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Rainfall Pattern in Maros District South Sulawesi Using the Isohyet Method

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ABSTRACT

Extreme rainfall that often occurs in South Sulawesi is caused by high rainfall intensity. Rainfall patterns greatly affect areas that are highly dependent on agriculture and natural resources. In this regard, research has been conducted on rainfall patterns in Maros Regency. The study used rainfall data analyzed using the isohyet method. The results of the study showed that rainfall patterns in the Maros Regency area in the last 10 years showed increasing shifts and variability, especially in the last three years (2021-2023). This can be seen on the 2014-2020 isohyet map showing that the distribution of rainfall in Maros Regency is uneven, with a tendency for increasing rainfall from the southwest to the northeast, in 2021 there was a change in rainfall intensity in the northeast and several central areas, in 2022 there was a decrease in the highest rainfall in the northeast and an expansion of the low rainfall area to the center, in 2023 an increase in rainfall in the southwest, the dominance of the 2000-3000 mm interval in most areas, and the disappearance of the very high rainfall zone in the northeast are important changes that indicate significant climate dynamics

INTRODUCTION

In general, Indonesia has a diverse climate, which can be divided into three main patterns: monsoonal, equatorial, and local. (Molle & Larasati, 2020). Rain is a major component of the water cycle and is responsible for depositing most of the fresh water on earth through the hydrological cycle process in the environment. Climate change has strengthened the need for accurate information on statistical variations in rainfall characteristics that vary over time and are influenced by local regional climate systems (Rusdi et al., 2023).

The distribution of rainfall varies depending on latitude, geographical position, and topographic conditions. One of the climate classifications widely used in Indonesia is the Oldeman classification, because it is related to the agricultural sector (Akhirianto, 2020).

The use of rainfall data from rainfall stations can be analyzed based on the project/area to be reviewed. This rainfall data is considered to be able to represent the rainfall intensity at the observation location. The first step in hydrological analysis is to determine the rainfall station to be used. After that, plot the rainfall station on a map to find out which stations are influential. Next, a hydrological analysis is carried out based on the rainfall data used (Rifan, 2017).

Various targets for water building planning, land erosivity and landslide estimation require rainfall data. Maximum daily rainfall data is needed to calculate regional rainfall. Regional rainfall in a catchment area or watershed can be calculated using the Thiessen Polygon, Isohyet and arithmetic mean methods. The maximum rainfall data is subjected to frequency analysis to produce the planned rainfall intensity in the specified return period (Irawan, 2020).

Extreme rainfall that often occurs in South Sulawesi is caused by high rainfall intensity. This can cause various disasters, such as floods, landslides, and strong winds. (Msy Aulia et al., 2021). High rainfall in South Sulawesi can cause various hydrometeorological disasters. These disasters have caused damage and losses in many areas, including Maros Regency. However, the daily lives of Indonesians are highly dependent on rain. Rainfall patterns greatly affect areas that are highly dependent on agriculture and its natural resources (Anida, 2029). Rainfall plays an important role in determining aspects of life, including agriculture. (Faradiba, 2020). Therefore, a deep understanding of the characteristics of rainfall in this area is essential to designing sustainable development strategies that can accommodate these various aspects.

Based on the phenomena and several theoretical studies that have been put forward previously, the researcher intends to review the problem of rainfall patterns by conducting research entitled "How is the rainfall pattern in Maros Regency using the isohyet method?"

Specifically, this study aims to answer the previous problem formulation, namely: To find out how the rainfall pattern in Maros Regency uses the isohyet method.

METHODS

Types of Research

The research method used in this study is a type of quantitative descriptive research with spatial analysis is the most appropriate approach to answer the formulation of the problem regarding the distribution pattern of agricultural crops in Maros Regency related to rainfall events using the isohyet method. This study will produce a clear and measurable picture of the spatial relationship between the two variables.

The data used in this study are secondary data. The research data are in the form of rainfall data for five years in a time interval. In addition to annual rainfall data, other data are coordinate data for each region that has a Rainfall Station or Post. There is also data on the Indonesian Topographic Map (RBI), which is a topographic map that shows some of the natural elements and man-made elements of regions in Indonesia.

Time and Place of Research

1. Research Time
   This research will be conducted from February to March 2024.
2. Research Place

This research was conducted at the Meteorology, Climatology, and Geophysics Agency (BMKG) Maros Climatology Station.

