth so that water can be available in rivers, seas, lakes and the earth's surface. (Syarifudin, 2017)

2.2. Effect of Rainfall on ENSO

ENSO stands for El Nino Southern Oscillation where the ENSO phenomenon consists of three phases namely El Nino, La Nina and Neutral. ENSO can be defined as an anomaly in sea surface temperature in the Pacific Ocean off the west coast of Ecuador and Peru that is higher than the normal average. ENSO causes annual climate variations in Indonesia. In ENSO year, the zonal circulation in Indonesia diverged, resulting in subsidence of the upper air. The divergence of these air masses causes the clouds that form to shift to the central and eastern Pacific, so that there is a deficiency of rainfall above Indonesia and even drought can occur (Tjasyono and Bannu, 2003).

During normal conditions the sea surface temperature in Indonesian waters is warm enough to cause the air mass to rise so that a lot of evaporation occurs. Circulation that occurs during neutral conditions is the presence of easterly trade winds that move towards Indonesian territory, where air masses from the eastern Pacific move towards Indonesia and cause Indonesian territory to become a convergence area (Fitria and Pratama, 2013). The process of El Nino is caused by increasing sea surface temperatures in the central and eastern Pacific Ocean. This causes the air temperature and humidity above it to increase. El Nino events have various and very broad impacts, when El Nino in the American Latin region will experience a high increase in rainfall. However, the opposite occurs in Indonesia. where there will be drought or drought and will have the impact of drastically reducing rainfall (BOM, 2011). La Nina is a cold phase and is the opposite of El Nino. In the event of La Nina, cold sea water in the eastern Pacific Ocean rises, the air temperature will cool down, so that evaporation occurs which will increase rainfall in Indonesian territory (BOM, 2011).

In an ENSO year, there is a divergence of air masses over Indonesia, so that the air above the drier will decrease (subside). This condition causes the amount of rainfall in ENSO years to be smaller than in the years before and after the ENSO occurred.

The amount of rainfall is less in ENSO years than rainfall in non-ENSO years. The small amount of rainfall in Indonesia in ENSO years is caused by surface air divergence and upper air subsidence (Tjasyono, 2003).

According to research by Athoillah, et al in 2017, the effect of a strong El Nino in 2015 on Indonesian regions is in the southern part, such as Java, Bali, Nusa Tenggara and southern Sulawesi. This effect is quite clear in the dry months, namely August to October. Meanwhile, when entering the wet month period (November – December) the impact of El Nino on rainfall is not too significant. When La Nina is weak, it can be seen that there is a significant increase in rainfall in the wet months. In this period, it can be seen that the rainfall anomaly has a positive value, which means that there is additional rainfall than normal.

A strong El Nino on the rainfall parameter causes a negative anomaly and occurs during the La Nina period positive anomaly. El Nino events have a low impact on annual rainfall in parts of Indonesia. This low influence covers most of Indonesia, namely Kalimantan, parts of northern Java, the Nusa Tenggara Islands, and parts of Papua. Whereas in La Nina events, it is almost the same as El Nino events, which has a low effect on annual rainfall in parts of Indonesia. The influence of La Nina covers almost all parts of Indonesia, such as parts of Sumatra, Kalimantan, Java, Sulawesi, Papua, the Ternate Islands and the entire Nusa Tenggara region (Sitompul, 2013).

2.3. Impact of Rainfall on National Security

In the Law of the Republic of Indonesia no. 17 of 2011, National Security is defined as a dynamic condition of the nation and the Unitary State of the Republic of Indonesia which guarantees the safety, peace and welfare of citizens, society and the nation, the sovereignty andthe territorial integrity of the country and the sustainability of national development from all threats. (RI, 2011). Disaster is one of the non-military threats to national security that is very likely to occur to destroy all joints in the life of the nation and state. For example, during the La Nina period it results in floods, landslides, strong winds and unstable weather. During the El

Nino period it can cause droughts to forest and land fires in Indonesia.

Talking about disasters is talking about the future of a nation, so that good disaster management is a form of protection for the entire nation from all threats, especially threats to national security originating from non-military threats in the disaster aspect.

III. RESEARCH METHODS

This study uses a descriptive quantitative method which explains how much influence El Nino and La Nina phenomena have on rainfall in the East Kalimantan region. The research location is the area of East Kalimantan Province which consists of 3 (three) research location points, namely Berau Meteorological Station which is at 2.1439282606559384 N, 117.43266517781204 E, Temindung Meteorological Station Samarinda at 0.48238360895690335 S, 117.1562347796816 E, Station Meteorology Sepinggan Balikpapan 1.2597749735456463 S, 116.89720474168801 E The time of research when the El Nino and La Nina phenomena occurred during the period 1991-2020.

The tool used in this study is Microsoft Excel, which is software that functions to process data or numbers using worksheets consisting of rows and columns. Microsoft Excel in this study is used to assist in processing rainfall climatological data in graphical form which will later be analyzed on the processed data.

