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Analysis Rice Field Drought Potential using the Standardized Precipitation Index (SPI) Method

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ABSTRACT

Drought analysis can be used as an early warning of drought in rice fields, which can be identified by connecting various parameters. This study aims to identify the potential for rice fields vulnerable to drought in Agam Regency. Drought is primarily caused by uneven rainfall distribution, leading to imbalanced hydrological conditions. This study used the last 30 years of rainfall data (1993-2022) from five stations located at Agam Regency (Canduang and Gumarang) and the rest outside of the study area (Padang Panjang, Suliki, and Paraman Talang). Spatial analysis of drought distribution was carried out using the Inverse Distance Weighted (IDW) method. The results showed the consistency test value of rainfall data for all five stations was obtained with an average of R^2 with a value of 0.992, the potential area of rice fields with a dry and very dry category was 13,640.61 ha and 904.55 ha, respectively. The conclusions of this study are (i) the districts with the most potential to be affected by drought (dry and very dry categories) are Tilatang Kamang and Malalak District, with an area of 2,058.15 ha and 750.48 ha, respectively, (ii) it is important to prepare the water shortage in the dry season by utilizing rivers, irrigation and reservoirs in the area.

1. INTRODUCTION

Drought poses significant threats to human livelihoods. This is related to surface water and groundwater reserves; these water reserves can be used to fulfill agricultural, domestic and industrial needs (Aprilliyanti & Zainuddin, 2017). Drought is basically caused by the hydrological conditions of an area in an unbalanced water condition due to the uneven distribution of rainfall, which is the main input of water resources (Ruminta, 2016; Surmaini *et al*., 2011). The uneven distribution of rain causes areas with low rainfall to experience an imbalance of water input and output (Kurnia, 2019).

Various natural disasters that occur due to the rainfall intensity, such as floods and droughts, are one of the most obvious impacts of climate change and can be felt by various sectors, especially the agricultural sector (Narulita *et al*., 2019). Climate change significantly affects crop production due to fluctuations in temperature and rainfall amounts (Irsyad *et al*., 2023; Lee *et al*., 2023; Masruroh & Bowo, 2022). Drought disasters have occurred frequently in Indonesia; however, when drought strikes a region, it is often not fully recognized by farmers, and there is a lack of quick and appropriate response, which can prolong the situation and make it difficult to resolve (Malini *et al*., 2021; Nurhasanah *et al*., 2018).

There are three types of drought: meteorological, hydrological, and agricultural (Shah *et al*., 2015). Agricultural drought occurs due to depressions of water content in the soil, making it unable to meet water demand for plants; of course, this condition after the meteorological drought. Agricultural drought has a crucial impact on the agrarian sector, especially in rice fields, which can cause a decrease in production yields from these (Widyastuti *et al*., 2020). Agricultural drought is also caused by hydrological drought, characterized by a reduction in surface water and groundwater supply. Information about drought potential can be used for planning planting time (Irsyad *et al*., 2023; Naylor *et al*., 2007), selecting drought-tolerant rice varieties (Ruminta *et al*., 2016), determining irrigation strategies, or water irrigation management (Hidayat *et al*., 2014; Irsyad & Oue, 2021; Supadi, 2009).

Information regarding drought potential is essential to serve as a guideline in preventing and mitigating the negative impacts caused by drought (Aprilliyanti & Zainuddin, 2017). Research on drought potential has been extensively conducted, such as using the standardized precipitation index (SPI) methods. SPI method is a commonly used for analyzing drought through a meteorological drought index that illustrates the level of drought due to rainfall deficits (Novita *et al*., 2021). This method is a model for measuring the shortage or deficit of rainfall over various periods based on normal conditions. SPI is calculated based on monthly rainfall data over n months, ideally over a continuous period of at least 30 years. A set of average periods is elected to determine a set of time scales for season i, where i is 1, 3, 6, 12, 24, or 48 months (Mckee *et al*., 1993). The drought used in the Standardized Precipitation Index (SPI) method is meteorological drought (Malini *et al*., 2021), which refers to the amount of rainfall that occurs below normal conditions during a particular season (Lotfirad *et al*., 2022; Nurhasanah *et al*., 2018). The calculation of drought levels is the first indication of the occurrence of drought conditions (Rahmalina & Novreta, 2020).