Research Focus

This study focuses on rainfall patterns in Maros Regency, and analyzes rainfall patterns in Maros Regency during a certain period

Data Collection Technique

Data collection techniques for rainfall research can be grouped into three, namely:

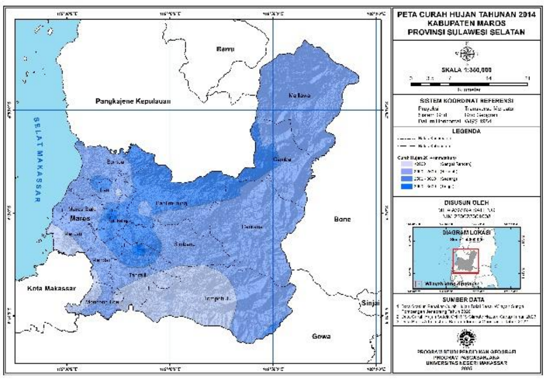
1. Rainfall Data: Collection of secondary data from BMKG and other relevant sources for an adequate time period.
2. Plant Distribution Data:
   a. Secondary data collection in the form of distribution maps, harvest area statistics, and cropping pattern information from the Department of Agriculture.
   b. Field survey (observation and interviews) to validate and complete secondary data.
   c. (Optional) Use of high resolution satellite imagery for agricultural land cover mapping.
3. Geographic and Topographic Data: Collection of RBI maps and DEM data from BIG or other reliable sources.

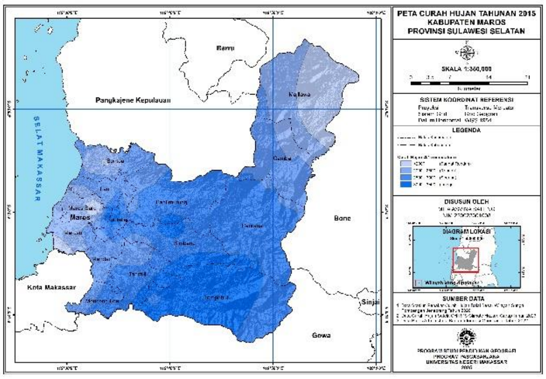
Data Analysis Techniques

1. Rainfall Data Analysis (Using Isohyet Map):
   a. Making an Isohyet Map:
      1) Data Collection: Collect rainfall data from various observation stations in and around Maros Regency for a relevant time period (e.g., annual average for the last 5-10 years or monthly/seasonal rainfall data).
      2) Station Mapping: Plot the locations of observation stations on the base map of Maros Regency.
      3) Interpolation: Use spatial interpolation methods (such as Inverse Distance Weighting/IDW or Kriging using GIS software) to estimate rainfall values between observation stations. Choose the interpolation method that best suits the data characteristics and station distribution.
      4) Isohyet Line Formation: Draw isohyet lines connecting points with the same rainfall value based on the interpolation results. Determine representative isohyet intervals to describe rainfall variations.
      5) Map Visualization: Generate clear and informative isohyet maps with appropriate legends.