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Month and year data for ENSO events based on the Oceanic Nino Index (ONI) obtained from: https://origin.cpc.ncep.noaa.gov. From these data it is known that in the 30 year period (1991-2020) the El Nino phenomenon occurred in 1997, 2002, 2004, 2006, 2009, 2015 and 2018. The La Nina phenomenon occurred in 1996, 1998, 1999, 2000, 2007 , 2009, 2010, 2016, and 2020. But this research use data El Nino very strong in 1997 and 2015; Strong El Nino in 2002 and 2009; and moderate El Nino in 2004, 2006 and 2009. Strong La Nina phenomena in 1998 and 2010 and moderate La Nina in 1996, 1999, 2000, 2007, 2009 and 2020.

IV. DISCUSSION

The Oceanic Nino Index (ONI) is the main parameter used by NOAA in determining the El Nino and La Nina indices, which are climate anomaly phenomena on a global scale. When the Oceanic Nino Index (ONI) is positive (+), the sea surface temperature in the eastern Pacific is warmer than usual. If the Oceanic Nino Index (ONI) is more than (>) +0.5 then the El Nino phenomenon is occurring. But otherwise if Oceanic Nino.

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
1990	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.4
1991	0.4	0.3	0.2	0.3	0.5	0.6	0.7	0.6	0.6	0.8	1.2	1.5
1992	1.7	1.6	1.5	1.3	1.1	0.7	0.4	0.1	-0.1	-0.2	-0.3	-0.1
1993	0.1	0.3	0.5	0.7	0.7	0.6	0.3	0.3	0.2	0.1	0.0	0.1
1994	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.4	0.6	0.7	1.0	1.1
1995	1.0	0.7	0.5	0.3	0.1	0.0	-0.2	-0.5	-0.8	-1.0	-1.0	-1.0
1996	-0.9	-0.8	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4	-0.5
1997	-0.5	-0.4	-0.1	0.3	0.8	1.2	1.6	1.9	2.1	2.3	2.4	2.4
1998	2.2	1.9	1.4	1.0	0.5	-0.1	-0.8	-1.1	-1.3	-1.4	-1.5	-1.6
1999	-1.5	-1.3	-1.1	-1.0	-1.0	-1.0	-1.1	-1.1	-1.2	-1.3	-1.5	-1.7
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.7	-1.4	-1.1	-0.8	-0.7	-0.6	-0.6	-0.5	-0.5	-0.6	-0.7	-0.7
2001	-0.7	-0.5	-0.4	-0.3	-0.3	-0.1	-0.1	-0.1	-0.2	-0.3	-0.3	-0.3
2002	-0.1	0.0	0.1	0.2	0.4	0.7	0.8	0.9	1.0	1.2	1.3	1.1
2003	0.9	0.6	0.4	0.0	-0.3	-0.2	0.1	0.2	0.3	0.3	0.4	0.4
2004	0.4	0.3	0.2	0.2	0.2	0.3	0.5	0.6	0.7	0.7	0.7	0.7
2005	0.6	0.6	0.4	0.4	0.3	0.1	-0.1	-0.1	-0.1	-0.3	-0.6	-0.8
2006	-0.9	-0.8	-0.6	-0.4	-0.1	0.0	0.1	0.3	0.5	0.8	0.9	0.9
2007	0.7	0.2	-0.1	-0.3	-0.4	-0.5	-0.6	-0.8	-1.1	-1.3	-1.5	-1.6
2008	-1.6	-1.5	-1.3	-1.0	-0.8	-0.6	-0.4	-0.2	-0.2	-0.4	-0.6	-0.7
2009	-0.8	-0.8	-0.6	-0.3	0.0	0.3	0.5	0.6	0.7	1.0	1.4	1.6
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2010	1.5	1.2	0.8	0.4	-0.2	-0.7	-1.0	-1.3	-1.6	-1.6	-1.6	-1.6
2011	-1.4	-1.2	-0.9	-0.7	-0.6	-0.4	-0.5	-0.6	-0.8	-1.0	-1.1	-1.0
2012	-0.9	-0.7	-0.6	-0.5	-0.3	0.0	0.2	0.4	0.4	0.3	0.1	-0.2

Table 1. Nino Index 3.4

(source:https://origin.cpc.ncep.noaa.gov/products/analysismonitoring/ensostuff/ONIv5.php)

If the Oceanic Nino Index (ONI) reaches a value lower than (<) -0.5 then the La Nina phenomenon is occurring. The Oceanic Nino Index (ONI) tabulation based on calculations by NOAA is shown below. Oceanic Nino Index (ONI) values greater than equal to >= +0.5 are colored red and Oceanic Nino Index (ONI) values lower than <= -0.5 are colored blue. However, this research focuses on la nina and el nino conditions in the very strong, strong, and moderate phases