Drought analysis can be used as an early warning of drought in areas that have the potential to experience drought and can be identified by various parameters that trigger drought (Saada & Abu-Romman, 2017). The SPI model in its analysis only requires rainfall data and it can predict wet months simultaneously (Mckee *et al*., 1993). The purpose of this study is to identify the potential of rice fields that are vulnerable to drought in Agam Regency using the Standardized Precipitation Index (SPI) method. This study would provided information about drought history and to know the estimation of the area affected by drought in rice fields that occur in Agam Regency and the countermeasure of the drought condition

2. MATERIALS AND METHODS

This research was conducted in Agam Regency. Data processing was conducted at the Land and Water Resources Engineering Laboratory, Department of Agricultural and Biosystem Engineering, Faculty of Agricultural Technology, Andalas University.

2.1. Materials

The materials utilized in this study included a topographic map of the research area, which was obtained from the website https://tanahair.indonesia.go.id. In addition, map of rice field land use at the research location was obtained from the Agam Regency Agriculture Service. Rainfall data for the last 30 years (1993-2022) was obtained from the BMKG West Sumatra Climatology Station on the website https://dataonline.bmkg.go.id and the West Sumatra Province Water Resources and Construction Service captured from the website https://sdabk.sumbarprov.go.ig

2.2. Data Collection

The rainfall data used in this study were from two rainfall stations in Agam Regency (Canduang and Gumarang) and three additional stations (Padang Panjang, Suliki, and Paraman Talang) around the regency (Irsyad & Oue, 2021). Rainfall data for the last 30 years (1993-2022) was analyzed for completeness using the Reciprocal method because not all stations had complete rainfall data. This method uses a weighting factor in the form of distance between stations, with the following equation:

$$Px = \frac{\frac{Pa}{Dxa^2}+\frac{Pb}{Dxb^2}+\dots+\frac{Pn}{Dxn^2}}{\frac{1}{Dxa^2}+\frac{1}{Dxb^2}+\dots+\frac{1}{Dxn^2}} \qquad (1)$$

where *Px* is the rainfall at the estimated station (mm). *Pa*, *Pb*, and *Pn* are rainfall at comparison stations A, B, and N (mm), respectively. *Dxa*, *Dxb*, and *Dxn* are the distances between stations A, B, and N with station X (km), respectively.

2.3. Consistency Test

The consistency test of rainfall data is intended to determine the accuracy of field data. The consistency of rainfall data is tested using the Double Mass Curve method by comparing the monthly cumulative rainfall of station A (y-axis) with the cumulative rainfall of the reference station (x-axis). The reference station is the average of several stations closest to the station whose consistency will be tested (Maulina *et al*., 2022). The cumulative value is then depicted in the Cartesian coordinate system x-y, and the curve formed is examined to see changes in slope (trend). The consistency value has a range of values from 0 to 1. If the value is closer to one, the data quality is considered more consistent.

2.4. SPI Calculation

The Standardized Precipitation Index (SPI) method is one of the methods used in analyzing drought indices. The findings are then used to identify drought events and evaluate the level of drought based on the values of the drought level classification. The SPI method is widely used because it can provide reliable and relatively easy-to-use comparative values capable of explaining the level of drought using a time scale and can identify dry and wet levels in the same way (Mckee *et al*., 1993).

