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Study of regional topography and rainfall distribution using the Inverse Distance Weighted (IDW) interpolation method in Serang City

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ABSTRAK

Indonesia has a reasonably large area with a high level of weather and climate diversity, causing various parts of the region to experience rain with different characteristics, one of which is influenced by the topography of the area so that it is not possible to use just one rain gauge to describe the rain in a region. Therefore, it requires the average rainfall from several nearby rain measurement stations or posts. This research aims to describe the influence of regional topography on the distribution of rainfall in Serang City using the Inverse Distance Weighted (IDW) interpolation method by varying the power value and processing and analyzing using the Geographic Information System (GIS). The research method used is non-experimental quantitative with spatial reclassification analysis. The data used is secondary data collected from previously existing data. The results of the research show that in areas that are at low altitudes and have gentle slopes, the average rainfall will be low, namely 1414.91 mm/year, and vice versa; if areas are at high altitudes and have steep slopes, the average rainfall is The rainfall will be high namely 1644.6 mm/year.

Keywords: IDW Interpolation, Rainfall, Topography.

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INTRODUCTION

Topography is the difference in an area's height or shape, including variations in slope slope, slope length, and slope location (Nurhijriah et al., 2022). Meanwhile, regional topography is a discussion of an area and generally refers to horizontal coordinates, such as latitude and longitude, as well as vertical coordinates, namely height (Astuti et al., 2021). Uneven topography, such as mountains and valleys, influences the rainfall that occurs in an area (Prasetyo et al., 2018).

Rainfall has units of millimeters, namely the height of precipitation that accumulates ina flat area, does not evaporate, does not flow, and does not seep (Gamarra et al., 2019). The characteristics of rainfall in various regions are different; several factors influence the characteristics of rainfall, such as latitude, altitude, wind patterns, distribution of land and water landscapes, mountains, and high mountains (Ruqoyah et al., 2023).

Geographic Information System (GIS) is a computer-based information system developed significantly over the last five years (Reddy, 2018). GIS functions for storing, managing, analyzing, and retrieving geographically referenced data to make it easier for users to determine choices related to spatial aspects (Wibowo et al., 2015). Using GIS, processing Data analysis can be done digitally, and is faster and more effective, and the data storage capacity is much greater than manual data (Masnur et al., 2022).

Interpolation is a process for determining observation values at a place or point based on the observation values around it (Akbar et al., 2022). When carrying out interpolation, an error will result due to a mistake in determining the data sampling method or an error in analysis in the laboratory (Simbolon et al., 2022). Meanwhile, Inverse Distance Weighted (IDW) is an interpolation method used to estimate a value at a location that does not have data with surrounding data as a reference (Purnomo, 2018).

Astronomically, Serang City is located between 5°99′ − 6 °22′ South Latitude and 106°07′ − 106°25′ East Longitude, located in Banten Province. Serang City consists of 6 sub-districts with different topography (relief) (Irnawati et al., 2020). The city of Serang has an area of 266.18 km^2; most of the Serang city area is in the lowlands with an average height of less than 500 meters above sea level (meters above sea level) (Serang, 2021).

RESEARCH METHODS

This research uses secondary data in the form of administrative data from Indonesia, Digital Elevation Model (DEM) data, coordinate data for rain measurement stations and posts, as well as ten years of rainfall data, namely 2012-2021, which was obtained from the Serang Class I Maritime Meteorological Station, BPTPHP Banten Province and BPTP Banten (Handayani et al., 2018). The instruments used were Microsoft Excel and ArcGIS software.

The GIS application in the form of ArcGIS 10.8 software is used using spatial analysis methods (Darmawan et al., 2023). It utilizes several tools contained in the application to create maps of Regency/City boundaries in Banten Province (Suni & Suni, 2023). The reclassification technique creates relief conditions (topography) with classifications from low to high altitudes with flat conditions and gentle slopes to steep slopes (Giyanto, 2022).

The average annual rainfall data was processed using ArcGIS 10.8 to obtain the rainfall distribution (Jati, 2016). The processing method is carried out by entering the coordinate data of the rain measurement post, then mapping using the inverse distance weighted (IDW) interpolation method using variations in power values and calculating the RMSE value of each variation (Ghazali et al., 2022).