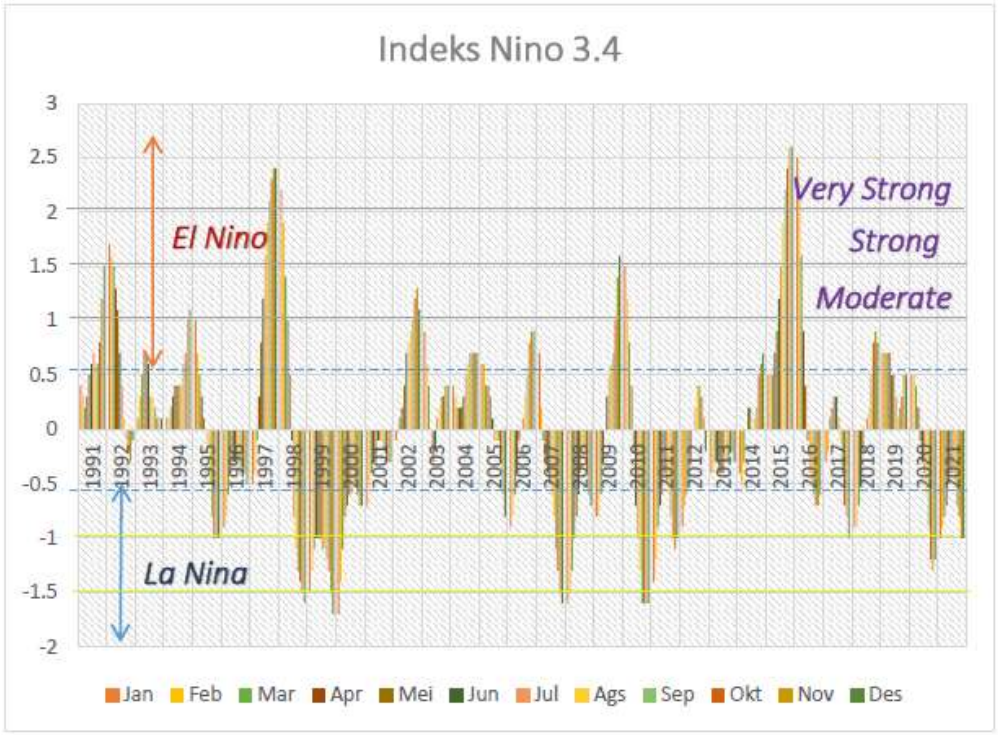
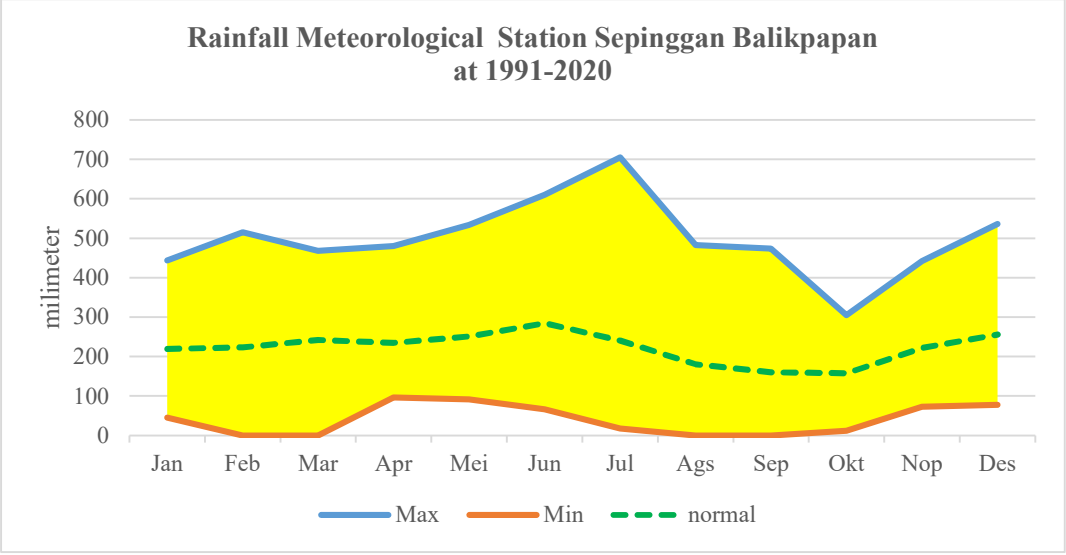


Figure 1. Nino Index 3.4 for a period of 30 years (1991-2020)

