Lensa: Jurnal Kependidikan Fisika
Penerbit: Universitas Pendidikan Mandalika
https://e-journal.undikma.ac.id/index.php/Lensa/index

June 2025, Vol. 13, No. 1
e-ISSN: 2686-0937
pp. 171-180

Rainfall and Temperature Analysis for Predicting Drought-Prone Areas in Tangerang Regency

Silsa Dwi Oktarina*, Yayat Ruhiat, Yuvita Oktarisa
Physics Education Department, Universitas Sultan Ageng Tirtayasa, Banten, Indonesia

*Corresponding Author: oktarinasilsadwi@gmail.com

Abstract

Drought has emerged as a critical issue in Tangerang Regency, Banten Province, primarily driven by the prolonged dry season, declining rainfall, and rising temperatures above average, all of which are exacerbated by the El Niño phenomenon. These conditions pose serious threats, including water shortages, reduced agricultural productivity, and the potential for widespread drought if left unaddressed. This study aims to map drought threat levels at the sub-district scale based on rainfall and temperature parameters. The integration of these two variables is essential, as drought is influenced not only by insufficient rainfall but also by elevated temperatures. Thus, a multivariable approach offers a more comprehensive and accurate spatial assessment. The analysis applied in this study involves scoring and overlay techniques for each contributing parameter. The results identify areas with varying degrees of drought threat—low, light, moderate, high, and extreme. Notably, 27.63% of the regency is classified under extreme drought risk, predominantly in the central to southern regions, due to the combination of very low rainfall and very high temperatures. The resulting drought threat map serves as a crucial reference for local governments, farmers, and the Regional Disaster Management Agency (BPBD) in planning effective mitigation strategies, early warning systems, and sustainable water resource management.

Keywords: Drought risk mapping; Rainfall; Temperature; Geographic information system; El Niño.

How to cite: Oktarina, S., Ruhiat, Y., & Oktarisa, Y. (2025). Rainfall and Temperature Analysis for Predicting Drought-Prone Areas in Tangerang Regency. *Lensa: Jurnal Kependidikan Fisika, 13*(1), 171-180. doi:https://doi.org/10.33394/j-lkf.v13i1.15818

INTRODUCTION

Climate change has emerged as a critical global issue and a substantial threat to all of humanity (Faruf et al., 2023). This complex problem cannot be resolved without significant human intervention and concrete action (Ainurrohmah & Sudarti, 2022). The rapid advancement of industrial and economic activities has significantly increased greenhouse gas emissions and fossil fuel consumption, often exacerbated by deforestation for land conversion. These factors have intensified the impacts of climate change. The manifestation of climate change can be observed through altered weather patterns and deviations of climatic parameters from their long-term averages. The consequences of climate change include shifts in rainfall distribution, rising global temperatures, and sea level rise. In particular, extreme rainfall fluctuations, prolonged droughts, and higher temperatures pose significant risks to ecosystems and human livelihoods (Malino & Arsyad, 2021).

Tangerang Regency, located in Banten Province, Indonesia, is an area that experiences complex climatic variability. The region lies within a tropical monsoon climate zone (Am) according to the Köppen climate classification. It is characterized by two distinct seasons: the wet season and the dry season, both influenced by monsoonal wind patterns and seasonal temperature variations. The wet season generally extends from November to April, marked by high rainfall exceeding 150 mm per month and relatively cooler temperatures. Conversely, the dry season spans from June to September, with rainfall dropping below 100 mm per month and higher temperature conditions (STEKOM, 2023). While the rainy season can benefit agricultural production through abundant water supply, excessive rainfall in disaster-prone areas can lead to flooding and landslides. Meanwhile, the dry season, with its reduced rainfall and temperatures reaching up to 34°C, can trigger droughts, resulting in water scarcity, crop failures, and increased wildfire risk (Suprayogi & Yuwono, 2017).

