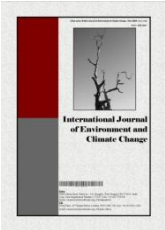

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The Dynamics of Rain Pattern in East Kalimantan

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Climate includes rain is the most dynamic and highly diverse component of the ecosystem, but because the rotation of the earth is a relatively persistent recurring occurrence, the elements of the climate are still likely to be suspected or interpreted.The study aimed to find out the pattern of rainfall on the 2 periods based on historical rain data of 1975-2019 years with a descriptive and authoritative analysis. The annual rainfall rate of East Kalimantan province generally forms an open upward curve, has a value of Q = 0 for both periods, the rainfall pattern tends to change from the C pattern (double wave pattern) in the period 1975-1980 became pattern A (single or single wave) in the period of 2010-2019.

Keywords: Climate; rainfall; rain patterns; forests.

1. INTRODUCTION

Rain plays an important role in hydrological cycles. The water vapour (humidity) from the sea evaporates, turning into clouds, accumulating into a cloudy cloud, then descending back to the Earth, and finally returning to the sea through rivers and tributaries to repeat the recycling again [1]. The intensity of rainfall is the amount of rainfall expressed in the high rain or the volume of rain of each unit of time, which occurs during a period of concentrated water. The intensity of rainfall varies depending on the length of rainfall and frequency of occurrence. Rainfall is the amount of water falling on the surface of the flat over a certain period measured by a high millimetre (mm) unit above the horizontal surface. In other explanations the rainfall can

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also be interpreted as the height of the raindrops accumulated in a flat area, not evaporated, not absorbed and not flowing.

The process of rain is the cycle that occurs in the Earth, namely water cycle. This cycle occurs rotating all the time that balances life on earth, so this could affect the life of all the classification of living creatures on earth. The cycle of rain is an absolute occurrence every year, because it is undeniable that water is a natural resource that is very important for the survival of living creatures and because the water benefits for life will affect the development of Earth is included in agricultural crops [2].

Climate and weather are manifestations of various physics processes in the atmosphere that originate from natural dynamics ranging from global scale to microscale. Climate therefore is the most dynamic and highly diverse component of the ecosystem, very difficult to control and modify and not easy to suspect [3]. However, because the main climate control factor is the rotation of the earth is a relatively constant occurrence, then using the approach of physics and mathematics, climate elements are still possible to be suspected or interpreted by their nature or better known for its characterization of climate elements. Although its role in various systems has been well understood, but in reality it is not uncommon to encounter climate/weather factors are a constraint in the management of the system Avissar et al. [4]. This is due to the limited and lack of appreciation of the elements of the climate, so often the existence of the influence of climate factors in a new system is realized when faced with extreme climate properties. It is also due to lack of understanding in how to exploit it. At other times and sites climate data is very much available, but it cannot be used because it lacks understanding how to use and integrate it into an applicative and useful insformation. Identification and understanding of appropriate climate dynamics is only possible by implementing various physical approaches, analytical methodologies and interpretation and data availability [5].

2. METHODS

According to Bey (1999) to analyze changes in some climate parameters, based on the data of long-term climate parameters (hystorical data). In this study using historical data on rainfall 2 periods, namely before 1981 and a period of 2010-2019, data was obtained from TAD (Transmigration Area Development) Central Bureau of Satistical (BPS). The method used in this research is a quantitative descriptive method with comparative analysis techniques of exploration of the area data and the characteristics of the climate elements that are owned. Rainfall patterns depict the average fluctuations in the monthly rainfall of a region within a year, which can be known by comparing the monthly rainfall value with an average intensity value. The monthly average value is the annual rainfall value divided by 12. Rain pattern determination using methods developed by Trojer (1976) which divide the pattern of rain into 10 pattern shapes (pattern 0 to 9). Next by Puslittanak Team (1994) in Anonymous (1996) modified, so that the entire pattern is broadly grouped into 3 main patterns, namely: Pattern A (single wave), pattern B (multi wave) and pattern C (double wave).

3. RESULTS AND DISCUSSION

The historical monthly rainfall Data used in this study is divided into 7 periods, results of analysis of the Trend of rainfall in East Kalimantan province carried out using the linear equation auto correlation can be known through the equation Y = 2,645.44+31.26 X.The tendency test of rainfall data carried out using the Cox-Stuart test, based on the Binomial distribution table at a real level of 5% indicates the rainfall data for 42 years used in the study is not significant, which means it is not has a tendency (ascending or descending), a pattern of the relationship between rainfall and time forming a curve line open upward.

