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CHANGE CLIMATE AND ITS IMPACT ON RAIN PATTERNS IN THE EQUATORIAL REGION

Gusti Rusmayadi[1], Umi Salawati[2], Hilda Susanti[3], Dewi Erika Adriani[4], Taufik Hidayat[5], Rizali Saidy[6], Syam'ani[7]

Abstract

Variability climate yearly and between unique year in Indonesia because all regions not the same and affect the pattern weather and rainfall the rain. Indonesia 's climate is influenced by the global exchange of current mass passing air its territory. Arrangement Island make Indonesia have characteristic climate that is local, equtorial, and tropical monsoons. Based on pattern rainfall During a year pattern climate in Indonesia sorted Becomes three pattern climate main that is pattern monsoon, equatorial pattern and pattern local. Profit distribution climate based on pattern rainfall is consistency each region only on controller prevailing climate relatively same. That thing what's up with the condition controller climate different because change, then will do it pattern bulk new rain formed. Incident the always occur almost all over Indonesia. Analysis used is mean, deviation, geostatistics with secondary data source from BPS and BMKG in 7 regions of West Kalimantan. Bengkayang /Sambas region showing change pattern to monsonal direction with one peak rain or pattern letter U. Other regions like Mempawah, Hedgehog, Sanggau, Sintang, Sekadau and Kapuas Hulu still Equatorial pattern with two peak rain. Precipitation and temperature air in the study area show upward trend at seven district representing the study area. There is a tendency enhancement temperature air about 0.2C for 15 years since 2004 to 2020 or 0.013 C per year. Region showing change pattern rain

[1] Fakultas Pertanian Universitas Lambung Mangkurat, Jl. Brigjen H. Hasan Basry. Kotak Pos 219. Banjarmasin. Indonesia, gustirusmayadi@ulm.ac.id
[2] Fakultas Pertanian Universitas Lambung Mangkurat, Jl. Brigjen H. Hasan Basry. Kotak Pos 219. Banjarmasin. Indonesia, asaidy@ulm.ac.id
[3] Fakultas Pertanian Universitas Lambung Mangkurat, Jl. Brigjen H. Hasan Basry. Kotak Pos 219. Banjarmasin. Indonesia, hilda.susannti@ulm.ac.id
[4] Fakultas Pertanian Universitas Lambung Mangkurat, Jl. Brigjen H. Hasan Basry. Kotak Pos 219. Banjarmasin. Indonesia, dewierika@ulm.ac.id
[5] Fakultas Pertanian Universitas Lambung Mangkurat, Jl. Brigjen H. Hasan Basry. Kotak Pos 219. Banjarmasin. Indonesia, taufikkdg@ulm.ac.id
[6] Fakultas Pertanian Universitas Lambung Mangkurat, Jl. Brigjen H. Hasan Basry. Kotak Pos 219. Banjarmasin. Indonesia, usalawati@ulm.ac.id
[7] Fakultas Kehutanan Universitas Lambung Mangkurat, Jl. Brigjen H. Hasan Basry. Kotak Pos 219. Banjarmasin. Indonesia, syam'ani.fhut@ulm.ac.id

from Equatorial type becomes type Moonsonal means the original area experience one peak rainy and very sensitive to impactful Monsoon wind to pattern planting.
Keywords: bulk trend rain, controller climate, pattern local, pattern monsonal, temperature trend air.

1 INTRODUCTION

Variability climate yearly and between yearly in Indonesia is enough unique because all regions not the same and affect the pattern weather and rainfall rain (Haylock and McBride, 2001). Indonesia 's climate is not free from influence global exchange of current mass air passing through this area. Arrangement such an archipelago make Indonesia have characteristic climate that is local, tropical, and tropical monsoon. By climatological pattern climate in Indonesia based on pattern rainfall During a year could shared Becomes three pattern climate main that is pattern monsoon, equatorial pattern and pattern local (Aldrian, E, 2001; Tjasjono, B. 2004). Then, Based on analysis amplitude and phase oscillation annual from average amount of bulk pentad-mean rainfall, Hamada et al.. (2002) classified Indonesia into four climatological areas. They find character similar from the three regions mentioned researcher previously and intermediate regions that are not have season clear rain and drought. The Monsoon pattern is characterized by the shape of pattern unimodal rainfall, i.e one peak season rain. During six month rainfall relatively height, which is called season rain and six month next low, which is called season drought. By general season drought in progress from April to with September and season rain from October until March. equatorial pattern characterized by pattern rain with bimodal form, i.e two peak the rain that happened around month March and October that is when sun is at close equator or at the moment occur echinox. Local pattern characterized by shape pattern unimodal rain, i.e one peak rain but opposite shape with pattern monsoon type rain. Profit distribution climate based on pattern rainfall is consistency every part or region only on controller prevailing climate the same (Aldrian, 2001). That thing what's up with the condition controller climate different because change, then will do it pattern bulk new rain formed. Incident the always occur almost all regions of Indonesia (Boer, 2001).