The calculation of the SPI value could be done based on the number of gamma distributions defined as the following frequency or probability function:

$$G(x) = \int_0^x g(x) = \frac{1}{\beta^{\alpha} T(\alpha)} \int_0^x x^{a-1} e^{-x/\beta} dx \tag{2}$$

where $G(x)$ is the gamma distribution, $T(\alpha)$ is the gamma function, n is the number of observed rainfall data, s is the standard deviation, x and $\bar{x}$ are the monthly and average monthly rainfall (mm/month), respectively. The values of α was estimated for each rain gauge station using Equation (3) or (4), whereas β was calculated using Equation (6).

$$\alpha = \frac{\bar{x}^2}{s^2} \tag{3}$$

$$\alpha = \frac{1}{4A}\left(1 + \sqrt{1 + \frac{4A}{3}}\right) \tag{4}$$

$$A = ln(\bar{x}) - \frac{\sum ln(x)}{n} \tag{5}$$

$$\beta = \frac{\bar{x}}{a} \tag{6}$$

The resulting parameters were used to find the cumulative probability of each station's observed rainfall time span for each month. Since the gamma function was not defined when the obtained x value was equal to zero, and the rainfall distribution can contain zeros, the cumulative probability can be calculated using the following equation:

$$H(x) = q + (1 - q)G(x) \tag{7}$$

The probability of zero is q. If m is the number of zeros in the rainfall period, the q value is predicted as m/n. The cumulative probability $H(x)$ is transformed into the standard normal random variable Z with a mean of zero and a variance of one, the SPI value. The calculation of Z or SPI was calculated using the following equation:

$$Z = SPI = -\left(t - \frac{c_0 + c_2 t + c_3 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}\right) \text{ to } 0 < \text{H(x)} \leq 0.5 \tag{8}$$

$$Z = SPI = +\left(t - \frac{c_0 + c_2 t + c_3 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}\right) \text{ to } 0.5 < \text{H(x)} \leq 1 \tag{9}$$

with, $t = \sqrt{ln\left(\frac{1}{(H(x))^2}\right)}$ to $0 < H(\text{x}) \leq 0.5$.

$$t = \sqrt{ln\left(\frac{1}{(H(x))^2}\right)} \quad \text{to} \quad 0 < \mathrm{H(x)} \leq 0{,}5 \tag{10}$$

$$t = \sqrt{ln\left(\frac{1}{1-(H(x))^2}\right)} \quad \text{to} \quad 0.5 < \mathrm{H(x)} \leq 1 \tag{11}$$

with c_0 = 2.515517; c_1 = 0.802853; c_2 = 0.010328; d_1 = 1.432788; d_2 = 0.189269 and d_3 = 0.001308

Each data is equipped with a gamma function to determine the probability of rain. After the rainfall probability ratio is determined based on all observed data, the feasibility of all rainfall data is calculated to obtain the SPI drought index value. Drought occurs when the SPI index value collected is negative and reaches an SPI slope intensity of -1 or less. A positive SPI value indicates that the rainfall captured is greater than the average rainfall, while a negative value indicates that the rainfall obtained is less than the average rainfall. The classification of drought levels can be seen in Table 1.

Table 1: Classification of drought levels

SPI Index Value	Drought Classification
≤ -2.0	Extremely dry
-1.99 to -1.50	Severely dry
-1.49 to -1.0	Moderately dry
-0.99 to 0.99	Near normal
1.00 to 1.49	Moderately wet
1.50 to 1.99	Severely wet
≥ 2	Extremely wet

Source: (Mckee *et al.*, 1993)

2.5. Spatial Analysis

The processing is carried out spatially to map the distribution of drought using ArcGIS software. The Indonesian Topographic Map data is used to determine the administrative boundaries of the research area which was obtained from the website https://tanahair.indonesia.go.id, and the rice field map used is the land use map obtained from the Agriculture Office. The interpolation method used to interpret the spatial values of the SPI drought index is the IDW (inverse distance weighted) method to obtain the distribution of the drought that occurs (Irsyad & Oue, 2021). IDW is a geostatistical interpolation method used to estimate values at unsampled locations based on surrounding data (Widyastuti *et al*., 2020). The IDW method provides more accurate interpolation results compared to other interpolation methods, this is because all results with the IDW method provide values close to the minimum and maximum values of the data sample (Pramono, 2008). The results of the drought distribution were then overlaid with the rice field land using the map of Agam Regency, allowing for the identification of the area of rice fields that were possibly affected by drought during that period (Awalina *et al*., 2021).