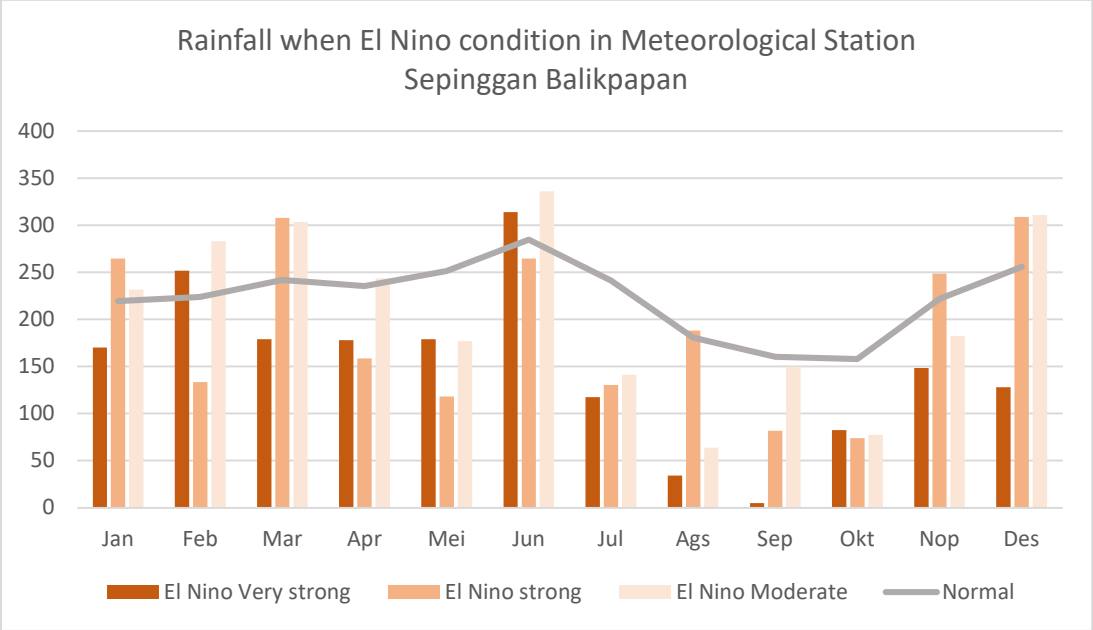
4.1. Rainfall in Balikpapan

Monthly rainfall in Balikpapan based on 30 yearly data shows an average of 223 mm with maximum conditions in June and minimum conditions in October. Normal rainfall is the average monthly rainfall for 30 years which can be used as a reference as normal data. The maximum rainfall for the last 30 years occurred in July 2008 of 705 mm during normal conditions, while the lowest rainfall occurred in February and March 1998 when El Nino conditions were very strong.



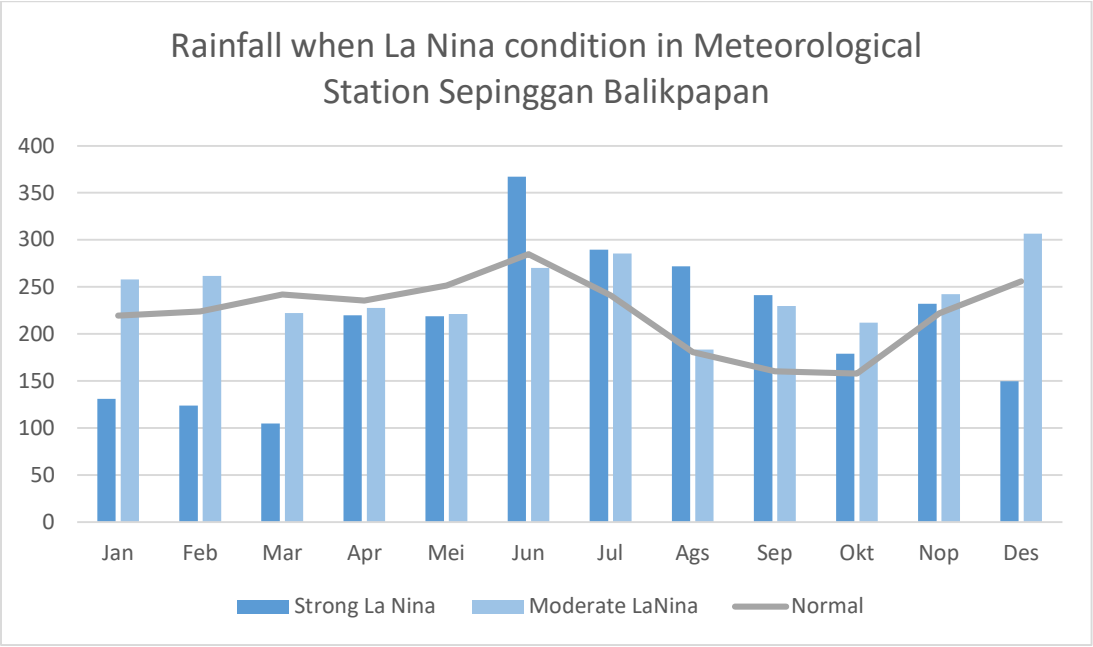
Graphic 1. Rainfall Normal Meteorological Station Sepinggan Balikpapan

Rainfall conditions in Balikpapan during El Nino conditions show an influence during the dry Monthly rainfall is very less than normal conditions, especially during a very strong El Nino.