Change global climate has influence intensity and pattern rainfall. Change climate (climate change) is a things that are not could avoided consequence global warming (global warming) and it is believed will impact large to various aspect life (Surmaini, et al., 2011). Too much rain tall could cause flood and vice versa if bulk too much rain low could cause drought. Change climate is a phenomenon natural the place change pattern climate and impact to change pattern the

weather in one area in period relatively long time like enhancement incident extreme and shift time plant. Change climate result in change condition environment that has an impact on growth and development plants. Growth plant disturbed under less than optimal conditions, which consequently decreases quantity and quality production and yield.

Change climate has bring challenge to commodities and society local. Moment this, change climate have implication big for the future production commodity and currency livelihood community in many parts of Indonesia, which include is West Kalimantan. Diversity rain and events weather / climate extreme other Keep going influence a number of aspects in the district area in West Kalimantan because enhancement temperature and variability rainfall as well as potential make it worse degradation environment in producing area commodity.

Besides that, factor economy like drop price, chain supply that is not efficient, have hit sector commodities and farmers in several districts until level bottom. A farmer with dependence on commodities single experience the worst impact, as well as the regional economy of the region. Farmers and their territories has directed to commodity single by market forces. Perspective like that must changed with enhancement capacity and assessment thorough about possible alternative Becomes Street go out from problem that.

Consistency each region only on controller prevailing climate relatively same. thing or problem the could formulated in areas where conditions controller the climate different because has change, then will do it pattern bulk new rain formed. Formation of new territory the always occur almost all regions of Indonesia which have an impact on shifting pattern plant. because of that destination study this is analyze change pattern rainfall in the study area of type pattern bulk affected equatorial rain change climate.

2 RESEARCH METHOD

2.1 Type and Source, Time and location Study

Type of data used are primary and secondary. Primary data obtained from interview with the Department of Agriculture and Forestry, BMKG. Secondary data climate obtained from BPS in the form of Regency in Numbers and at 7 stations Meteorology and Geophysics within the scope of BMKG West Kalimantan. Study implemented in 2019/2020 in 7 districts of West Kalimantan. West Kalimantan Province is located in the western part of the island of Borneo, between the lines 2 08'N - 3 02'LS and 108 0 30' - 114 10 ' east

longitude on the map earth. Based on location specific geography this then, the area of West Kalimantan is right traversed by the equator at latitude 0, precisely above the city of Pontianak. because of Therefore, West Kalimantan is one of the tropical regions with temperature high humidity and air. Point location study in 7 districts in West Kalimantan, namely Mempawah, Bengkayang, Landak, Sanggau, Sekadau, Sintang and Kapuas Hulu as shown in Figure 1.

Figure 1. Study Area (o) West Kalimantan

2.2 Climate Data Analysis

In study this, calculation climatology used for describe the average variability of the data. Calculation climatology use equality following,

$$\bar{X}_i = \frac{\sum_{j=1}^{N} x_{ij}}{N}$$

$\bar{X}_i$ is score average climatology for month certain, N is amount of data for year observations , and i and j are month and year observation. Based on score average climatology this made chart distribution rain from January until with december. Bulk pattern rain will determined based on analysis this.

Standard deviation calculated use equality following,

$$S = \frac{\sqrt{\sum(x_i - \bar{x})^2}}{n-1}$$

S is deviation standard, is the original data, is the mean value, and n is amount of data.

Precipitation of the area is approached with geostatistics. Climatic data period rainfall annual shared Becomes three period for get fluctuation rain on the range 2010 – 2020. Rainfall data rain and temperature air obtained from BMKG station in West Kalimantan, then analyzed with use geostatistics for get bulk area rain. Geostatistics used for see connection between the variable measured at the point certain with same variable measured at the point with distance certain from point first (spatial data) and used for estimate parameters where it is not is known the data (Oliver and Carol, 2005). Special trait from spatial data this is independence and heterogeneity. Unfreedom caused by calculation error observations and researched results in one point determined by another point in system and heterogeneity caused existence regional differences. The results of the data processing used for map change bulk according to period certain.

Analysis statistics above using SPSS software version 22 and Arc Geographic Information System (GIS) version 10.0 for make map distribution rainfall and its changes.

3 RESULTS AND DISCUSSION

3.1 Profile General Element Climate

Wind and Air Temperature. The factor which is characteristic general for something plains low in the tropics is temperature relative air hot or high, while especially the high temperature area of West Kalimantan this followed by humidity high air. Based on notes empirical from a number of Station Meteorology (BC) such as SM Supadio Kubu Raya, SM Pangsuma Putussibau, SM Paloh Sambas, SM Susilo Sintang, SM Nanga Pinoh Melawi and Stations Climatology Siantan Regency Mempawah, generally temperature the air in West Kalimantan is quite normal but varied, namely in the average range of 26.7^{o}C - 27.8^{o}C.

Temperature maximum air in West Kalimantan reached 37.8^{o}C which was recorded at the Pontianak Maritime SM in the month of July. Temporary Meanwhile, the minimum temperature recorded was 19.8^{o}C which occurred at SM Paloh Sambas in the month of February. Whereas for speed wind in West Kalimantan recorded from station meteorology, along month in 2018, the average ranged from between 1.83 to 7.25 knots/hour while number maximum recorded in SM Rahadi Usman Ketapang at 31 knots/hour in the month March .