3. RESULTS AND DISCUSSION

3.1. Rainfall Data of Agam Regency

The rainfall data (1993-2022) used in this study come from two rainfall stations in Agam Regency (Canduang and Gumarang) and three additional stations (Padang Panjang, Suliki, and Paraman Talang) at the around the regency. The average monthly rainfall at each station can be seen in Table 2. Based on the analysis of rainfall data from 1993 to 2022, the average monthly rainfall for 30 years in Agam Regency shows that the lowest average monthly rainfall value occurred between June and August with consecutive values of 186.12 mm, 173.63 mm and 229.13 mm. This is in line with previous research which stated that the average dry season in Agam Regency occurs in April and ends in September (Irsyad & Oue, 2021). The lowest average monthly precipitation occurred in July, with a value of 174 mm/month. According to (Hidayati, 2017), the average rainfall of <100 mm/month is categorized as a dry month, 100-200 mm/month is a humid month, and rainfall of >200 mm/month is categorized as a wet month. The average rainfall in Agam Regency in July is included in the category of humid months. The humid month serves as an early sign of drought, so we can analyze the drought that occurs in Agam.

Table 2: Average monthly rainfall for each station (1993-2022)

Month	Average Monthly Rainfall (mm)					Average
	Canduang	Gumarang	BMKG Padang Panjang	Suliki	Paraman Talang	
Januari	209	272	321	252	364	283
Februari	180	238	292	210	305	245
Maret	264	302	357	227	424	315
April	295	310	405	308	453	354
Mei	189	245	242	158	339	235
Juni	135	196	211	144	244	186
Juli	140	189	197	116	226	174
Agustus	152	245	255	162	331	229
September	171	295	301	259	366	278
Oktober	227	339	365	332	382	329
November	287	425	448	357	467	397
Desember	246	362	462	317	409	359
Total	**2,495**	**3,419**	**3,857**	**2,841**	**4,310**	**3,384**