Graphic 2. Rainfall when El Nino condition in Meteorological Station Sepinggan Balikpapan

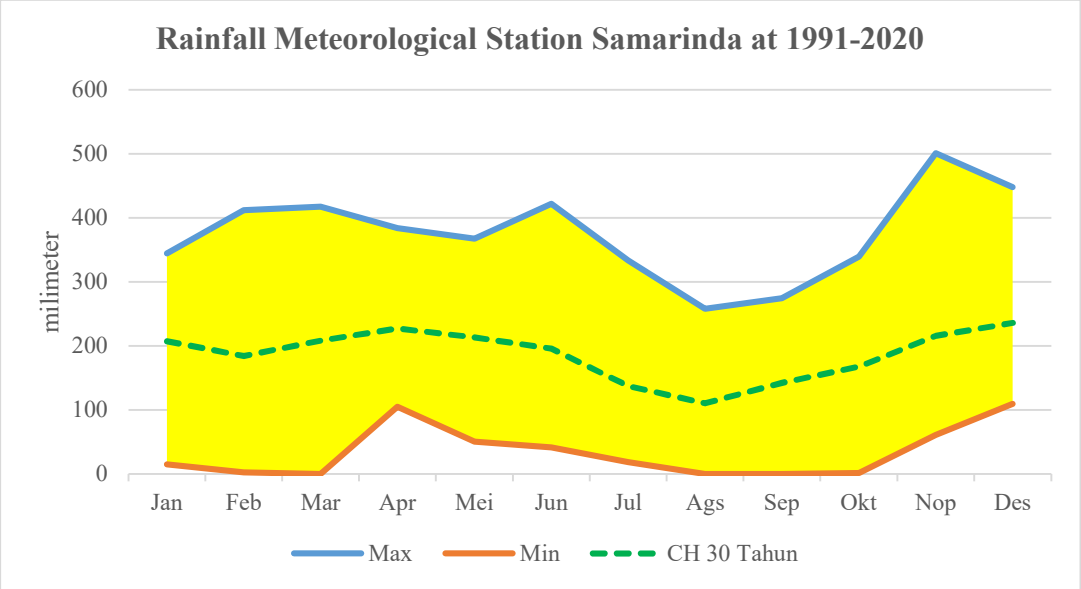
Rainfall conditions in Balikpapan during El Nino conditions show an influence during the dry Monthly rainfall is very less than normal conditions, especially during a very strong El Nino.



Graphic 3. Rainfall when La Nina condition in Meteorological Station Sepinggan Balikpapan

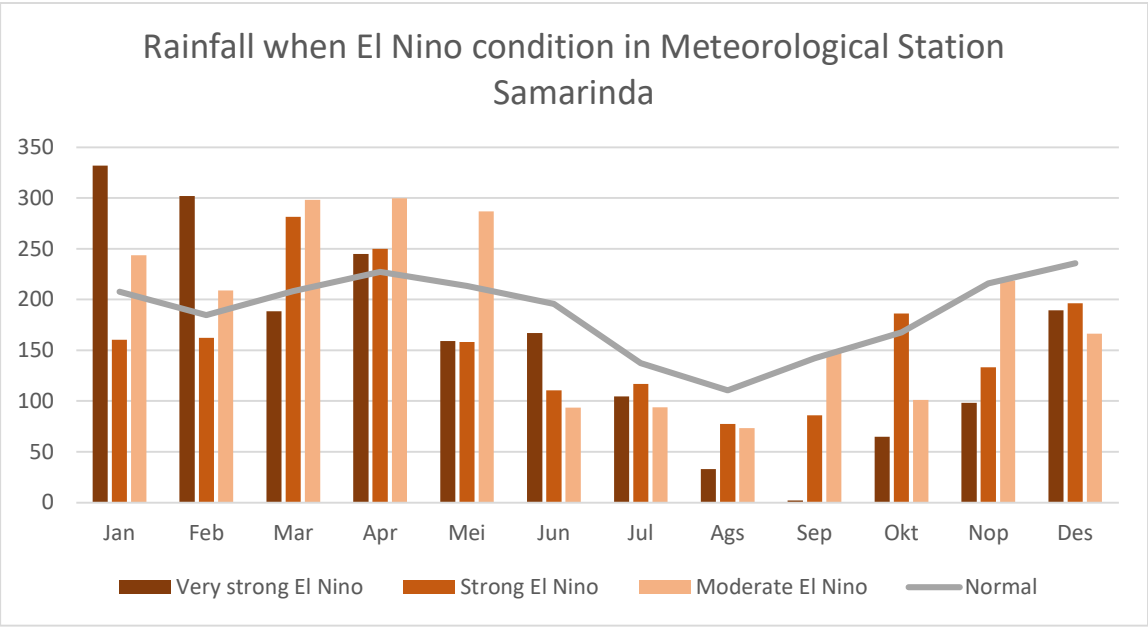
4.2. Rainfall in Samarinda

Monthly rainfall in Samarinda based on 1991-2020 data shows an average of 187 mm with the highest rainfall during the rainy season, namely December and the lowest rainfall during the dry season, namely August. The maximum rainfall for 30 years was in November 2008 when El Nino was weak, while the lowest rainfall was in March 1998 and September 2015 when El Nino was strong.