Rainfall and Rainy Days. Average rainfall rain monthly highest registered at SM Pangsuma Putussibau on the moon October i.e 701 mm and the lowest recorded at SM Rahadi Usman Ketapang in the month of July about 21 mm. rainy day highest registered at SM

Pangsuma Putussibau on the moon December 27 days and the lowest recorded by SM Rahadi Usman Ketapang in the month of August as much as 3 (three) days .

3.2 Change Conditions of Rainfall and Air Temperature in 2010, 2015, 2020

Precipitation and temperature _ air in the study area show a number of upward trend at BMKG stations in seven districts that represent the study area (Figure 2). Change rainfall and temperature air according to the period of 2010, 2015 and 2018 can be seen in Figure 3 .

Figure 2. Trend rainfall in 7 districts in West Kalimantan

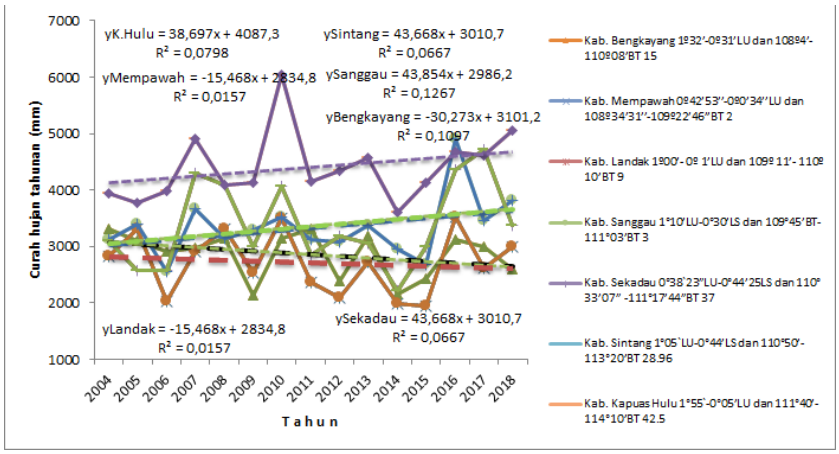
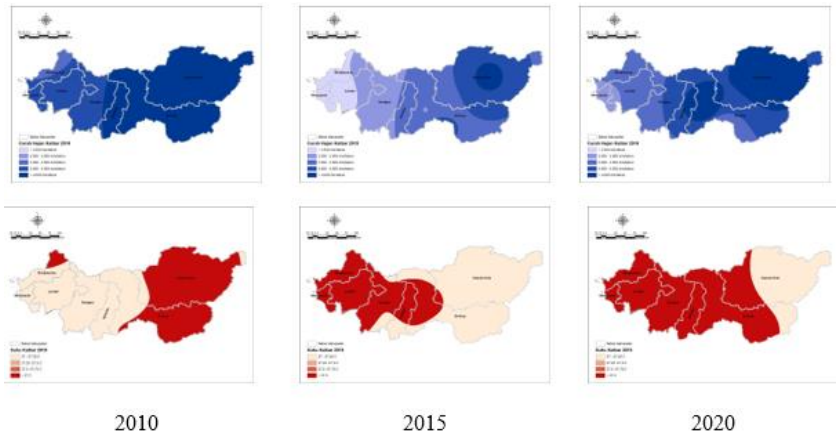
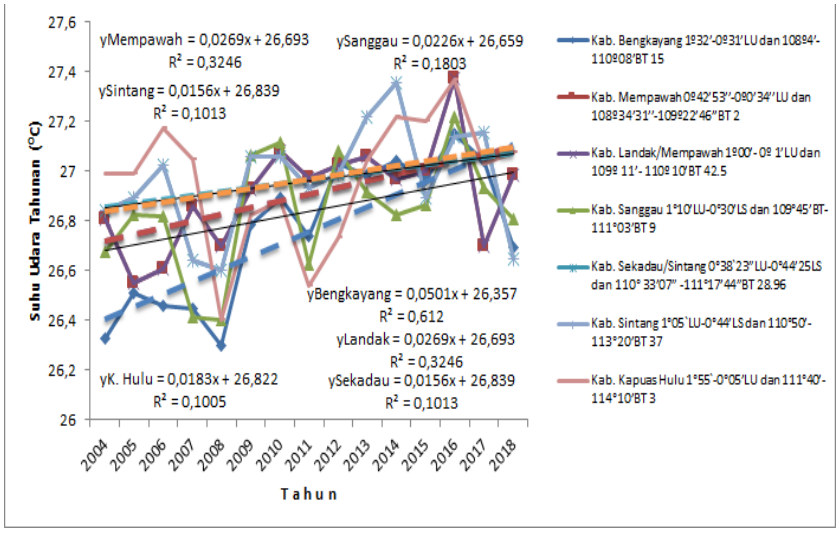


Figure 3. Changes in Rainfall and Temperature air in West Kalimantan in 2010, 2015, and 2020



In the area in West Kalimantan, it can be seen all regions showing increase rainfall, that is Bengkayang, Mempawah, Hedgehog, Sanggau, and Kapuas Hulu (Figure 2).

Figure 4. Trend Air Temperature in 7 Regencies in West Kalimantan.