RESULTS AND DISCUSSION

Rainfall Patterns in Maros Regency Using the Isohyet Method

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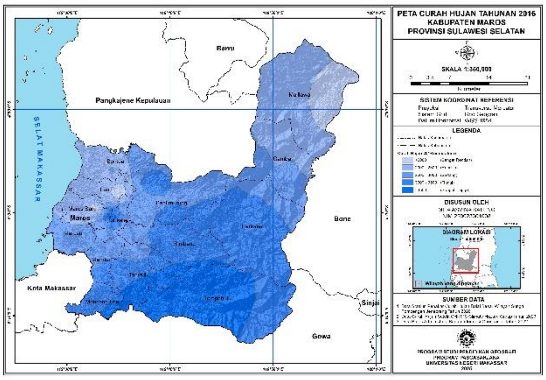
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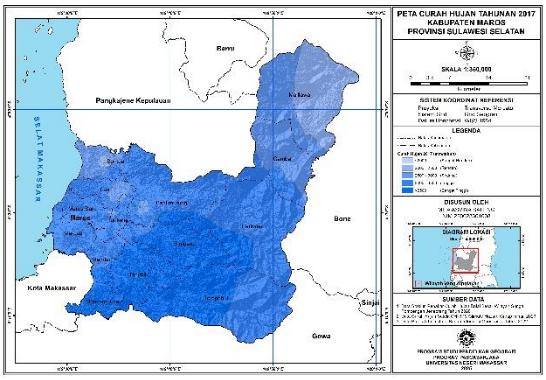
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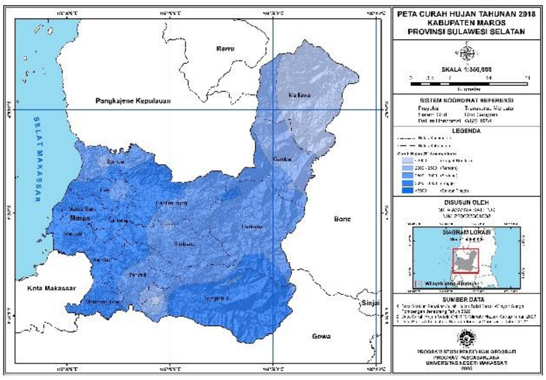
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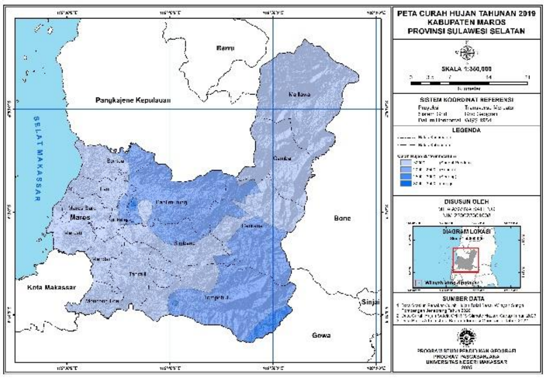
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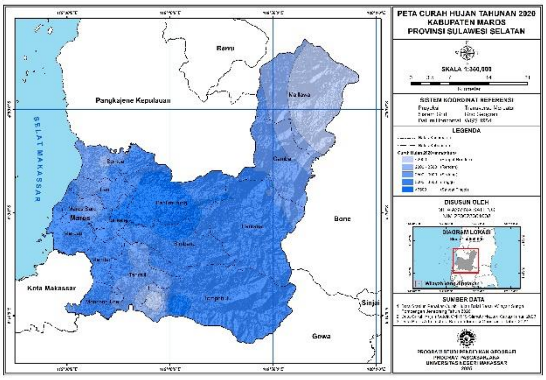
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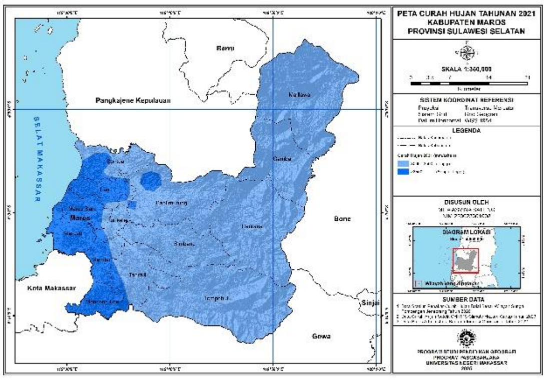
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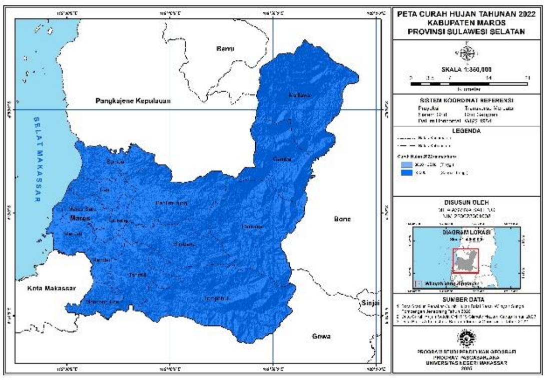
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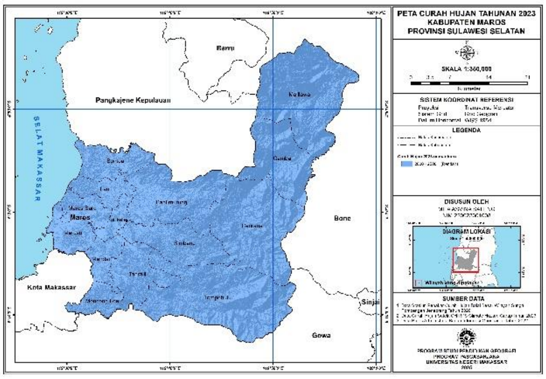