Root Mean Square Error (RMSE) measures the error size resulting from observation data with estimated data (ANTARA & SQUARE, 2020). Equation 1 is the RMSE calculation formula

$$RMSE = \sqrt{\frac{1}{n}\sum_{k=1}^{n}\left(y_k - o_k\right)^2} \quad (1)$$

Information:

$y_k =$ Observed value on location k

$o_k =$ Value observed at location k with the MAE method

$n =$ Number of pairs of observed and predicted values

After the rainfall distribution map shapefile data with the smallest RMSE value is obtained, the ArcGIS application uses the overlay technique.

RESULTS AND DISCUSSION

In general, the topography of the Serang City area is lowland, ranging from 0 to 337 meters above sea level (meters above sea level). Figure 1 shows a topographic map of the Serang City area (Cahya & Metalia, 2011). The information obtained from Figure 1 is that Serang City is classified into five classes, namely: dark green indicates a height of less than 5 meters above sea level (meters above sea level), which has a flat or very flat relief (topography), covering the northern part of Kasemen District. These results are in accordance with the results of research conducted by Mirajiani (2017) and Mahpudoh et al., (2021) which shows that the Kasemen area, Serang City is included in the lowlands.

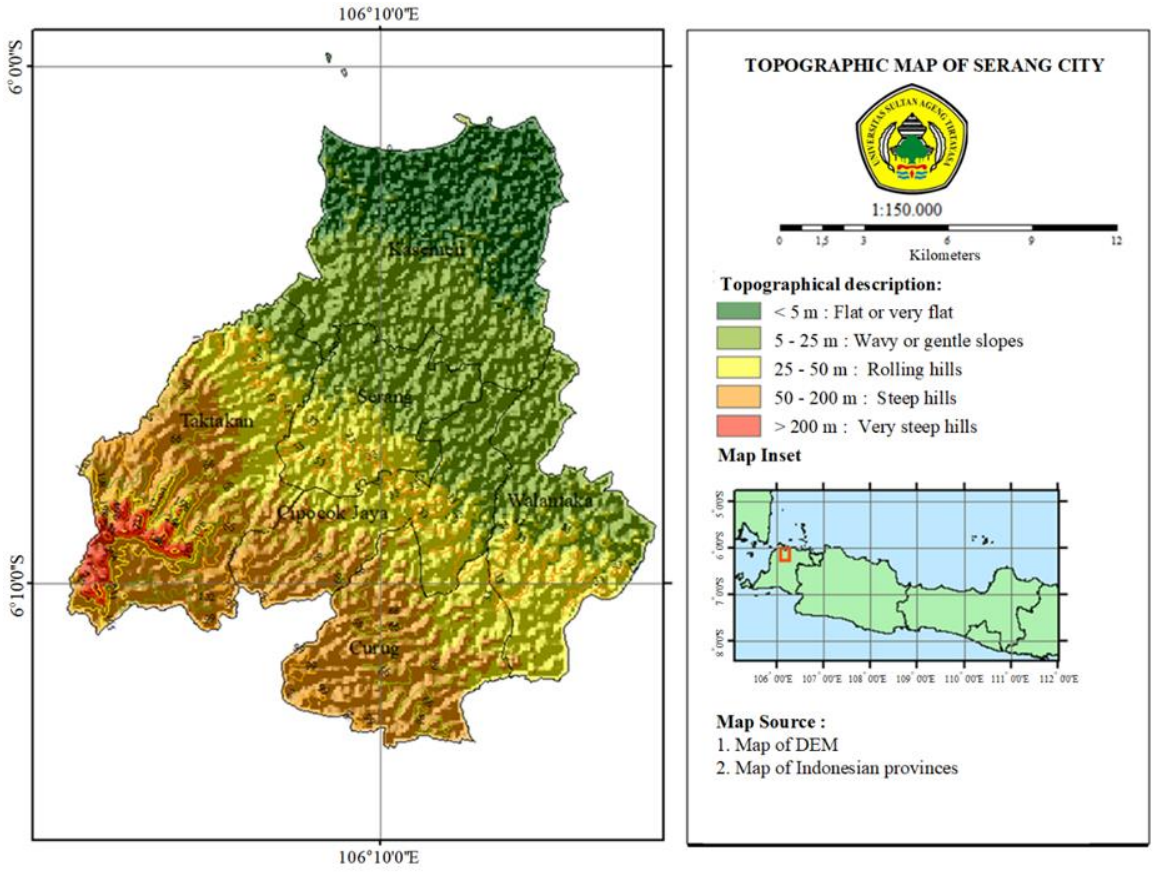

Figure 1. Topographic map of Serang City

The light green color indicates a height from 5 to 25 meters above sea level (meters above sea level), which has a wavy relief (topography) or gentle slope, covering the southern part of Kasemen District, part of the northern area of Taktakan District, the north part of Serang District, part of the northern area of the District Cipocok Jaya, and the north part of Walantaka District. These results are in accordance with topographic data for Serang City (Wiguna, 2012).

The yellow color indicates a height from 25 to 50 meters above sea level (meters above sea level), which has a form of relief (topography) with sloping waves; the area includes the northern part of Taktakan District, the southern part of Serang District, part of Cipocok Jaya District, the north part of Curug District, and the south part of Walantaka District. These results show that some areas of Serang City have hilly topography (Setyawan et al., 2019).

The orange color indicates a height from 50 to 200 meters above sea level (meters above sea level), which has a steep hilly relief (topography); the area covers parts of Taktakan District, the southern part of Cipocok Jaya District, and the south part of Curug District. The City of Serang also consists of a steep hilly area (Setiawan et al., 2017). The red indicates a height of more than 200 meters above sea level (meters above sea level) with a very steep hilly relief (topography); the area covers the southern part of Taktakan District.

In the rainfall distribution pattern using the inverse distance weighted (IDW) interpolation method using varying power values of 1, 2, and 3, we get:

