Trend analysis of total rainfall events with light and heavy intensity for the 1976 – 2019 periode in Majene District – West Sulawesi

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Abstract. The increase of rain events due to climate change can affect local activities in several sectors such as agriculture, trade, infrastructure, etc, so climate information is importantly considered for operational sustainability. Therefore, this research is conducted to determine trend of changes in total rainy days and tendency of rain which refers to light rain <5 mm/day and heavy >30 mm/day every month in Majene based on Majene Meteorological Station data during 1976 – 2019 using linear regression method. Besides this research aims to provide information to related parties to consider policies as anticipatory and mitigating steps for natural phenomena to achieve effective activities. Results of analysis indicated a tendency of increasing trend in total of rainy days, the number of light and heavy rainy days in certain months. Based on rain posts, the increasing number of rainy days is dominantly followed by light rain events. This study informs that climate change has occurred in Majene, namely the increasing number of light rainy days. The information in this study can be used as knowledge to readers and consideration in certain policies, that the light rain happens a lot, but it cannot be denied that heavy rain will occur at any time unexpectedly.

1. Introduction

Changes in the number of rain events occur due to the influence of global warming which has an impact on climate change. Climate change analysis can be carried out using trend analysis methods based on weather elements such as air temperature [1] and rainfall. An increasing number of rain events in several areas can affect local activities that impacts on time effectiveness in several sectors such as agriculture, trade, infrastructure development programs and others [2 – 8]. In recent years, the increasing trend of rain has occurred in almost all region of Indonesia, for example, in the areas of Sumatra, Waingapu, Semarang, Seram Island, Sentani, Merauke, Biak and Timika [9 – 12]. Some areas that have been mentioned have a positive trend value, which means that the number of rain events has increased and is predicted to continue to increase.

This study aims to determine the trend of changes in total rainy days and the tendency of rain which refers to rain with a light intensity <5 mm/day and heavy >30 mm/day in every month throughout the year in Majene Regency area based on data from the Majene Meteorological Station in the 1976 – 2019 period which carried out using the linear regression method, besides this research aims to provide information to related parties to consider the policies that will be made as well as anticipatory and
mitigating steps against natural phenomena that have and will occur in order to achieve effective activities regarding operational in related sectors.

2. Data and methods

The trend determination of changes in the number of rain events carried out in this study aims to determine how much the change or the growth in the number of monthly and annual rainfall events that occur in Majene Regency, West Sulawesi [13]. In determining this trend, time series climate data are used with a long period of time, namely the 1976 – 2019 period. The data used are observation data from several rain posts belonging to the BMKG Majene, including the Majene Meteorological Station rain post, Sendana rain post, East Banggae rain post, Malunda rain post, Pamboang rain post and Banggae rain post.

3. Results and discussion

In Figure 1a, it can be seen that the tendency of the growth rate of rainfall events <5 mm/day or rain with light intensity with the highest number of trend escalation occurred in July with a growth value of 0.0815 events/year and the lowest number of trend derivation occurred in November or in that month is dominated by heavy rainfall with intensity of >30 mm/day. Furthermore, for rainfall events >30 mm/day or rain with heavy intensity with the highest number of escalation occurred in April with a growth value of 0.0299 events/year and the lowest trend derivation occurred in March or in that month is dominated by rain with light intensity. Then the number of rainy days with the highest number of trend escalation occurred in June with a growth value of 0.0741 days/year and the lowest occurred in March. Overall (Figure 1a), the tendency of the number of rainy days at Majene Meteorological Station has experienced a decrease and on those rainy days is dominated by the increasing number of rainy days with light intensity compared to heavy rainfall in each year in certain months.

In Figure 1b, it can be seen that the tendency of the growth rate of rainfall events <5 mm/day or rain with light intensity has increased by 0.1784 times/year compared to rainfall events with heavy intensity > 30 mm/day which has experienced a derivation in the number of events by −0.0402 times/year 1984 – 2019 period. The escalation in rainfall events <5 mm/day was accompanied by an increase in the number of rainy days with a growth rate of 0.0224 days/year. Based on Figure 1b, the escalation tendency in the number of rainy days that occurs in the Majene Meteorological Station area is dominated by rain with light intensity <5 mm/day. This analysis is supported by Figure 1a which shows that the number of months that experienced an increase in the amount of rainfall between light and heavy rain
were more dominated by rain with light intensity namely 8 months, compared to rain with heavy intensity which were only 5 months.