Figure 1. Rainfall Patterns in Maros Regency Using the Isohyet Method

Rainfall in Maros Regency ranges from 2000 mm to more than 3500 mm per year. Rainfall in Maros Regency varies from low to very high. High rainfall is spread across the sub-districts of Bantimurung, Simbang and Tompobulu. Rainfall decreases following the height of the earth's surface. Rainfall in the western part which is the western slope of the Maros Mountains has high rainfall, but on the eastern slope of the Maros Mountains rainfall is low. This area includes Cenrana, Camba and Malawa Districts. The western slope is influenced by the western monsoon which has high rainfall, and the eastern slope is influenced by the eastern monsoon which has low to very low rainfall (Hasriyanti, 2019). Maros Regency's rainfall is included in the monsoon rainfall pattern type. Rainfall is the main factor in the availability of water in an area. High rainfall is supported by rock, soil and vegetation factors. Mountain slopes are an area that has great water potential. There is a strong relationship between rainfall and the availability of water, both groundwater and surface water.

Land use in Maros Regency is mostly pond, rice field, and dry land agriculture (dry land) and less than 30% forest land, both natural forest and secondary forest. Land use plays an important role in the potential for drought in an area. Therefore, land cover functions as a water reservoir. The more plants in an area, the greater the groundwater. Forests are very effective in controlling surface flow and increasing the infiltration rate in the upstream watershed area. The use of residential land, open land and mining has the potential to dry out due to lack of infiltration because most of the water becomes surface runoff into rivers and reaches the sea. Land that has no vegetation, direct sunlight and wind will experience evaporation that occurs directly on the surface of the land. This causes a lot of water loss (Hasriyanti, 2024).

In general, during the 2014-2020 period, the rainfall pattern in Maros Regency showed a relatively stable trend, namely an increase in rainfall from the southwest (around Maros Baru and Turikale) which has the lowest annual rainfall (less than 2000 mm) to the northeast (Camba and Mallawa) which consistently has the highest annual rainfall (often exceeding 3000 mm). This pattern is in accordance with the orographic principle, where higher areas (northeast) receive more rainfall due to the effects of mountains (Lesik et al., 2020).

The maximum effective rainfall r 80 Tasikmalaya (83.46 mm / month) 89.7% greater than the maximum effective rainfall r 80 Garut (44.00 mm / month). The maximum effective rainfall r 50 Tasikmalaya (152.75 mm / month) 98.25% greater than the maximum effective rainfall r 50 Garut (77.05 mm / month). R ef rice Tasikmalaya (58.42 mm / month) 89.67% greater than r ef rice Garut regency (30.80 mm / month). R ef crops Tasikmalaya (106.93 mm / month) 98.23% greater than r ef rice Garut regency (53.94 mm/ month). Return period rainfall Tasikmalaya higher than the return period rainfall Garut. The results of the research of effective precipitation rice and pulses can be used as a material consideration cropping pattern for maximum results. Future studies should use data from a variety of STA in Garut and Tasikmalaya City to see the influence of both regions tofografi to precipitation (Hidayat & Empung, 2016).

The results showed (Prasetyo et al., 2018) that the monthly, inter-seasonal and interannual scale of North Sumatra rainfall variability on all the six topographic areas were different compared to each other. The average rainfall of North Sumatra generally decreased from the West to East, causing significant differences between regions located in the East and in the West. The highest rainfall that occurred in the West Coast region is 230–570 mm/month or >4550mm/year, whereas the lowest rainfall that occurred in the East Coast region is 100–150 mm/month or 1500– 2000 mm/year. The peak of North Sumatera rainfall generally occurs during the month of November, except in the Eastern coast and slope area which occurs during October. Annual rainfall generally showed negative anomaly standard value during the 90s and positive anomaly after the year 2000 except in the Eastern Slope and Islands region.