Drought is categorized as a slow-onset disaster, meaning it develops gradually and can have widespread impacts across multiple sectors including the economy, health, education, and society at large (Yulia et al., 2020). The occurrence of drought is influenced by a variety of local, regional, and global factors. One of the most significant phenomena associated with drought is the El Niño Southern Oscillation (ENSO). During El Niño events, rainfall in several parts of Indonesia tends to decrease, whereas La Niña brings increased rainfall (Rahmabudhi, 2024). Drought can be classified into four types: meteorological drought, hydrological drought, agricultural drought, and socio-economic drought (Andono et al., 2017). In recent years, various regions across Indonesia have been affected by drought. Tangerang Regency, due to its proximity to the capital and dense population, is particularly vulnerable. The region has experienced severe drought conditions due to the extended dry season driven by El Niño, resulting in decreased rainfall and above-average temperatures (Hendrik, 2023).

To address such climatic risks, spatial approaches and Geographic Information Systems (GIS) have been increasingly employed to analyze and map drought vulnerability (Mujtahiddin, 2014). For instance, a study using only rainfall data in Indramayu demonstrated that approximately 47% of the region was classified as drought-prone. Similarly, Pranata and Aji (2021) employed spatial analysis in Grobogan Regency and found that areas with low rainfall had higher drought potential. Fattah and Widyasamratri (2024) also used GIS with inverse distance weighting (IDW) interpolation to analyze rainfall distribution, which is crucial for early warning systems and water resource planning.

However, a common limitation in previous research is the sole reliance on rainfall as the primary drought indicator, without incorporating temperature data. This approach may not provide an accurate or comprehensive assessment of drought conditions, as rising temperatures significantly influence evaporation and transpiration processes. Hence, assessing both rainfall and temperature as contributing variables can yield a more detailed and accurate spatial analysis of drought threats.

In this context, the present study integrates rainfall and temperature parameters to map the spatial distribution of drought risk across sub-districts in Tangerang Regency. The multivariable approach adopted in this research aims to enhance the precision of drought threat mapping by acknowledging the interdependence between rainfall deficit and elevated temperatures. By employing scoring and overlay techniques within a GIS framework, the study classifies drought risk into five categories: low, light, moderate, high, and extreme.

The outcomes of this study are expected to serve as a vital reference for local governments, farmers, and the Regional Disaster Management Agency (BPBD) in planning early warning systems, designing effective mitigation strategies, and managing water resources efficiently. Furthermore, the drought threat map produced can support data-driven decision-making to reduce the risks and long-term impacts of drought in Tangerang Regency.

METHODS

This study was conducted in Tangerang Regency, one of the administrative regions located in Banten Province, Indonesia. Geographically, Tangerang Regency lies between 6°0' – 6°20' South Latitude and 106°20' – 106°43' East Longitude. It borders the Java Sea to the north, South Tangerang City, Tangerang City, and Jakarta to the east, Bogor Regency to the south, and Serang and Lebak Regencies to the west.

The data used in this study include administrative boundary data at the sub-district level obtained from the Geospatial Information Agency (BIG) in shapefile format. Rainfall and temperature data were collected from the online repository of the Meteorological, Climatological, and Geophysical Agency (BMKG) for the period of 2019–2023. These climate data were initially in daily Excel format and were processed into monthly averages over the five-year period. The processed data were then converted into SHP format to allow for spatial analysis. Observations were based on two meteorological stations: BMKG Budiarto-Curug Station and BMKG Tangerang Geophysics Station. A region was classified as having an extreme drought risk if the average monthly rainfall was below 100 mm and the air temperature exceeded 41°C, in accordance with classification thresholds suggested by Ruqoyah et al. (2023) and Dewi et al. (2023).

The methodological framework of this study involved several key phases. The first phase was data collection and preprocessing. This involved gathering all necessary spatial and attribute data, particularly the rainfall and temperature values recorded by the BMKG stations. These values were used to calculate monthly averages from 2019 to 2023. To provide a comprehensive spatial representation across Tangerang Regency, spatial interpolation was applied to the point data. This interpolation resulted in continuous distribution maps of rainfall and temperature for the entire study area, enabling a more detailed spatial understanding.