In Figure 2a, it can be seen that the tendency of growth rate of rainfall events <5mm / day or rain with light intensity with the highest number of trend escalation occurred in May with a growth value of 0.0701 events/year and the lowest number of derivation occurred in November or that month is dominated by heavy rainfall with an intensity of >30 mm/day. Furthermore, for rainfall events >30 mm/day or rain with heavy intensity with the highest number of escalation occurred in April with a growth value of 0.0813 events/year and the lowest derivation occurred in March and May or in those months dominated by light rain intensity. Then the number of rainy days with the highest trend escalation occurred in October with a growth value of 0.1504 days/year and the lowest occurred in January. Overall (Figure 2a), the tendency in the number of rainy days at Sendana Rain Post has experienced an increase and on those rainy days were dominated by the increasing number of rainy days with light intensity, compared to rain with heavy intensity in each year in certain months.

In Figure 2b, it can be seen that the tendency of the growth rate of rainfall events of <5 mm/day or rain with light intensity has experienced an increase by 0.334 times/year compared to rainfall events with heavy intensity >30 mm/day, which is 0.0121 times / year for the 1977 – 2019 period. The escalation in the incidence of rainfall <5 mm/day was accompanied by an increase in the number of rainy days with growth rate of 1.1882 days/year. Based on Figure 2b, the escalation tendency in the number of rainy days that occurred in the Sendana Rain Post area was dominated by rain with a light intensity <5 mm/day. This analysis is supported by Figure 2a which shows that the number of months that experienced an increase in the amount of rainfall between light and heavy rain were more dominated by rain with light intensity namely 11 months, compared to rain with heavy intensity, which were only 4 months.

In Figure 3a, it can be seen that the tendency of the growth rate of rainfall events <5 mm/day or rain with light intensity with the highest number of trend escalation occurred in February with a growth value of 0.0511 events/year and the lowest number of derivation occurred in April or that month is dominated by heavy rainfall with an intensity of >30 mm/day. Furthermore, for rainfall events > 30 mm/day or rain with heavy intensity with the highest number of escalation occurred in April with a growth value of 0.0106 events/year and the lowest trend derivation occurred in November or in that month dominated by rain with light intensity. Then the number of rainy days with the highest trend escalation occurred in June with a growth value of 0.0292 days/year and the lowest occurred in March. Overall (Figure 3a), the tendency in the number of monthly rainy days throughout the year in Banggae Timur Rain Post has experienced a derivation and on these rainy days is dominated by the increasing number of rainy days with light intensity compared to rain with heavy intensity in each year in certain months.
Figure 3. a) Trend of rainfall changes <5 mm/day, >30 mm/day and the number of monthly rainy days in the 1976 – 2019 period at Banggae Timur Rain Post; b) Trend of rainfall changes <5 mm/day, >30 mm/day and the number of annual rainy days in the 1976 – 2019 period at Banggae Timur Rain Post.

In Figure 3b, it can be seen that the tendency of the growth rate of rainfall events <5 mm/day or rain with light intensity has increased by 0.2557 times/year compared to rainfall events with heavy intensity >30 mm/day which tends to decrease by –0.2468 times/year in the 1976 – 2019 period. Although the number of rainy days and rain events with heavy intensity tend to decrease, the number of rainfall events with light intensity <5 mm/day is increasing. It can be seen from Figure 3a that rain with light intensity occurs more frequently throughout the year in certain months, although the number of rainy days and rain events with heavy intensity experienced a derivation. This means that the rain that often occurs in the Banggae Timur Rain Post area until 2019 is rain with light intensity of <5 mm/day and the number of rainy days occurrences throughout the year in certain months in the region tend to decrease.

Figure 4. a) Trend of rainfall changes <5 mm/day, >30 mm/day and the number of monthly rainy days for the 1976 – 2019 period at Malunda Rain Post; b) Trend of rainfall changes <5 mm/day, >30 mm/day and the number of annual rainy days for the 1976 – 2019 period at Malunda Rain Post.