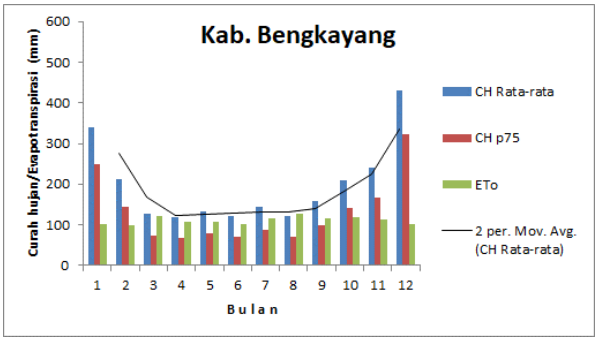
There is a tendency enhancement temperature air about 0.2^{o}C for 15 years since 2004 to 2020 or 0.013 C per year .

3.3 Rainfall Pattern and Period Length Wet And Dry

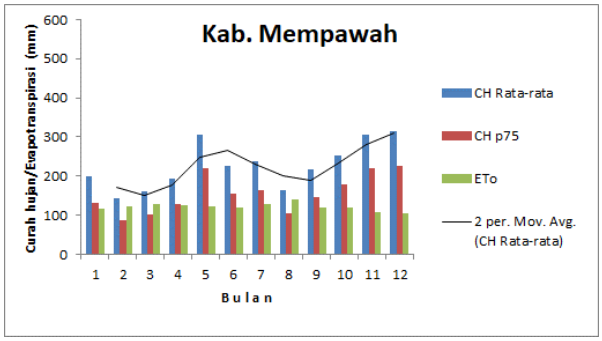
Bulk pattern rain in the study area served in Figure 5. Based on the analysis of the average visible area of Bengkayang / Sambas shows change pattern to monsonal direction or letter U pattern . Northwestern part of Kalimantan according to Aldrian and Susanto (2003) and Bayong (2004) including equatorial type. Change pattern the suspected change climate that has affect the controlling factor climate like Inter Tropical Continental Zone (ITCZ), current cross Indonesian sea (Arlindo) and the wind Moonson Becomes more dominant compared with the others. Study carry on about domination controller climate Becomes interesting study.

On pattern monsonal rain , season rain (MH) happened since month October until with month March (OKMAR), while season drought (MK) since April to with September (APSEP). While other areas like Mempawah, Landak, Sanggau, Sintang, Sekadau and Kapuas Hulu still show Equatorial pattern with two peak rain. On pattern rain pattern this season rain (MH) happened March until with May and August until with December, while season dry season (MK) occurs in the month January until with February and month June until with July.

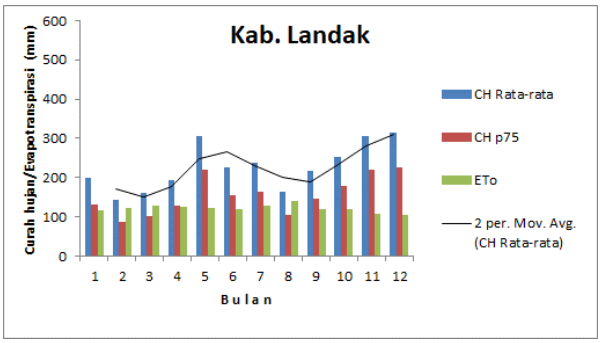
Figure 5. Monsoonal and Equatorial Rainfall Patterns and Water Balance of the Study Area

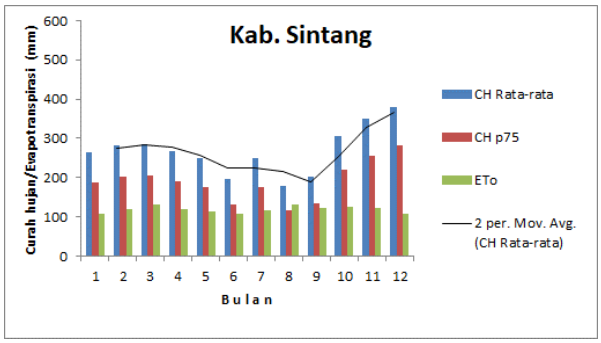


SM Sambas/ Sambas Regency

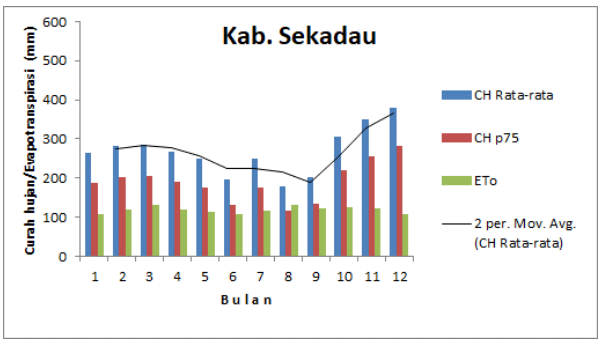


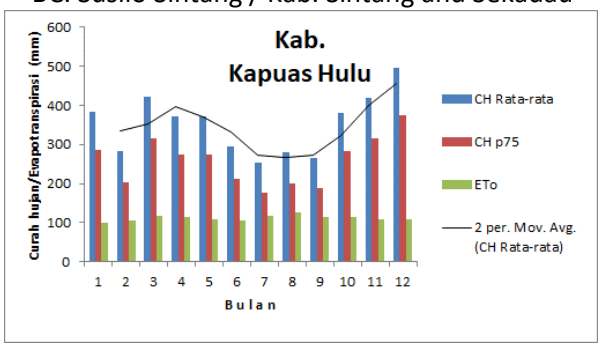
SM Siantan Pontianak/ Kab Mempawah and Kab . Landak