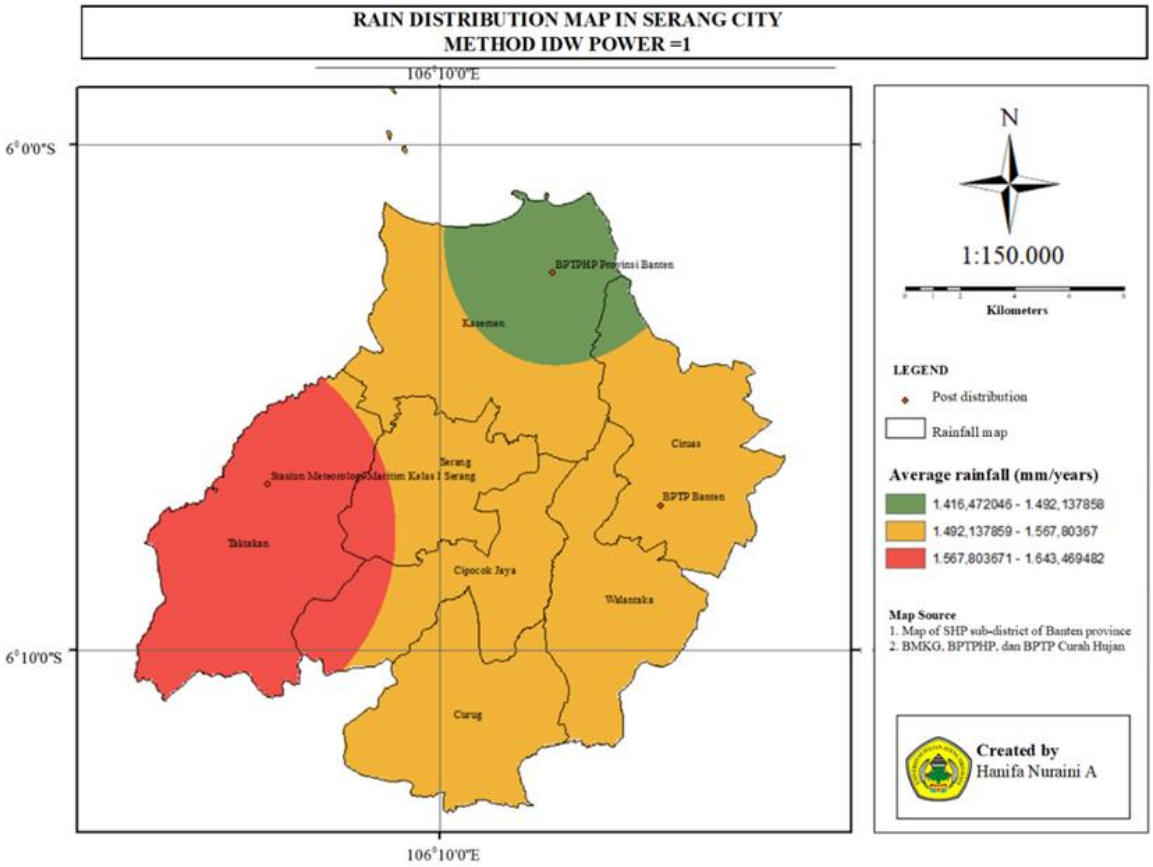

Figure 2. Power 1 rainfall distribution map

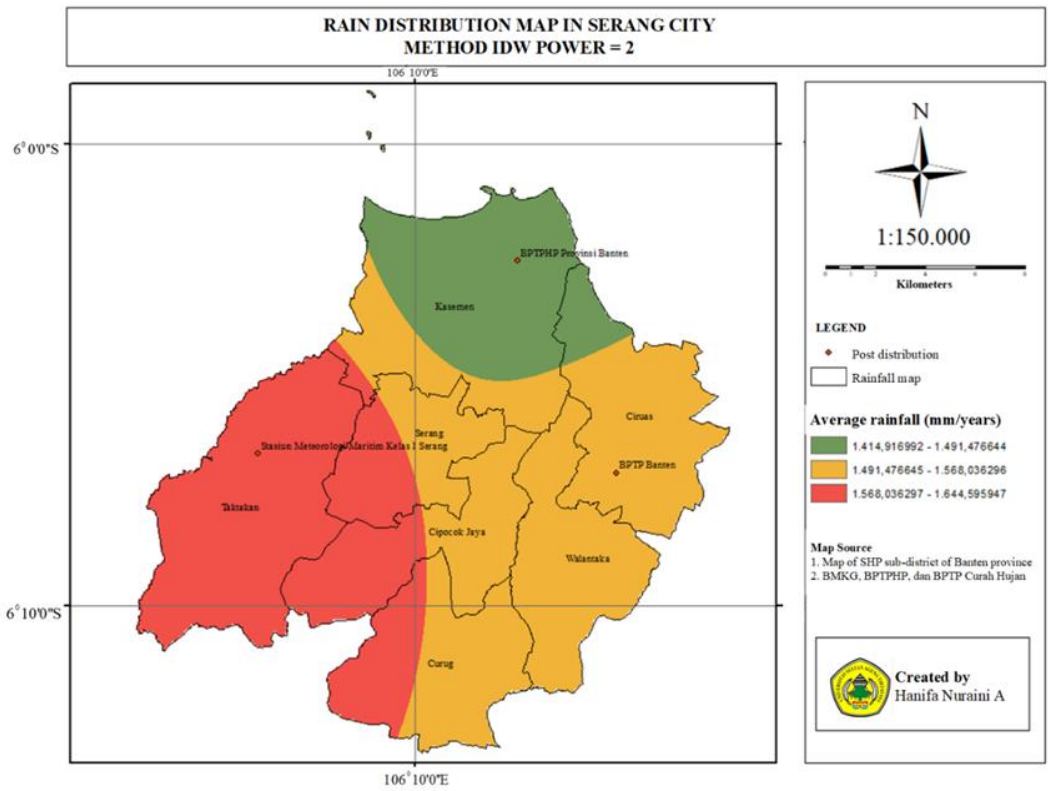

Figure 3. Power 2 rainfall distribution map

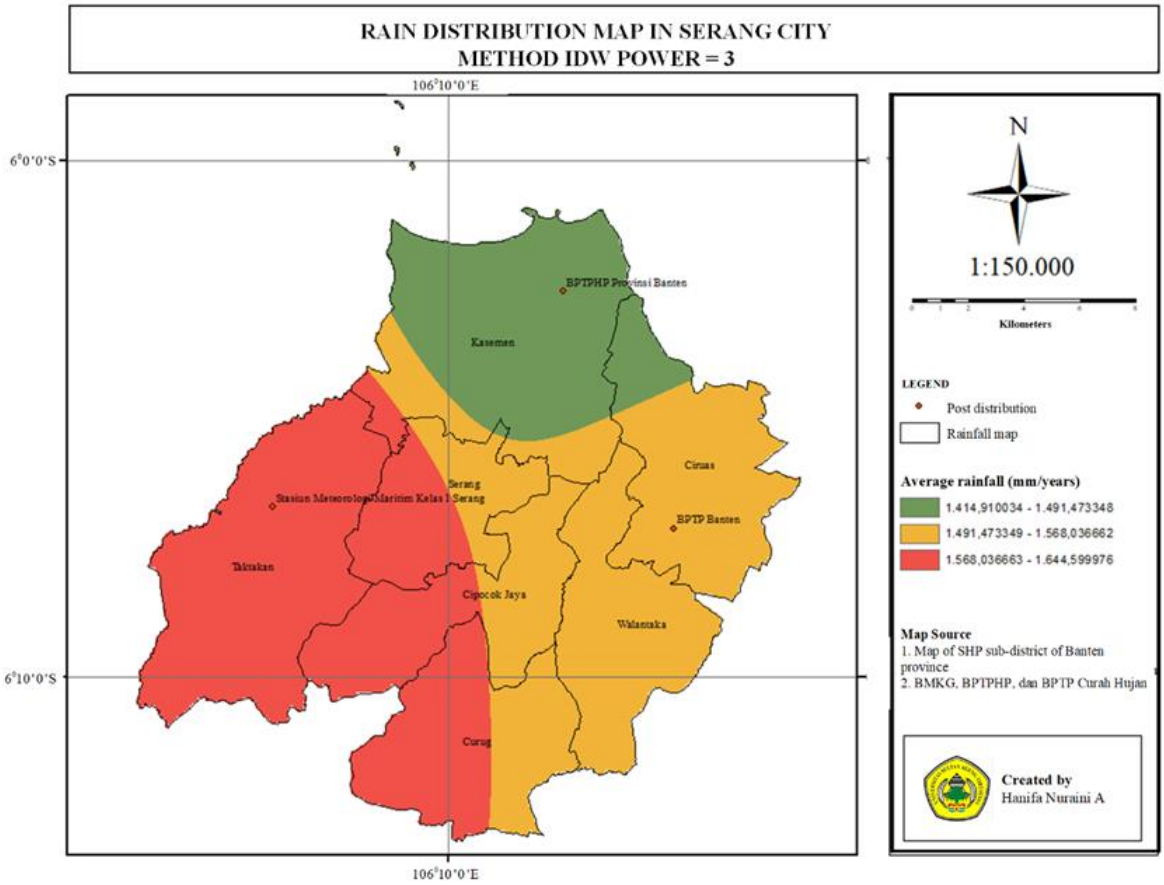

Figure 4. distribution map Power 3 rainfall

Table 1 shows the error and percentage error in rainfall for each year based on variations in IDW power 1, 2, and 3.

Table 1. IDW Inerpolation method error values

Power Variation	RMSE (mm/years)	RMSE percentage
1st Power	141,77	9,22%
2nd Power	143,31	9,32%
3rd Power	145,62	9,47%

Based on the RMSE value in Table 1, the power variation with the highest accuracy is power 1, with an error of 141.77 mm/year (9.22%). The average RMSE percentage result is 9.34% which is included in the very good category (Nurani et al., 2023).

The next step taken is the overlay method, combining two maps between the topographic map of Serang City and the rainfall distribution map of power one variation (Wulandari & others, 2017), as shown in Figure 5.