In Figure 4a, it can be seen that the tendency of the growth rate of rainfall events of <5 mm/day or rain with light intensity with the highest number of trend escalation occurs in July with a growth value of 0.063 events/year and the lowest number of trends occurs in November or in that month it is dominated by heavy rainfall with an intensity of > 30 mm/day. Furthermore, for rainfall events >30 mm/day or rain with heavy intensity with the highest number of escalation occurred in November with a growth value of 0.0536 events/year and the lowest trend derivation occurred in August or in that month it is dominated by rain events with light intensity. Then the number of rainy days with the highest number
of trend escalation occurred in December with a growth value of 0.1937 days/year and the lowest occurred in September. Overall (Figure 4a), the tendency in the number of monthly rainy days throughout the year at Malunda Rain Post has experienced an increase, accompanied by an increase in the number of rain events with light and heavy intensity.

In Figure 4b, it can be seen that the tendency of the growth rate of rainfall events of <5 mm/day or rain with light intensity has experienced an increase by 0.4884 times/year compared to the rain events with heavy intensity >30 mm/day, which is 0.3967 times/year for the 1976 – 2019 period. The increase in rain events with intensity of <5 mm/day was accompanied by an increase in the number of rainy days with a growth rate of 1.6692 days/year. Based on Figure 4b the escalation tendency in the number of rainy days that occurred in Malunda Rain Post area was followed by an increase in the number of rain events with light and heavy intensity, but still dominated by rain with light intensity <5 mm/day compared to rain with heavy intensity >30 mm/day. This analysis is supported by Figure 4a which shows that the number of rainy day occurrences, rain with light and heavy intensity tends to experience an increase in the number of events in each month throughout the year.

In Figure 5a, it can be seen that the tendency of the growth rate of rainfall events of <5 mm/day or rain with light intensity with the highest number of trend escalation occurred in January with a growth value of 0.2186 events/year and the lowest number of trends occurred in February. Furthermore, for rainfall events >30 mm/day or rain with heavy intensity with the highest number of escalation occurred in October with a growth value of 0.0498 events/year and the lowest trend derivation occurred in January or in that month it is dominated by rain with light intensity. Then the number of rainy days with the highest number of trend escalation occurred in October with a growth value of 0.3185 days/year and the lowest occurred in March. Overall (Figure 5a) the tendency in the number of monthly rainy days throughout the year at Pamboang Rain Post has experienced an increase accompanied by an increase in the number of rain events with light intensity.

In Figure 5b, it can be seen that the tendency of the growth rate of rainfall events <5 mm/day or rain with light intensity has experienced an increase by 1.4291 times/year compared to rainfall events with heavy intensity >30 mm/day, which is 0.1219 times/year for the 1980 – 2019 period. The increase in rainfall events <5 mm/day was accompanied by an increase in the number of rainy days with a growth rate of 1.8504 days/year. Based on Figure 5b, the escalation in the number of rainy days that occurs in Pamboang Rain Post area is followed by an increase in the number of rain events with light and heavy intensity, but still dominated by rain with light intensity <5 mm/day compared to rain with heavy intensity >30 mm/day. This analysis is supported by Figure 5a which shows that the number of rainy days, rain with light and heavy intensity tend to experience an increase in the number of events in each
month throughout the year. Although rainfall trend with heavy intensity in certain months, such as January, March and November, tend to decline.

Figure 6. a) Trend of rainfall changes <5 mm/day, >30 mm/day and the number of monthly rainy days for the 1994 – 2019 period at Banggae Rain Post; b) Trend of rainfall changes <5 mm/day, >30 mm/day and the number of annual rainy days for the 1994 – 2019 period at Banggae Rain Post

In Figure 6a, it can be seen that the tendency of the growth rate of rainfall events of <5 mm/day or rain with light intensity with the highest number of trend escalation occurred in June with a growth value of 0.2186 events/year and the lowest number of trends occurred in December. Furthermore, for rainfall events >30 mm/day or rain with heavy intensity with the highest number of escalation occurred in October with a growth value of 0.0523 events/year and the lowest trend degradation occurred in March or in that month it is dominated by rain with light intensity. Then the number of rainy days with the highest number of trend escalation occurred in June with a growth value of 0.2779 days/year and the lowest occurred in March. Overall (Figure 6a), the tendency in the number of monthly rainy days throughout the year in Banggae Rain Post has experienced an increase, accompanied by an increase in the number of rain events with light intensity.