Based on the results of the analysis and testing of rainfall data at three rainfall monitoring stations in the Tangerang Regency area, namely: Budiarto Curug Meteorological Station, UPTD Jatiwaringin Mauk Rain Post and BPP Tegal Kunir Rain Post, it can be concluded that the rainfall data is normally distributed, with a minimum P-Value (0.009> 0.005) and a maximum (0.115), and through the Kolmogorov-Smirnov test with a minimum value of 0.103 and a maximum of 0.195. The results of rainfall mapping in the Tangerang Regency area using the Isohyet Method also show that rainfall in the area is evenly distributed (Damayanti et al., 2018).

The accuracy of parameter validation using rainfall data thiessen polygon method and slope parameters using DEM TerraSAR-X with AHP weighting with an accuracy of 81.81% while map validation from parameters using rainfall data using thiessen polygon method with slope parameters using DEM TerraSAR-X by weighting the Indonesian National Standard with an accuracy rate of 83.64%. Therefore the use of geographic information systems can be used more efficiently to determine landslide-prone areas quickly and precisely (Pangaribuan et al., 2019).

During this six-year period, the spatial distribution of rainfall zones tends to be persistent. The southwest region is consistently a dry area, the central region has moderate rainfall (2000-2500 mm), and the northeast region is a pocket of high rainfall (2500-3000 mm and above 3000 mm). This indicates strong geographic and climatic controls on rainfall distribution in Maros Regency. The rainfall pattern in South Sulawesi is influenced by the monsoon pattern (Julianti, 2023) Changes Begin to Appear in 2021: The 2021 map indicates a change in pattern, most notably with the convergence of the highest rainfall zone in the northeast into the 2000-3000 mm interval, indicating a potential reduction in extreme rainfall in the region.

The area of Nabire Regency with 12.075,00 km2 includes the category of place with high rainfall intensity where the average rainfall ranges from 2000 mm – 5000 mm per year. The results of rainfall mapping with IDW (Inverse Distance Weighting) interpolation and Kriging interpolation show that there are several areas with the highest rainfall, Napan, Siriwo, Kimi, Menou, and Dipa, while the lowest rainfall areas are in the coastal areas, Teluk Umar and the northern region of Wapoga.(Prayitno et al., 2023).

The benefit that can be obtained from this research is that the rainfall in the Upper Citanduy watershed can be digitally mapped for periods of 2 years, 5 years, 10 years, 25 years, 50 years, 100 years, 200 years and 1000 years. This map will facilitate research and studies on hydrology in the Upper Citanduy watershed. The method used is starting from the data resilience test, analysis of the frequency of rain, planning the rain intensity design to mapping using ArcGIS 10.5 software. The results of the analysis are in the form of rain plan ishyet map in the Citanduy watershed with a return period of 2 years, 5 years, 10 years, 25 years, 50 years, 100 years, 200 years and 1000 years. These results are very important for water construction planning, flood safety and potential hydrological disasters (Irawan et al., 2020).

The results of the calculation of rainfall from the three observation posts show that the rainfall in the Tangerang Regency area is normally distributed. The results of the rainfall mapping using the Isohyet method also show that the rainfall in the Tangerang Regency area is evenly distributed (Nurhijriah et al., 2022)

The pattern changes become more pronounced in 2022 with the disappearance of the rainfall zone above 3000 mm in the northeast and the expansion of the low rainfall area to some central parts. This indicates stronger climate dynamics affecting rainfall distribution.

The 2023 map shows substantial changes. The southwest region experienced increased rainfall, the 2000-3000 mm interval became dominant in almost the entire region, and the very high rainfall zone in the northeast disappeared. This indicates a significant change in rainfall distribution in Maros Regency this year. These changes indicate that annual climate variability and regional factors play an increasingly important role. Climate phenomena such as El Niño-Southern Oscillation (ENSO) can significantly affect rainfall patterns (Sitompul & Nurjani, 2013).

CONCLUSION

Overall, the annual rainfall pattern in Maros Regency from 2014 to 2023 shows a shift and increasing variability, especially in the last three years (2021-2023). Although the general trend of increasing rainfall from the southwest to the northeast was stable in the early period, there was a significant change leading to a different rainfall distribution in 2023. The decrease in the highest rainfall in the northeast and the increase in the southwest are important trends that need to be considered. Annual climate variability and regional factors are likely to play an important role in this changing pattern. A deep understanding of these changes is important for development planning, natural resource management, and disaster risk mitigation in Maros Regency.

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