Vegetation affects rainfall patterns with moisture mediation of air, energy and flux gases between surfaces and atmospheres. The belief that forests needed to be protected to stabilize climate influenced the rise of the first global environmental movement [6]. When the forest is replaced by grasslands or forest crops, the evapotranspiration of soil moisture and vegetation is often reduced, resulting in reduced atmospheric humidity and potentially depressing precipitation [7]. Research on large forests suggested that established canopies and forest ecosystems could have a positive influence on the water balance. Vegetation can contribute as much as 90% of the atmospheric moisture comes from the ground surface which is much more than the previous estimate. The tree produces a water vapor flow more than 10 times greater than that of shrub vegetation per unit

area, exceeding that produced by wet or open water soils. Increasing the carbon dioxide in the atmosphere affects the amount of moisture in the atmosphere and, affecting the amount of rainfall [2], (Lawrence, 2014).

The influence of the physiographic factors of Indonesia's region to the climate element causes three types of rainfall, namely Equatorial, Monsoon and Local. The equatorial type is characterized by twice the maximum monthly rainfall in a year. Monsoon type is influenced by the sea breeze on a very broad scale, this type of rain is characterized by the obvious differences between the rainy and dry season periods of the year, and only happens one time maximum monthly rainfall in a year. Local types are characterized by the magnitude of influence of environmental conditions, such as landscape of waters, mountains and intensive local warming. This pattern only occurs one time maximum of monthly rainfall within one year, and occurs several months of dry [8].

East Kalimantan Province is located in the tropics that crossed the equator line, so that some of its territory is north of the equator (northern hemisphere) and some of its territory is south of the equator (Southern hemisphere). This geographical position causes East Kalimantan province to be influenced by the equatorial climate, which generally leads to having 2 peaks of high rainfall and 2 peaks of low rainfall. Rainfall pattern conditions in the province of East Kalimantan in period 1 and period 7 (Fig. 2).

Based on the annual rainfall data of 1975-2019 as shown in Fig. 2, it can generally be said some changes, as follows:

a. Multiple patterns or Bimodel patterns (double wave), given notation C occurring in the period 1975-1980, with high rainfall occurs in April-May and December-January. Low rainfall occurs in February-March and July-August
b. Single pattern or simple wave, given notation A occurred in the period of 2010-2019 years. With high rainfall occurs in April-May, and low rainfall occurs in July-September

According to Murdiyarso (2003), Aldrian E, and D.Susanto [8] the pattern of rainfall in Indonesia has changed. Most of Java and South Sulawesi, rain intensity in the rainy season tends to increase, while in the dry season it tends to decline or dry. However in some other areas it shows the tendency of the opposite rain pattern. The same conditions also occur at the length of the rainy season, in many areas the rainy season becomes shorter or vice versa.

Overall changes in forest cover can reduce transpiration due to the loss of vegetation, this condition leads to reduced humidity and decreased rainfall. The Model used shows that the forest area that is being used has reduced the annual rainfall to 80%, with areas outside the bare area as well as the impact of rainfall changes. Forest cover changes and large-scale land use could alter rainfall patterns of hundreds to thousands of kilometers away from the deforestation area [7]. This mechanism applies to all types of forests and can be divided into two main classes: physical and chemical. The primary physical mechanism is associated with a process involving albedo, cooling, vaporize and aerodynamic turbulence. Important chemical