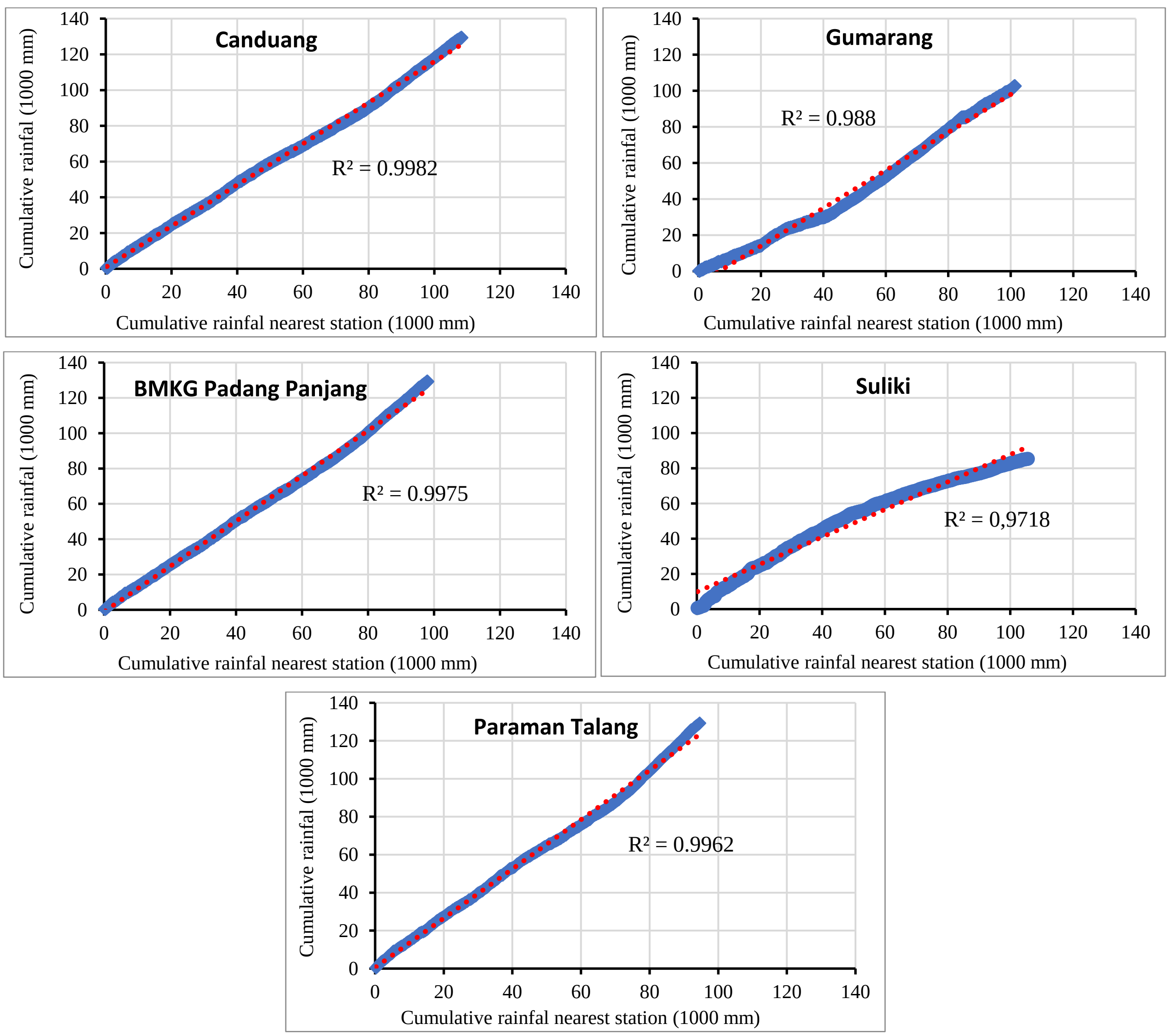

Figure 1: Rainfall data consistency at stations of Canduang, Gumarang, BMKG Padang Panjang, Suliki, and Paraman Talang

3.2. Rain Data Consistency Test

The consistency test results show that the rainfall data have acceptable consistency at each station, indicated by the coefficient of derivation (R^2) value approaching one. Figure 1 displays the results of the rainfall data consistency test for each station. Based on the graph, the R^2 values obtained are 0.9982 (Canduang Station), 0.9966 (Gumarang Station), 0.9972 (BMKG Padang Panjang Station), 0.9718 (Suliki Station), and 0.9962 (Paraman Talang Station). The R^2 values obtained at each station indicate that the rainfall data is consistent with a value approaching one (Firmansyah & Muliati, 2021). It means a high level of consistency in the rainfall data, which means that there are no significant changes in the rainfall data at each station.

3.3. SPI Drought Index Classification Analysis

SPI drought analysis was conducted at one-month intervals, using rainfall data over 30 years from 1993 to 2022, and was guided based on rainfall data tested for data consistency. Figure 2 displays the result of the SPI method drought analysis. Based on the graph, droughts have occurred at all observation stations, although the intensity, frequency, and