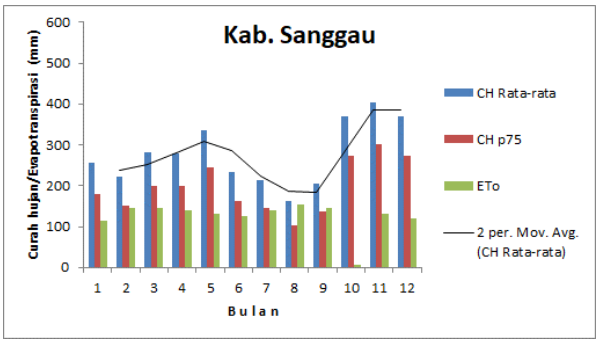


BC. Susilo Sintang / Kab. Sintang and Sekadau





SM Putusibau / Kab. Kapuas Hulu



SM Supadio/Kubu Raya/Kab. Sanggau

Change equatorial pattern to mosoonal will impact to pattern planting and shifting , because pattern rain sensitive monsoon type to monsoon wind. Rainfall in Indonesia is regulated by the Australia-Asia Monsoon, which begins in progress from the northwest to southeast During austral spring (Naylor et al., 2007). This is also the time when El Nino Southern Oscillation (ENSO) the effect is strongest to bulk Indonesian rain, especially During beginning season September – December rains (Hamada et al . 2002). The impact of ENSO then reduce during the core of the season rainy December – February (Haylock and McBride 2001; Hendon 2003; Aldrian et al., 2005, 2007; Giannini et al., 2007). Date beginning season rain important to sector agriculture in Indonesia (Naylor et al ., 2002, 2007). This thing determine time suitable planting, while start of El Ni o delayed for nine years (Hamada et al . 2002; Boer and Wahab 2007) and can cause fail harvest . For farmer paddy irrigated in Java , information about onset time is also important for develop strategies (Boer and Subbiah 2005; Naylor et al., 2007) to avoid exposure plant paddy second risk drought more high on planting season dry season (April– July).

Period length wet and dry or long period growth plant showed in Figure 5 . On opportunity 75% rain , rainfall the rain that happened by 1,863 mm to with 3,098 mm per year with period deficit 1 to with 3 months by 5 mm to with 158 mm. because of that, long period wet range from 9 to with 11 months that occurred in the Mempawah, Bengkayang, Landak, Sanggau, Sekadau, Sintang areas, while the Kapuas Hulu region did not experience period deficit.

Plant coconut palm grow with good in areas with rainfall annual between 1750 - 3000 mm and spread equally along year (Adiwiganda et al., 1999). Except Mempawah region, 6 other regions rainfall sufficient along year. For areas with heavy rainfall the rain not enough from 2000 mm/ year need anticipation drought. Likewise, the region with pattern rain monsoonal type because the area is very sensitive with incident climate extreme such as El-Nino and La-Nina (ENSO).

Incident climate extreme This also has an impact on citrus cultivated on tidal land type Surjan (Rusmayadi, 2021).

3.4 Typology Risk Climate And Adaptation District Level Potential

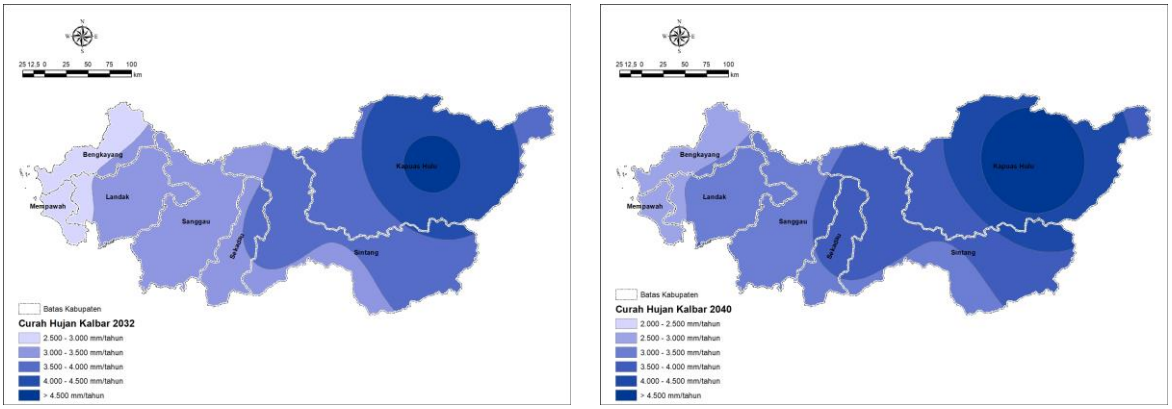
30 year prediction to front , projection increase temperature of 1 to 2 degrees . Ascension temperature of course happen and not can avoided with different speed. Global warming is happening if atmosphere covered by clouds. Only impact bad. Effort from BMKG for anticipate impact bad like information climate and warning early el-Nino and La-Nina (ENSO).