Following the data preprocessing, scoring and weighting of the parameters were conducted. Each climate parameter—rainfall and temperature—was categorized into classes and assigned specific scores based on its impact on drought conditions. This scoring system was developed using a combination of field data and relevant literature, such as the work by Fattah and Widyasamratri (2024). The relative importance of each parameter in contributing to drought threats was then determined through a weighting process. The weighting was computed using a ranking method with the following formula:

$$wj = \frac{(n-rj+1)}{\sum((n-rp+1))} \times 100 \qquad (1)$$

Where *n* is the number of parameters under evaluation, *wj* is the normalized weight of the parameter, *rj* is the rank of the parameter in question, and *rp* denotes the parameter positions.

Once the scoring and weighting were finalized, spatial analysis and classification of drought threat levels were carried out using ArcGIS 10.8. The rainfall and temperature maps, each embedded with their respective scores, were overlaid to compute combined scores for each location. These combined scores were derived by summing the product of each parameter's score and its weight. Based on the resulting composite scores, the areas were classified into five categories of drought threat: low, light, moderate, high, and extreme. This classification was guided by predefined score intervals that represent the combined effect of low rainfall and high temperature as potential indicators of drought severity.

The final phase of the methodology involved calculating the area of each drought threat category. This was achieved using the "Calculate Geometry" function in ArcGIS 10.8, which allowed for the determination of spatial coverage for each class. This spatial quantification was essential to understanding the extent and distribution of drought threats across the regency. The resulting thematic map not only visualizes the spatial pattern of drought risk but also serves as a valuable decision-support tool for regional planning, early warning systems, and resource management (Pratiwi, 2020).

RESULTS AND DISCUSSION

The results highlight the spatial distribution of drought threat levels across Tangerang Regency, derived from the integration of rainfall and temperature parameters through scoring and overlay analysis. Regions within the regency are categorized into five levels of drought risk: low, light, moderate, high, and extreme. The findings reveal clear patterns influenced by climatic and geographic conditions, with central and southern areas showing higher vulnerability due to the combined effects of low rainfall and elevated temperatures. The interpretation of these patterns provides important insights for disaster preparedness, water resource planning, and agricultural adaptation strategies.

The parameter data used to determine the weighting values, based on the data obtained in this study, is presented in Table 1.

Table 1. Parameter weights

Parameter	Class	Weights (%)
Rainfall	1	67
Temperature	2	33
Total %		100

Based on Table 1, the weighting percentages for the drought parameters indicate that rainfall accounts for 67% and air temperature for 33%. These weights are based on the assumption that rainfall has a more dominant influence in determining drought conditions compared to temperature, although temperature also plays a significant role in accelerating evaporation and transpiration processes that exacerbate drought severity.

Rainfall Parameter

The spatial distribution of rainfall across Tangerang Regency from 2019 to 2023 reveals distinct variations among different regions. The western and northern parts of the regency, including sub-districts such as Mekar Baru, Kronjo, Kemiri, Mauk, Pakuhaji, Teluknaga, and Kosambi, experienced higher rainfall, with monthly averages ranging from 250 to over 300 mm. This elevated precipitation is primarily attributed to the geographic and topographic proximity of these areas to the Java Sea. The closeness to this major moisture source, coupled with the influence of monsoonal winds, contributes to increased humidity and consequently higher rainfall levels (Kurniawan et al., 2019). In contrast, the central and southern areas of the regency—covering sub-districts like Legok, Curug, Kelapa Dua, Pagedangan, Cisauk, and most parts of Cikupa and Panongan—exhibited significantly lower rainfall levels, ranging between 157 and 200 mm per month. These areas are located farther from coastal moisture sources and generally have lower topographic elevation, which may limit atmospheric moisture accumulation, thereby increasing their vulnerability to drought conditions (Masruri, 2018).