In Figure 6b, it can be seen that the tendency of the growth rate of rainfall events <5 mm/day or rain with light intensity has experienced an increase by 0.3504 times/year compared to rainfall events with heavy intensity >30 mm/day, which is 0.1074 times/year for the 1994 – 2019 period. The increase in rainfall events <5 mm/day was accompanied by an increase in the number of rainy days with a growth rate of 0.9812 days/year. Based on Figure 6b, the escalation tendency in the number of rainy days that occurred in Banggae Rain Post area was followed by an increase in the number of rain events with light and heavy intensity, but still dominated by rain with light intensity of <5 mm/day compared to rain with heavy intensity of >30 mm/day. This analysis is supported by Figure 6a which shows that the number of rainy days, rain with light intensity and heavy intensity tend to experience an increase in the number of events in certain months each year.

This research is supported by previous studies which state that climate change is really happening. Climate change can be seen from the trend of several weather parameters such as rainfall and air temperature, besides human activity and greenhouse gases from motorized vehicles, factories and volcanoes can also be used as indicators of climate change in an area that causes natural conditions in certain areas experience changes in land cover so that the climate condition in its area changes. This global phenomenon has a serious impact on the world for economic growth through disruption of activities in several vital sectors such as agriculture, trade, infrastructure and others because it can slow down (time effectiveness) activities in vital sectors [3–5, 8, 14, 15]. Adaptation and mitigation regarding climate change need to be carried out in order to reduce the number of worst risks that can occur such as crop failure, stagnation of trade through expeditions and obstruction of infrastructure development which in turn can harm the parties concerned [16, 17].
4. Conclusion
From the results and discussion, it was found that the number of rainfall events with light intensity <5mm / day, dense intensity > 30mm / day and the number of rainy days in the Majene Regency, West Sulawesi Province tended to increase in certain months throughout the year based on the available data period. The increase in the number of dominant rainy days was followed by an increase in the number of light rain events compared to heavy rain events. This study informs that climate change has occurred in the Majene Regency, namely the increasing number of rainy days with light intensity. Information contained in this study can be used as knowledge to readers and consideration in certain policies that the rain which often occurs is the rain with light intensity, but it cannot be denied that rain with heavy intensity will occur at any time unexpectedly.

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References
[1] Nugroho S, Febriamansyah R, Ekaputra D G 2019 J. Ilmu Lingkung 17 7–14
[2] Apriana Y, Susanti E, Ramadhani F and Surmaini E 2016 inform.Pertan 25 69–80
[3] Estiningtyas W and Syakir M 2018 J. Meteorol. dan Geofis 18 2
[4] Adidarma W K, Martawati L, Syofyan D M K, Levina L and Subrata O 2010 J. Tek. Hidraul 1 43–56
[5] Kurniawan T and Azizi A 2012 J. Masy. Dan Budaya 14 499–518
[6] Ruminta R, Irwan A W, Nurmal A and Ramadayanty G 2020 Analisis dampak perubahan iklim terhadap produksi kedelai dan pilihan adaptasi strategisnya pada lahan tadah hujan di Kabupaten Garut Kultivasi 19 1089–1097
[7] Salam A R, Haryotejo B, Mahatama E and Fakhruddin U 2012 JurnalStandardisasi BSN 14 117–130
[8] Ridwan R and Chazanah N 2013 J. Tek. Sipil 20 113–142
[9] Laimheriwa S, Madubun E L and Rarsina E D 2020 Analisis Tren Perubahan Curah Hujan dan Pemetaan Klasiikasi Iklim Schmidt-Ferguson untuk Penentuan Kesaualan Iklim Tanaman Pala (Myristica fragrans) di Pulau Seram Agrologia 8 71–81
[10] Puspitasari N and Surendra O 2016 J. MIPA dan Pengajarannya 16 66–72
[11] Perdanawanti M 2019 Trend of Extreme Precipitation over Sumatera Island for 1981-2010 Agromet 33 41–51
[12] Kusumawardhani I D and Gernowo R 2015 Youngster Phys. J 4 49–54
[13] Garuda S R and Banti Y 2018 Inform. Pertain 27 35–46
[14] NSS R I P, Suryawardana E and Triyani D 2015 J. Din. Sos. Budaya 17 82–103
[15] Sunarti S and Apriliasari N K 2015 Dampak Perubahan Iklim terhadap Perumkin Pesisri di Kelurahan Demaan kabupaten Jepara TATAFOKA 17 248–256
[16] Kusumasari B 2015 J. Kebeancanaan Indones. 4 2–15
[17] Putri T D, Sunarsih S and Muhammad F Proceeding Biology Education Conference: Biology, Science, Enviromental, and Learning 16 256–264