Tendency change climate to front Year 2032 and 2040 respectively study area show occur increase amount rainfall in period 15 years time last in Sanggau, Sekadau and Sintang (Table 1 and Figure 6.) and some areas that actually occur subtraction rainfall like Bengkayang, Mempawah, Landak, and happened an increase in the areas of Sanggau, Sekadau, Sintang, and Kapuas Hulu. BMKG (2019) in period 30 years time last also predict subtraction and addition rainfall in West Kalimantan (Table 1). Then, increase temperature air occur in period 15 years time final about 0.013 °C per year (Table 2 and Figure 7). Enhancement temperature air the years 2032 and 2040 in the Kalimantan region are also predicted by the BMKG (2019) which ranges from Among small (0.76 – 0.8 °C) to with moderate (0.91 – 0.95 °C).

Table 1. Rainfall Trend Period 2018, 2032 and 2040 in the study area

Region	Coordinate	Rainfall (mm)		
		2018	2032	2040
Bengkayang Regency	1 32' -0 31'N and 108 4' - 110 08'E	2,586	2,677	2.435
Mempawah Regency	0 42'53 ''-0 0'34''N and 108 34' 31'' - 109 22'46''E	2,991	2.618	2.495
Landak Regency	1 00'- 0 _ 1'LU and 109 11'- 110 10'BT	2,991	2.618	2.495
Sanggau Regency	1 ° 10'N-0 ° 30'S and 109 ° 45'E- 111 ° 03'E	3,814	3,600	3.951
Sakadau Regency	0 ° 38`23”N-0 ° 44'25LS and 110 ° 33'07” - 111 ° 17'44”E	3.367	3,622	3.971
Sintang Regency	1 ° 05`N-0 ° 44'LS and 110 ° 50'-113 ° 20'E	3.367	3,622	3.971
Kapuas Hulu Regency	1 ° 55`-0 ° 05'N and 111 ° 40'- 114 ° 10'E	5.048	4.629	4.939

Figure 6. Rainfall Prediction Years 2032 and 2040 in West Kalimantan

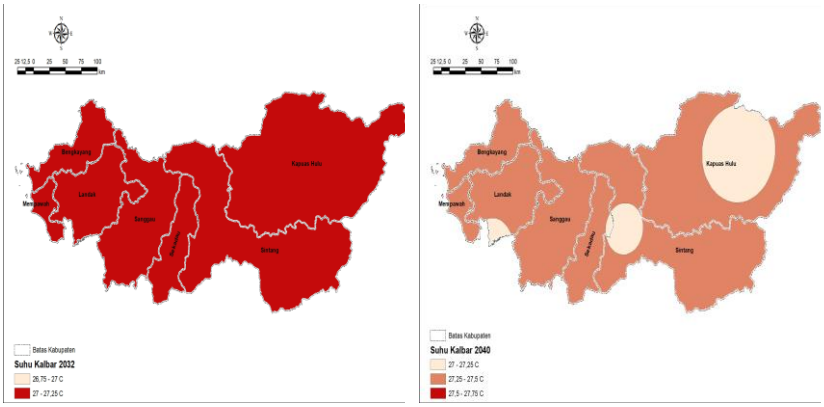


2032 2040

Table 2. Trend Average Air Temperature for the 2018 Period, 2032 and 2040 in the study area

Region	Coordinate	Temperature (C)		
		2018	2032	2040
Bengkayang Regency	1º32'-0º31'N and 108º4'-110º08'E	27.1	27.5	27.1
Mempawah Regency	0º42'53''-0º0'34''N and 108º34'31''-109º22'46''E	27.1	27.3	27.1
Landak Regency	1º00'- 0º 1'N and 109º 11'- 110º 10'E	27.1	27.3	27.1
Sanggau Regency	1 ° 10'N-0 ° 30'S and 109 ° 45'E- 111 ° 03'E	27.0	27.2	27.0
Sekadau Regency	0 ° 38`23”N-0 ° 44'25LS and 110 ° 33'07” - 111 ° 17'44”E	27.1	27.2	27.1
Sintang Regency	1 ° 05`N-0 ° 44'LS and 110 ° 50'-113 ° 20'E	27.1	27.2	27.1
Kapuas Hulu Regency	1 ° 55`-0 ° 05'N and 111 ° 40'- 114 ° 10'E	27.1	27.2	27.1