A transitional zone is also observed in sub-districts such as Pasar Kemis, Sepatan, Tigaraksa, Solear, and Balaraja, where rainfall levels fall within a moderate range of 200 to 250 mm per month. These intermediate conditions reflect the gradual climatic shift between high-rainfall coastal zones and the drier inland areas. To evaluate drought risk based on rainfall levels, a classification system was developed using a scoring model that assigns higher scores to lower rainfall ranges, reflecting greater drought susceptibility. Table 2 presents the scoring system used to assess the rainfall parameter in this study.

Table 2. Rainfall parameter assessment

Class	Rainfall (mm/month)	Score	Category
1.	157 - 200	3	Low
2.	200 - 250	2	Moderate
3.	250 - 300	1	High

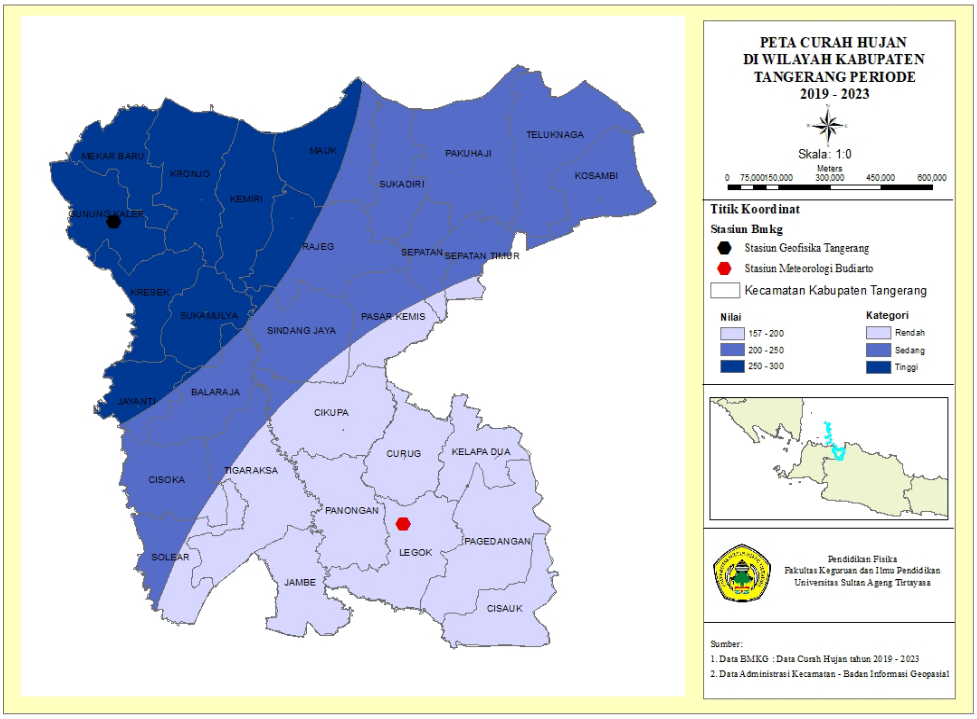

Figure 1. Spatial distribution map of rainfall parameter in Tangerang Regency

Air Temperature Parameter

Based on the analysis of air temperature data, most areas within Tangerang Regency fall under the "Hot" and "Very Hot" categories. The central to southern parts of the regency, including sub-districts such as Tigaraksa, Curug, Legok, Cisauk, Pagedangan, and Panongan, recorded high average temperatures ranging from 32.35°C to 33.00°C, classified as "Hot," with some areas even reaching 33.00°C to 33.89°C, falling into the "Very Hot" category. These elevated temperatures, especially during El Niño periods, can significantly increase the rate of water evaporation from the soil surface and transpiration from vegetation. As a result, this accelerates the loss of moisture from both hydrological and atmospheric systems, intensifying drought conditions (Prayoga, 2017). Such temperature-induced effects play a crucial role in reducing water availability and exacerbating drought severity across the region.