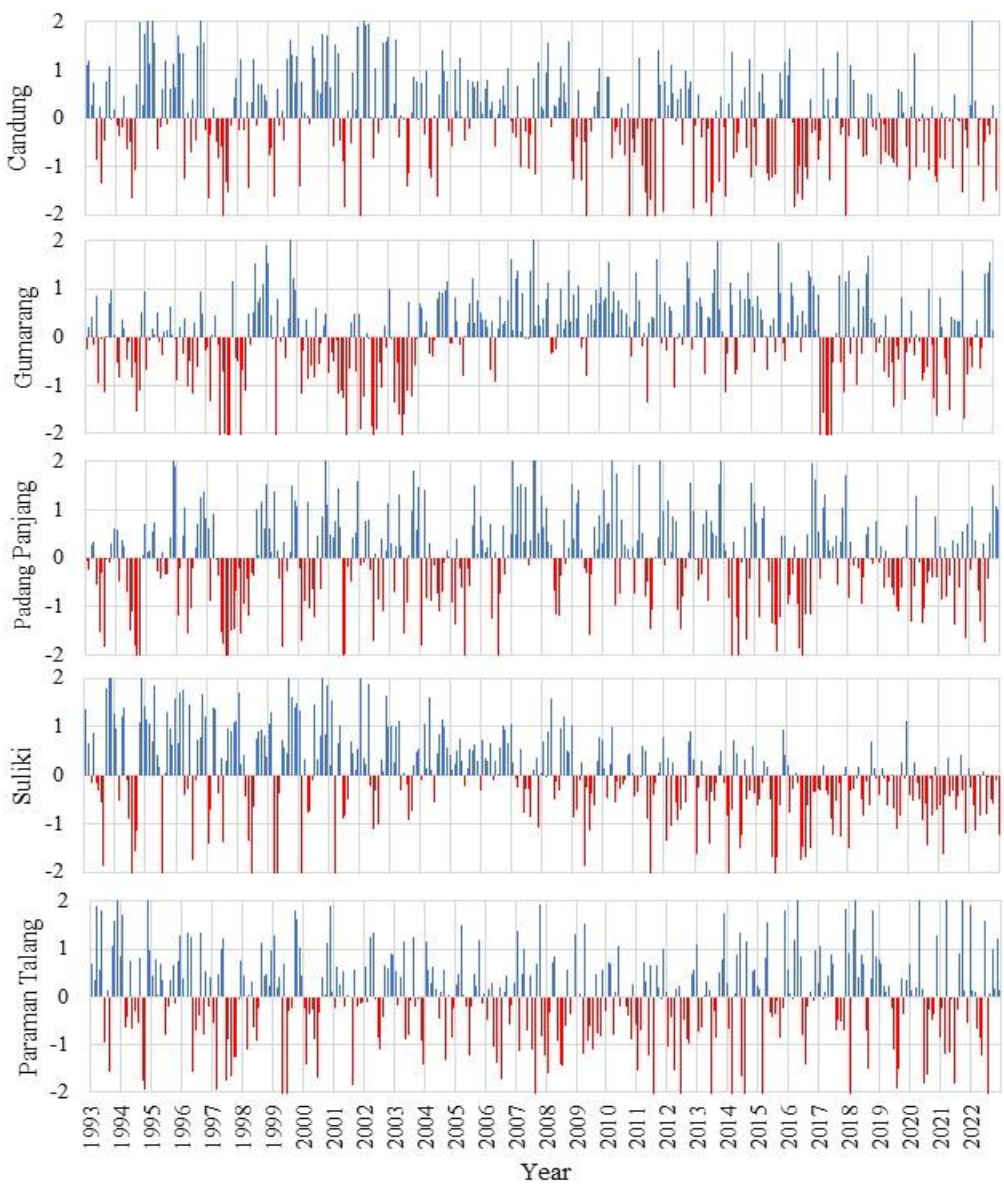

Figure 2. Graph of monthly SPI values for each station (Red: Dry condition; Blue: Wet condition)

duration of such droughts are not always the same from one station to another (Widyastuti *et al*., 2020). This difference was cognate by the period of the drought between the coverage of each station, which has a different average rainfall, which affect the severity and timing of drought in each region, so when the SPI drought index analysis, the results obtained were also different (Lotfirad *et al*., 2022; Saada & Abu-Romman, 2017). The results of the drought index analysis show that the resulting drought value is influenced by rainfall, so the rainfall value is directly proportional to the drought index obtained. Research conducted by (Nurhasanah *et al*., 2018) states that the higher the rainfall deficit, the higher the possibility of a meteorological drought.