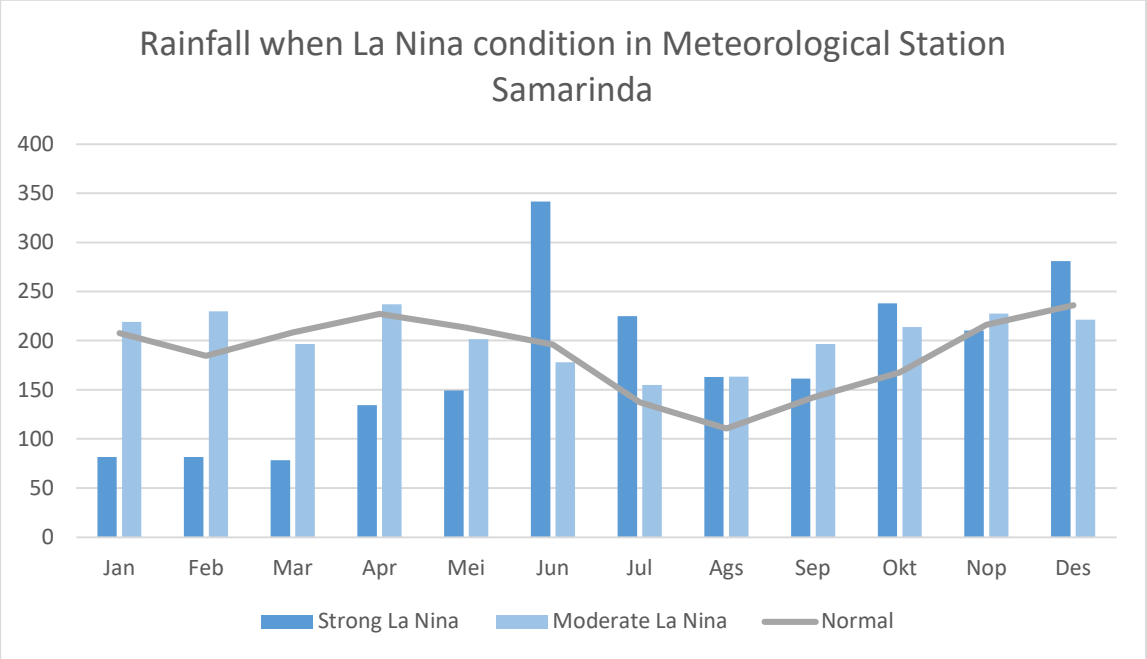
Graphic 4. Rainfall Normal Meteorological Station Samarinda

Rainfall conditions in Samarinda during El Nino conditions have an influence on the dry season. Rainfall shows a decrease in the dry season compared to normal, especially when El Nino is very strong. However, under certain conditions, additional rainfall occurs in Samarinda when El Nino conditions are strong in the rainy season. This may be influenced by other weather disturbance factors that cause these conditions.



Graphic 5. Rainfall when El Nino condition in Meteorological Station Samarinda

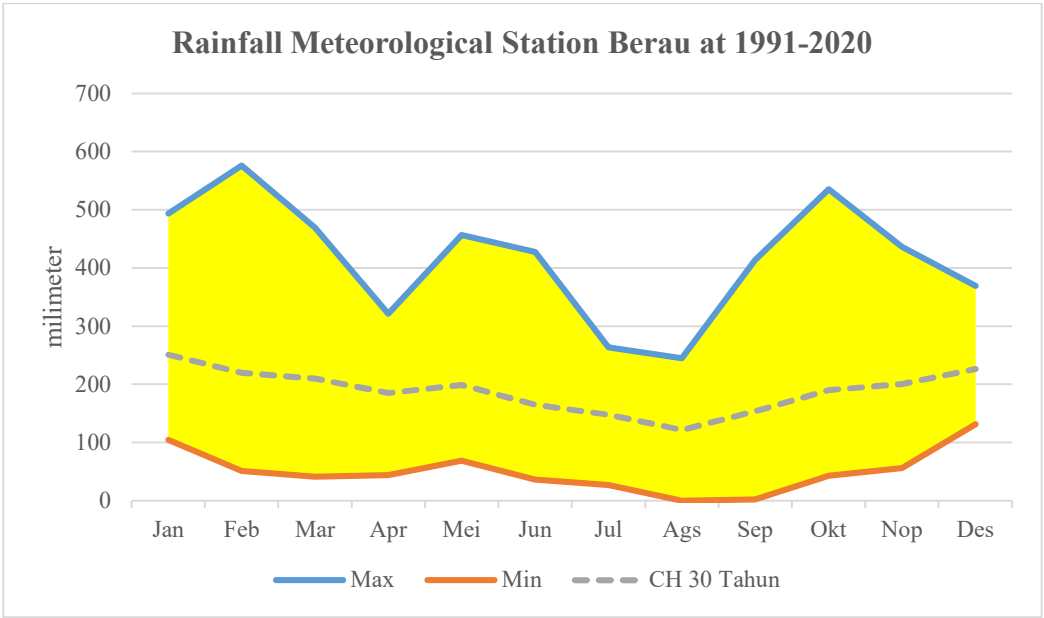
Rainfall conditions during La Nina show influence during the dry season and the transition period from the dry season to the rainy season. In this condition, additional rainfall occurs, especially during strong La Nina. However, under certain conditions when La Nina is strong in Samarinda it shows a decrease in rain. This may be influenced by various other weather disturbance factors so further research is needed.