Table 3. Air temperature parameter assessment

Class	Air Temperature (˚C)	Score	Kategori
1.	31.29 - 32.35 ˚C	1	Slightly Hot
2.	32.35 - 33.14 ˚C	2	Hot
3.	33.14 - 33.89 ˚C	3	Very Hot

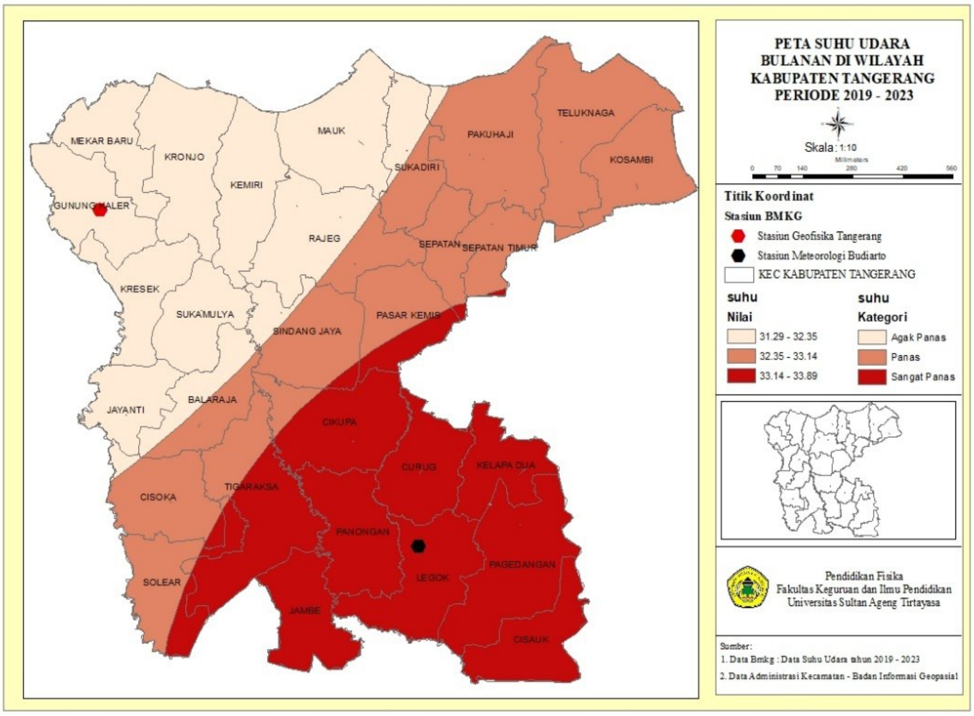

Figure 2. Spatial distribution map of air temperature in Tangerang Regency

Drought Threat Map Analysis

Following the generation of individual spatial distribution maps for each parameter, the next step involved overlaying the respective layers to identify areas vulnerable to drought. This process enabled the calculation of spatial coverage associated with each level of drought risk and served as the basis for constructing the drought threat classification map. A drought threat map is a spatial visual representation that identifies and delineates regions with potential or high risk of experiencing drought. The resulting drought threat map for Tangerang Regency is presented in Figure 3, which illustrates the classification of the region into five categories of drought threat based on a scoring and weighting approach—67% for rainfall and 33% for temperature. These categories include Low, Light, Moderate, High, and Extreme drought threats, with the corresponding area sizes and composite score intervals detailed in Table 4.