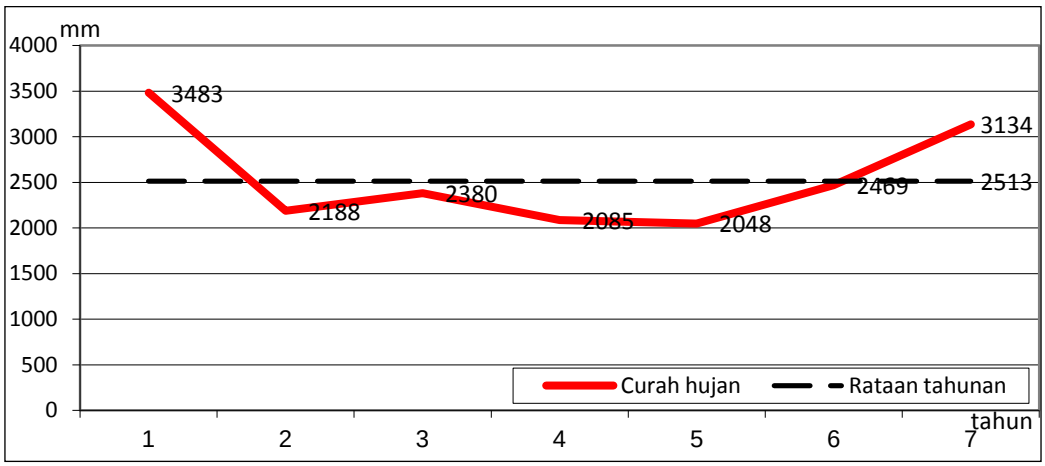

Fig. 1. Average annual rainfall for each period

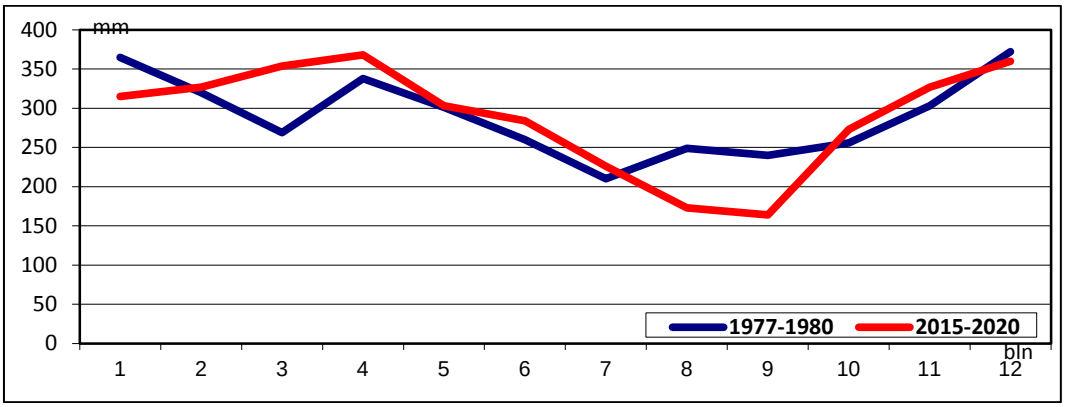

Fig. 2. Rainfall Pattern 1975-1980 and 2015-2019

mechanisms include absorption, and interactions with hydrocarbons and the formation of aerosol particles (Arneth et al., 2010). Forests are absorbing more moisture than the soil than other types of vegetation. This moisture transfer through the trees and evaporation from leaves to the atmosphere cools air through latent heat transfer. The mechanism causes increased moisture above the forest to encourage clouds to be formed and rainfall. Forests also form roughness surfaces that will increase turbulence and reduce wind speeds and subsequently can also improve convection, cloud formation and rainfall [2].

The observation of the East Kalimantan rainfall data period of 1975-2019 shows the change in natural forest cover due to deforestation and degradation activities in the period has increased the dry months to 43% that occurred during the period Year 1981-1985 compared to 2% of dry months that occurred in the period before 1981. Although the relationship between the occurrence of dry-month dried months in East Kalimantan with the magnitude of forest cover change is not linear, but the change of forest cover resulted in the rise of dry months [9]. The condition also occurs in several provinces in India, [10] (Meher, 1986) The 15% land cover depreciation in the 1944-1961 period resulted in a change in rainfall patterns of 36-47% below the average normal rainfall over the same year period, the lowest 20-year rainfall occurred in 1982 of 800 mm/year. The average annual rainfall and number of rainy days in India decreased from 1415 mm in 106 rainy days in the period of 1902-1921 decreased to an average of 1200 mm in 89 rainy days during the 1965-1984 period. The dry years also increased from 8 years in 1902-1922 to 12 years in the period of 1965-1984. The dry years also increased from 8 years in 1902-1922 to 12 years in the period of 1965-1984. Observations up to the year 1988 showed a decrease in rainfall and the number of rainy days not only occurred in the lowlands, as this condition significantly also occurred in the highlands of Kerala and Ranchi Plateau.

In tropical areas, widespread forest cover loss is generally related to erratic rainfall, the rain tends to decrease and the weakening of monsoon atmospheric circulation [11-13]. Forest cover changes are suspected to cause a shift to the east of the rainfall zone in southeast Asia, with potential regional and global impacts that may have been demonstrated by the heat of forest and land fires in Sumatra and Kalimantan, Indonesia. and causing thick haze (Werth and Avissar, 2005). Avissar et al. [4], Webb et al., [1] and Spracklen et al. [7] shows the change in the large-scale land use impacts the circulation of local thermodynamics that can alter rainfall patterns of hundreds to thousands of kilometers away from the deforestation area. Deforestation can reduce evapotranspiration due to the loss of vegetation. Rainfall shifts could be better explained as secular variations rather than as being caused by changes to forests [14-16]. This results in reduced moisture circulation and decreased rainfall [6]. Changes in rainfall patterns can result in drought above normal, especially in the dry season, this condition negatively affects agricultural activities and water availability. The Model indicates that the forest area that is being used has reduced the annual rainfall to 80%, with areas outside the bare area as well as impacting rainfall changes [17].

4. CONCLUSION

Rainfall characteristics during the 1975–2019 period fluctuated, namely in the period 1975-

1985 annual rainfall tended to decrease, the period 1986–2000 annual rainfall tended to be flat, the period 2001-2019 annual rainfall tended to increase. There has been a shift in rainfall patterns from a double pattern or a bimodel pattern that was given C notation, because it experienced 2 periods of rainfall above the annual average and 2 periods of rainfall below the annual average that occurred in the period 1975–1980, tend to be a simple wave given A notation, because it experiences 1 period of rainfall above the annual average and 1 period of rainfall below the annual average that occurred in the period 2010-2019, even so Q value in East Kalimantan has not changed (Q = 0).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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