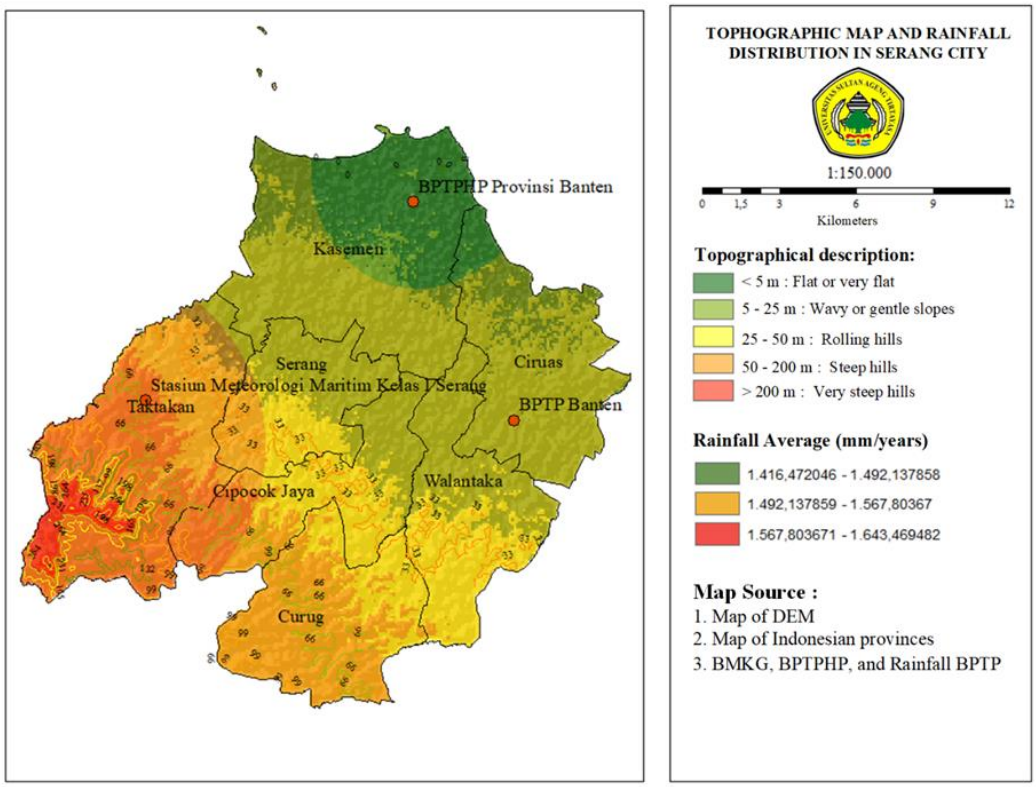

Figure 5. Topographic map and distribution of rainfall in Serang City

The dark brown color indicates the average distribution of rainfall in the area around the Rain Protection Hall rain measurement post Food Crops, Horticulture and Plantation (BPTPHP) Banten Province ranges from 1.414,915894 to 1.491,476034 mm/year, where the region has height less than 5 meters above sea level to 25 above sea level with flat relief (topography) or wavy or gentle slopes which is marked with dark green and young on the map. The area covers parts of Kasemen District and the northern part of Ciruas District. These results show that regional topography determines rainfall, areas with low topography have low rainfall (Alfiandy et al., 2020).

Areas that have higher topography tend to have higher rainfall (Yunus, 2014). Brown shows the average distribution of rainfall in the area around the post-Assessment Center rain measurements Agricultural Technology (BPTP) Banten ranges from 1,491.476035 to 1,568.036174 mm/year, where the region has a height from 5 meters above sea level to 200 meters above sea level with the relief (topography) of the slopes gentle hills, gentle hills, and steep hills marked in light green, yellow and orange. The area includes parts of Kasemen District, most of Ciruas District, Walantaka District, Curug District, most of Cipocok Jaya District, and most of the Serang District.

The light brown color shows the average distribution of rainfall in the region, which is around the Meteorological Station Maritime Class I Serang range 1,568.036175 to 1,644.596313 mm/year, where the area has a height from 25 meters above sea level to more than 200 meters above sea level with relief conditions (topography) gentle hills, steep hills and marked very steep hills in yellow, orange and red. The area includes Taktakan District, a small

part of the Serang District area, and a small part of the sub-district area, Cipocok Jaya. These results show that areas that have high topography have a tendency to produce high rainfall (Prasetyo et al., 2018).

CONCLUSION

The city of Serang is included in the lowland area category, ranging from 0 to 337 meters above sea level (meters above sea level). Areas with a height of <5 meters above sea level have flat or very flat relief (topography) in Kasemen District. Areas with an altitude of >200 meters above sea level have very steep hilly relief (topography) in Taktakan District.

The rainfall distribution pattern with the smallest RMSE value or highest accuracy uses power one variation with an error of 141.77 mm/year. Areas that have low altitudes and flat slopes have low average rainfall, namely 1414.91 mm/year, in Kasemen District, while areas that have high altitudes and steep slopes have high average rainfall, namely amounting to 1644.6 mm/year in Taktakan District.

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