Table 4. Drought threat levels in Tangerang Regency

Interval	Drought Threat Level	Area (m)	Percentage (%)
1.00	Extreme Drought	0.021	27.63
1.67	High Drought	0.005	6.58
2.00	Moderate Drought	0.023	30.26
2.67	Light Drought	0.001	1.32
3.00	Low Drought	0.026	34.21
Total score		0.076	100

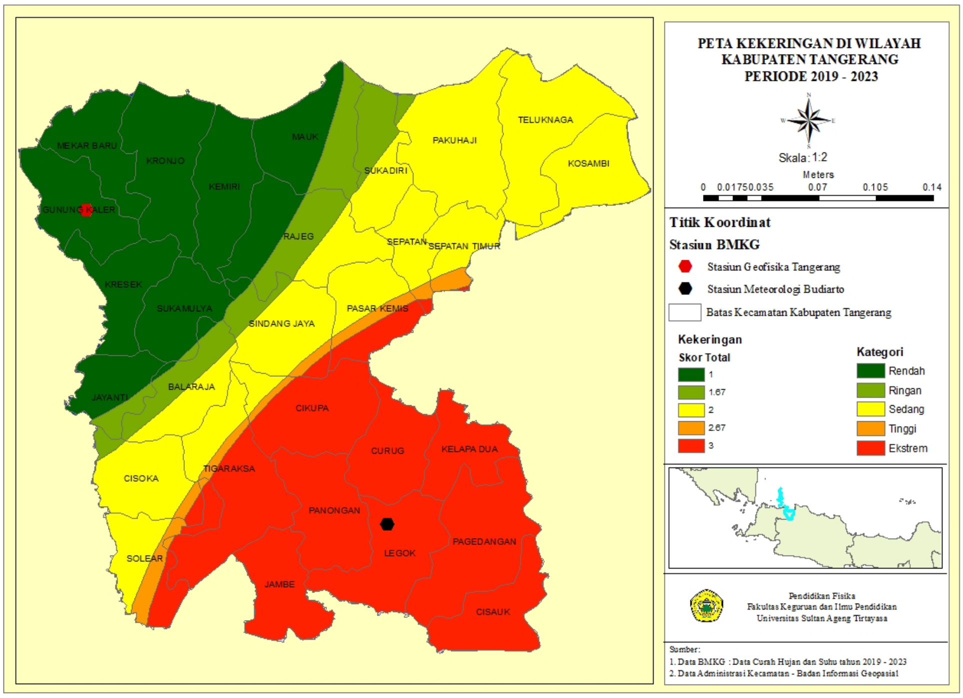

Figure 3. Spatial distribution map of drought threat in Tangerang Regency

Drought threats are typically characterized by reduced rainfall, elevated air temperatures, and limited groundwater availability (Widyastuti, 2020). In Tangerang Regency, areas classified as experiencing extreme drought threat—with a composite score of 3.0—are concentrated in the central to southern parts of the region. Sub-districts such as Cikupa, Tigaraksa, Panongan, Legok, Curug, Kelapa Dua, Pagedangan, Cisauk, Jambe, and Solear fall into this category, covering approximately 27.63% of the total area. This extreme threat level is attributed to the synergistic effect of very low rainfall combined with very high temperatures, which significantly exacerbate drought conditions.

The high drought threat zone, with a score of 2.67, is located in parts of central Tangerang Regency, including areas around Pasar Kemis and the northern part of Cikupa, comprising 6.58% of the regency. These areas face considerable hydrological stress due to a combination of low to moderate rainfall and elevated temperatures. Meanwhile, the moderate drought threat zone (score 2.0) is found in the northern part of the regency, including sub-districts such as Sindang Jaya, Rajeg, Sepatan, Sepatan Timur, Sukadiri, Pakuhaji, and Kosambi. This category represents the second largest area, covering 30.26%, and reflects a more balanced interplay between rainfall and temperature.

The light drought threat category, with a score of 1.67, is distributed across the northern and northwestern regions of Tangerang Regency, including Teluknaga, Mauk, Kemiri, Kronjo, Mekar Baru, Gunung Kaler, Kresek, and Sukamulya. This zone represents a very small portion—only 1.32%—characterized by relatively high rainfall and cooler temperatures. Lastly, the low drought threat zone (score 1.0) is located predominantly in the northwestern area, around Gunung Kaler. This zone, with the highest spatial coverage at 34.21%, benefits from ample rainfall and lower temperature levels, reducing the risk of drought.