Figure 7. Prediction Air Temperature in 2032 and 2040 in West Kalimantan



2032 2040

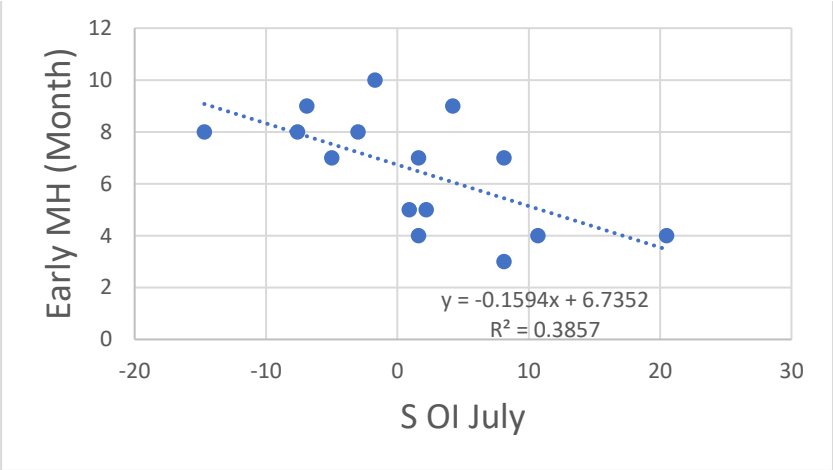
3.4.1 Risk Climate and Adaptation Potential Planted Area

Change climate could occur as consequence global warming . Global warming is caused by an increase in house gas concentration glass, one of them is CO2 , in the atmosphere earth . In the period of 400,000 years then until in 1950, CO2 levels in the atmosphere were below 300 ppm with an average temperature of around 15 °C. However, when this CO2 concentration in the atmosphere earth already up to 400 ppm. Research conducted by PPKS in North Sumatra in period time 1971-2005 shows has occur enhancement temperature average air up to 0.47 °C Siregar et al., 2006). Temporary it , reported the average increase global temperature already reach up to 1 oC (Boer, 2017). Many experts believes that global warming has cause enhancement phenomenon climate extreme in various a place in the world like enhancement melting polar ice caps, increasing sea level, drought, flood, wave heat and so on. In Indonesia, the incident climate extreme (especially rainfall) associate with the ENSO/El Niño Southern Oscillation phenomenon. The intensity and frequency of ENSO experiencing expected increase as consequence effect from global warming (Boer, 2017).

EL-Nino phenomenon causes rainfall far below normal conditions . In the range 1950–2019 , el -Niño with intensity of 1, 2, 3, and 4 years very have frequency incident highest , 4, 4, 5, and 4 times respectively with opportunity around 18.2% to 22.7%. La-Niña with 1 year intensity very with frequency highest 10 times with 41.7% chance. With so, chance incident EL-Nino and La-Niña extremes are 64.4%. Side by side La-Niña events with El-Nio as much as 13 times and generally El-Nio precedes La-Nia about 50% every two year (Rusmayadi, et al ., 2022) .

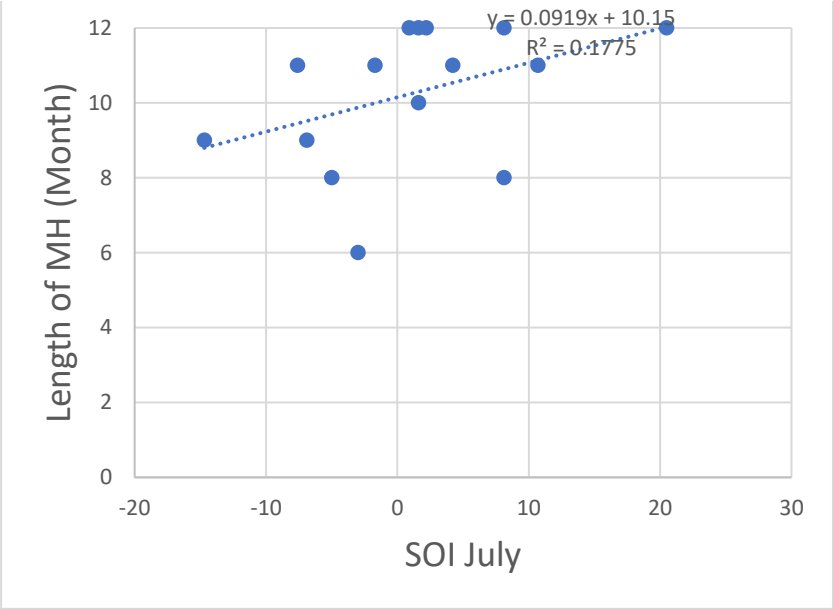
The relationship between July's SOI and the beginning and length of the rainy season (MH) is shown in Figure 8 . If the SOI in July is around zero (normal), then the start of the rainy season (MH) is around the beginning of July. If the SOI value increases by 10 from zero (La-Nina), then the beginning of MH will advance to May, otherwise if it decreases by 10 (El-Nino), then the beginning of MH will advance to August.

Figure 8. Moon SOI relationship July with the Beginning of the Season Rain (Moonth) in Sambas/ Bengkayang area



If the July SOI is around zero (normal), the length of the rainy season is estimated to be 10 months. If the SOI value increases by 10 from zero (La-Nina), then the length of MH becomes 11 months. On the other hand, if SOI falls by 10 (El-Nino), the length of MH will be 9 months.

Figure 9. Connection between SOI July with Season Length Rain (Moonth) in Sambas/ Bengkayang area



3.4.2 Prediction of Initial Opportunity and Length of MH Entry based on the July SOI Phase in the Bengkayang/Sambas area.