Graphic 6. Rainfall when La Nina condition in Meteorological Station Samarinda

4.3. Rainfall in Berau

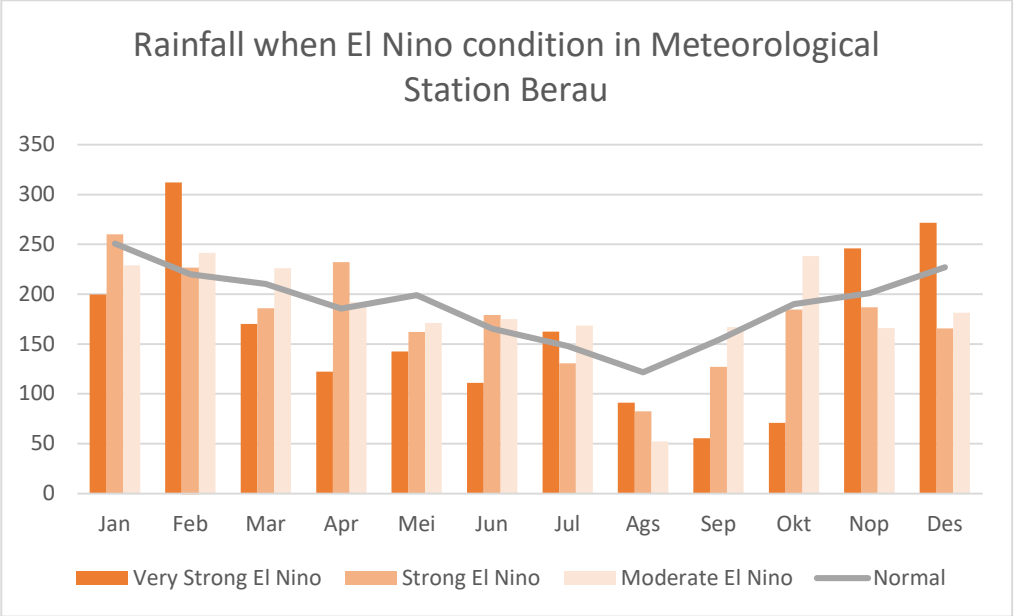
Monthly rainfall in Berau based on 1991-2020 data shows an average of 189 mm with the highest rainfall generally in January during the rainy season and the lowest rainfall in August during the dry season. Maximum rainfall in 1991-2020 occurred in October 2016 when El Nino was weak and the lowest was in August 2004 when LaNina was weak.



Graphic 7. Rainfall Normal Meteorological Station Berau

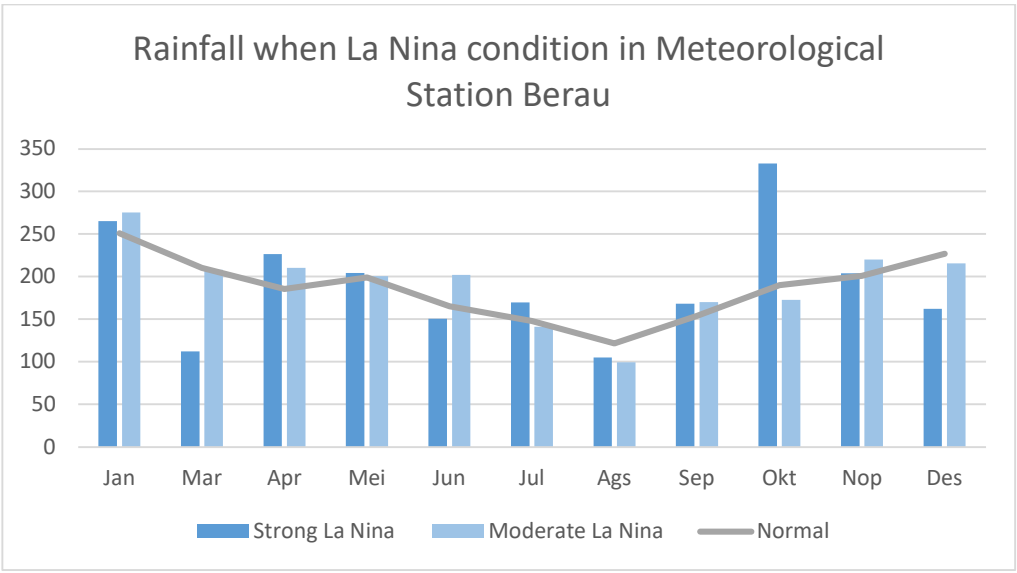
Rainfall conditions in Berau during El Nino conditions have an influence on the dry season. Rainfall shows a decrease in the dry season compared to normal, especially when El Nino is very strong. However, under certain conditions, additional rainfall

occurs in Berau when El Nino conditions are strong in the rainy season. This may be influenced by other weather disturbance factors that cause these conditions.