These findings indicate that the central-southern parts of Tangerang Regency are at the greatest risk of drought due to their unfavorable climatic conditions, while the northern and western areas are comparatively less vulnerable. The resulting drought threat map is a critical tool for regional stakeholders, including local governments, for implementing data-driven drought mitigation strategies, irrigation planning, emergency water distribution, agricultural adaptation, and comprehensive water resource management across the regency.

CONCLUSION

The findings of this study reveal that areas facing extreme drought threats are concentrated in the central to southern regions of Tangerang Regency, particularly in sub-districts such as Cikupa, Tigaraksa, and Panongan. These regions account for approximately 27.63% of the total area and are characterized by a combination of very low rainfall and very high temperatures. In contrast, the northern and western areas show lower drought risk due to higher rainfall and cooler temperatures. The drought threat map generated in this study is a vital tool for the Tangerang Regency government, the Regional Disaster Management Agency (BPBD), and other related institutions in formulating data-driven drought mitigation and adaptation policies. Concrete recommendations include prioritizing emergency clean water provision and water conservation infrastructure development in extreme zones, promoting agricultural adaptation through improved cropping patterns and efficient irrigation systems, and managing water resources with resilient network planning strategies.

RECOMMENDATION

For future research, it is highly recommended to enrich the analysis by integrating additional parameters that can provide a more comprehensive picture of drought conditions. One crucial aspect is the use of vegetation indices such as the Normalized Difference Vegetation Index (NDVI), which can be derived from satellite imagery. NDVI data would allow for a more accurate identification of agricultural drought, complementing the meteorological drought analysis already conducted. Additionally, improving the spatial mapping accuracy should be a primary objective. This could be achieved by enhancing multi-station interpolation through increasing the number of climate observation points, considering the limitations of only two BMKG stations in the current study. Where feasible, the application of more advanced geostatistical interpolation techniques, such as kriging, should also be considered due to their ability to estimate values at unmeasured locations by accounting for the spatial structure of the data, potentially resulting in more precise drought threat maps.

ACKNOWLEDGEMENT

We would like to express my deepest gratitude to my advisor for the invaluable guidance, support, and encouragement throughout the course of this research. Your willingness to share knowledge and expertise has been instrumental in the completion of this study.

REFERENCES

Ainurrohmah, S., & Sudarti, S. (2022). Analisis Perubahan Iklim dan Global Warming yang Terjadi sebagai Fase Kritis. *Jurnal Phi Jurnal Pendidikan Fisika Dan Fisika Terapan*, *8*(1), 1-10. https://doi.org/10.22373/p-jpft.v3i3.13359

Andono et al. (2017). Analisa Indeks Kekeringan dengan Metode Standardized Precipitation Index (SPI) dan Produktivitas Sawah Tadah Hujan di Kabupaten Indramayu. *Jurnal SPATIAL Wahana Komunikasi dan Informasi Geografi, 17*(2), 39–48.

CNN Indonesia. (2023). *BPBD Kab. Tangerang: 47 Desa Terdampak Kekeringan*. https://www.cnnindonesia.com/tv/20231004084057-410-1006843/

Dewi et al. (2023). Kajian Kerawanan Bencana Kekeringan di Kabupaten Gunungkidul di Yogyakarta, Indonesia. *Jurnal Harian Regional*, *12*. https://doi.org/https://doi.org/10.24843/JBETA.2024.v12.i01.p01

Faruf, A., Yasar, M., Studi, P., Pertanian, T., Pertanian, F., & Kuala, U. S. (2023). *Jurnal Ilmiah Mahasiswa Pertanian, 8*(4), 622–630.