If in July the SOI phase is in the La-Nina category, then the initial chance of MH will be large and the duration of MH will be relatively longer than the El-Nino phase (Figure 10).

Figure 10. MH's initial prediction based on July's SOI phase

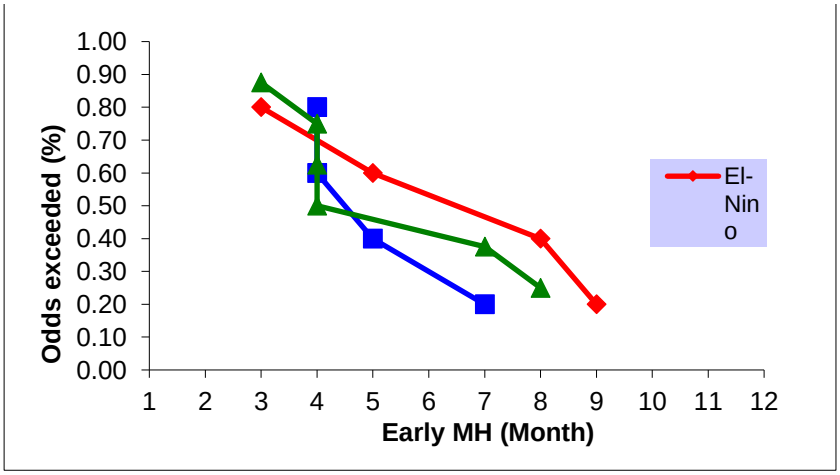
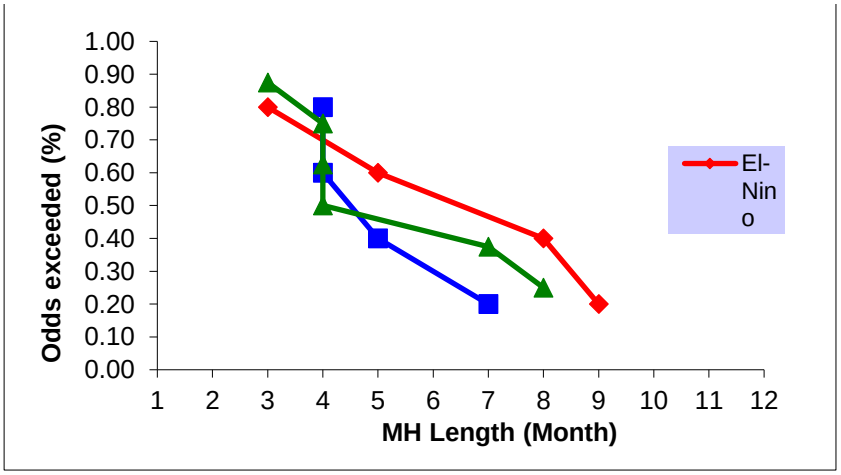


Figure 11. MH long prediction based on SOI phase



On the other hand, if the SOI Phase in July falls into the El-Nino category, the chance of a long rainy season (MH) is smaller than the other normal or La-Nina phases (Figure 11).

Potency occur change climate specifically rainfall in the future, then need conducted efforts system adaptation and mitigation effort farmer. By general, effort adaptation and mitigation that can conducted among others through use varieties stand drought , increased nutrient use efficiency through technology nano fertilizers, as well as adjustment technique cultivation .

In relation with plant coconut palm oil, negative ENSO / El Nio phenomena can cause drought the length that will be disturb growth and development as well as lower productivity plants. Territory of Indonesia part south and part east is an area that is more susceptible drought. Consequence change climate, it is estimated that the Sumatra region will relatively more wet, while the rest of Indonesia relatively more dried in the future. Besides that, Percent rain rate the year that falls in season rain estimated by general increase. This thing signify that frequency and intensity incident climate extreme increased (Boer, 2017).

4 CONCLUSIONS AND SUGGESTIONS

4.1 Conclusion

a) The Bengkayang region in West Kalimantan showing change pattern rain from Equatorial type becomes type Moonson. That thing means the original area experience two peak rain Becomes one peak rainy

and very sensitive to monsoon wind. This thing implication to change pattern planting

b) In the area in West Kalimantan, it can be seen all regions showing increase rainfall, that is Bengkayang, Mempawah, Landak, Sanggau, and Kapuas Hulu. Temporary that , temperature air also happens trend enhancement about 0.2^{o}C for 15 years since 2004 to 2020 or 0.013 °C per year.

c) Change climate to front Year 2032 and 2040 respectively study area show occur increase amount rainfall in period 15 years time The last one was in Sanggau, Sekadau and Sintang and some areas that actually occur subtraction rainfall like Bengkayang, Mempawah Landak. Then, increase temperature air occur in period 15 years time final about 0.013 °C per year. Enhancement temperature air 2032 and 2040 in the Kalimantan region are also predicted range Among small (0.76 – 0.8 °C) to with moderate (0.91 – 0.95 °C).

4.2 Suggestion

Enhancement intensification agriculture as anticipation change pattern rain with change pattern plant .

5 THANK-YOU NOTE

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