Graphic 8. Rainfall when El Nino condition in Meteorological Station Berau

Rainfall conditions during La Nina show influence during the transition period from the dry season to the rainy season in September, October and November. In this condition, additional rainfall occurs, especially during strong La Nina. However, under certain conditions when La Nina is strong in Berau it shows decreased rain, such as in August and December. This may be influenced by various other weather disturbance factors so further research is needed.



Graphic 9. Rainfall when La Nina condition in Meteorological Station Berau

V. CONCLUSION & SUGGESTION

El Nino and La Nina are global weather disturbances that affect weather conditions in Indonesia East Kalimantan. This condition is shown in the rainfall in Balikpapan, Samarinda, and Berau. Under normal conditions, the monthly average rainfall for 30 years ranges from 180 -200 mm with the lowest rainfall during the dry season and the highest rainfall during the rainy season.

When El Nino and La Nina weather disturbances can affect rainfall in these three locations.

El Nino conditions in East Kalimantan show the influence of rainfall during the dry season, rainfall is less than normal conditions. Reduced rainfall from normal conditions can lead to droughts which can result in forest and land fires. La Nina conditions in East Kalimantan show the influence of the dry season, there is an increase in rainfall compared to normal conditions. Additional rainfall from normal conditions can cause flooding which can result in landslides and flash floods. However, in certain conditions, such as in Berau and Samarinda, additional rainfall occurs during the rainy season during El Nino conditions. La Nina conditions in Samarinda indicate reduced rainfall during the rainy season. This may be influenced by other weather disturbances so further research is needed.

La Nina and El Nino conditions affect rainfall in East Kalimantan which can have an impact on disasters. This condition must be anticipated in order to reduce the risk of an impending disaster. Anticipation efforts can guarantee the safety and welfare of citizens, communities,

REFERENCES

[1] Aldrian, E. 2002. Spatial Patterns of Enso Impact On Indonesian Rainfall. Jurnal Sains& Teknologi Modifikasi Cuaca.

[2] Aldrian, E., Susanto, R.D., 2003. Identification of three dominant Rainfall Regions Within Indonesia and Their Relationship to Sea Surface Temperature. International Journal of Climatology, 23:1435-1452.

[3] Athoillah, I., Sibarani, R.M., Doloksaribu, D.E., 2017. Analisis Spasial El Nino Kuat Tahun 2015 dan La Nina Lemah Tahun 2016 (Pengaruhnya Terhadap Kelembaban, Angin, dan Curah Hujan di Indonesia). Jurnal Sains & Teknologi Modifikasi Cuaca, Vol.18 No.1,2017:33-41.

[4] Fitria, W., Pratama, M.S., 2013. Pengaruh Fenomena El Nino 1997 dan La Nina 1999 Terhadap Curah Hujan di Biak, Jurnal Meteorologi dan Geofisika (2013) Vol.14, No.2.

[5] RI. (2011). Undang-Undang Republik Indonesia Nomor 17 Tahun 2011 Tentang Intelijen Negara. Jakarta: Pemerintah Republik Indonesia.

[6] Syarifudin, A. (2017). Hidrologi Terapan. Penerbit Andi.

[7] Sitompul, Z., Nurjani, E., 2013. Pengaruh El Nino Southern Oscillation (ENSO) Terhadap Curah Hujan Musiman dan Tahunan di Indonesia. Jurnal Bumi Indonesia.

[8] Tjasyono, B.H.K dan Bannu., 2003. Dampak ENSO pada Faktor Hujan di Indonesia, Jurnal Matematika dan Sains, Vol. 8 No.1 Hal 15-22, Institut Teknologi Bandung, Bandung.

[9] BMKG, … BMKG Stasiun Klimatologi Jawa Timur. https://karangploso.jatim.bmkg.go.id/index.php/prakiraan-iklim/prakiraan-musim/prakiraan-musim-. hujan/prakiraan-sifat-hujan-musim-hujan. Diakses pada 01 Mei 2023

[10] Kaltimprov, …. Kondisi Wilayah. https://kaltimprov.go.id/halaman/kondisi-wilayah. Diakses pada 1 Mei 2023. Diakses pada 01 Mei 2023

[11] National Oceanic And Atmospheric Administration (NOAA). Historical El Nino & LaNina Episode. https://origin.cpc.ncep.noaa.gov/products/analysismonitoring/ensostuff/ONI_v5.php. Diakses pada 05 Mei 2023