Fattah, M. N., & Widyasamratri, H. (2024). Analisis Potensi Rawan Bencana Kekeringan Menggunakan Sistem Informasi Geografis. *Jurnal Kajian Ruang*, *4*(1), 78-93. https://doi.org/10.30659/jkr.v4i1.35587

Hendrik, S. (2023). *Kekeringan di Kabupaten Tangerang Meluas Hingga 16 kecamatan*. Medcom.Id. https://www.medcom.id/nasional/daerah/ob3ZnGJN-kekeringan-di-kabupaten-tangerang-meluas-hingga-16-kecamatan

Kurniawan, B., Ruhiat, Y., & Septiyanto, R. F. (2019). Penerapan Metode Thiessen Polygon untuk Mendeteksi Sebaran Curah Hujan di Kabupaten Tangerang. *Prosiding Seminar Nasional Pendidikan Fisika Untirta*, *2*(1), 122–130.

Malino, C. R., & Arsyad, M. (2021). Analisis Parameter Curah Hujan dan Suhu Udara di Kota Makasar Terkait Perubahan Iklim. *Jurnal Sains Dan Pendidikan Fisika*, *17*(2), 139–145.

Masruri, M. S. (2018). Analisis Kondisi Geologis Dan Geomorfologis Wilayah Sekitar Escarpment Baturagung Untuk Pengembangan Ekowisata. Geomedia, *15*(2), 45–60.

Mujtahiddin, M. I. (2014). Analisis Spasial Indeks Kekeringan Kabupaten Indramayu. *Jurnal Meteorologi Dan Geofisika*, *15*(2), 99–107. https://doi.org/10.31172/jmg.v15i2.179

Pranata, K. A., & Aji, A. (2021). Analisis Spasial Tingkat Potensi Kekeringan dan Tingkat Kesiapsiagaan Masyarakat dalam Menghadapi Bencana Kekeringan di Kabupaten Grobogan. *Indonesian Journal Conservation*, *10*(2), 108–114. https://doi.org/10.15294/ijc.v10i2.33138

Pratiwi, N. I. (2020). *Pemetaan Potensi Kekeringan Lahan Di Kabupaten Cirebon Berbasis Sistem Informasi Geografis Dan Pengindraan Jauh*. Skripsi: Institut

Teknologi Nasional Bandung.

Prayoga, M. P. (2017). Analisis Spasial Tingkat Kekeringan Wilayah Berbasis Penginderaan Jauh dan Sistem Informasi Geografis. *Institut Teknologi Sepuluh Nopember*, 1–96.

Rahmabudhi, S. (2024). Analisis Hubungan Suhu Udara di Provinsi Banten Terhadap Parameter Kelembapan Udara, Curah Hujan, ENSO, SOI, dan IOD. *Buletin Meteorologi, Klimatologi Dan Geofisika*, *5*(1), 37–47.

Ruqoyah, R., Ruhiat, Y., & Saefullah, A. (2023). Analisis Klasifikasi Tipe Iklim Dari Data Curah Hujan Menggunakan Metode Schmidt-Ferguson (Studi Kasus: Kabupaten Tangerang). *Jurnal Teori dan Aplikasi Fisika, 11*(01), 29–38.

STEKOM, S. (2023). *Kabupaten Tangerang*. Ensiklopedia Dunia.

Suprayog, S., & Yuwono, Y. (2017). Kajian Variasi Pemodelan Peta Klasifikasi Curah Hujan pada Analisis Kekeringan Menggunakan Sistem Informasi Geografis (Studi Kasus: Kabupaten Blora). *Media Pengembangan Ilmu dan Profesi Kegeografian, 15*(2), 1-13.

Widyastuti, R. (2020). Pola Sebaran Kekeringan di Kecamatan Simpenan Menggunakan Metode SPI (Standardized Precipitation Index). *Jurnal Geosaintek*, *6*(1), 19-24. https://doi.org/10.12962/j25023659.v6i1.6272

Yulia, M., Fauzi, A., & Hakim, D. M. (2020). Pemodelan Spasial Bahaya Bencana Kekeringan Meteorologis Pada Kawasan Pertanina Di Indonesia Menggunkan Indeks SPI (Standardized Precipitation Index). *Repository - ITERA*. https://repo.itera.ac.id/depan/submission/SB2009110034