3.4. Drought Distribution SPI Index

Drought distribution information was analyzed using the SPI (Standardized Precipitation Index) drought index value and displayed in the form of a map that provided spatial representation. Figure 3 shows one of the results of the drought distribution map which provides an overview of the spatial distribution of drought in Agam Regency. The distribution is depicted with colored lines that reflect the severity of drought, according to the classification that has been determined. In this analysis, seven color classes were used that described the intensity of drought, based on the threshold values determined by the SPI classification. This approach is consistent with the methods used in similar studies (Malini *et al*., 2021). Figure 3 illustrates the spatial distribution of drought based on SPI values, which are grouped into four classes of drought intensity. Areas with high drought intensity (indicated by red) indicate areas that are particularly vulnerable to water shortages, especially during certain periods. In contrast, regions with lighter colors (yellow) have a lower risk of drought. Based on the distribution of drought, areas with high drought intensity must be a priority in the allocation of irrigation water, especially in the dry season.

Drought in July was preferred based on the results of the monthly rainfall analysis in Table 2, which has the lowest average rainfall value in the Agam Regency. The rainfall value is in the category of humid months, which was the first indication of a drought event (Wahyudi, 2018). Based on the results of the analysis of the distribution of drought in July 2022 in Figure 3, related to the level of drought distribution that occurred in Agam Regency through the interpretation of the SPI index value, the level of drought in Agam Regency occurred at three levels, moderately dry, severely dry and extremely dry. The distribution of drought in every sub-district in Agam Regency is in Table 3.

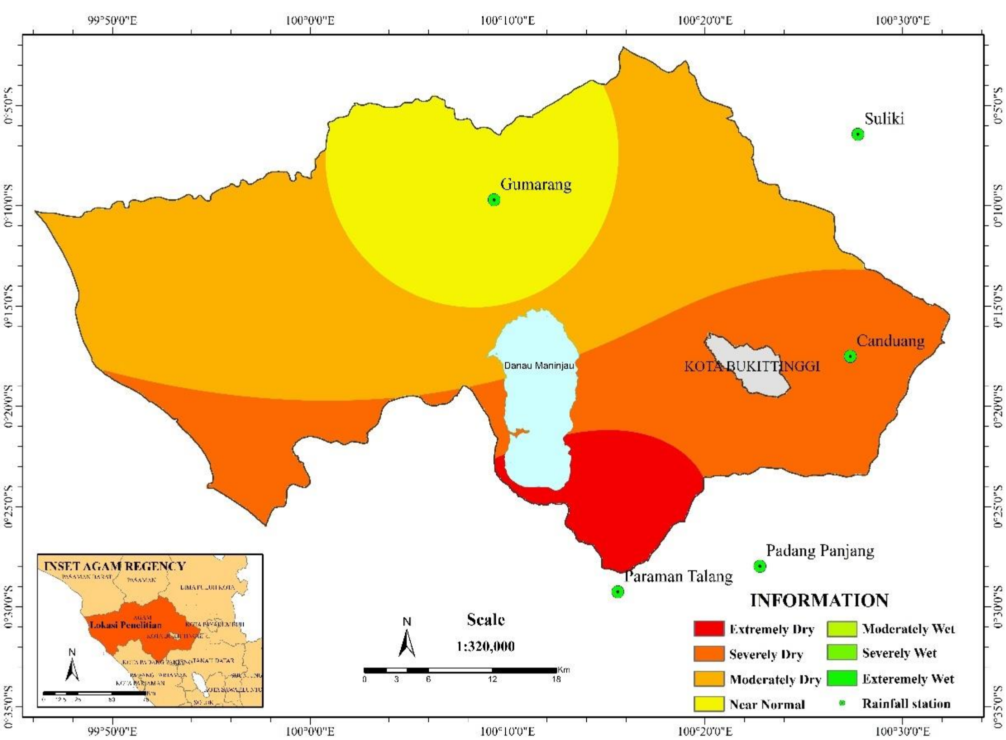

Figure 3: Map of drought potential distribution in Agam Regency during July 2022

Table 3. Potential area of drought for each district in Agam Regency.

Drought Index	Subdistrict	Area		Total (ha)
		ha	%	
Extremely Dry	IV Koto	614.46	0.28	15,452.19
Extremely Dry	Malalak	9,870.68	4.42	
Extremely Dry	Tanjung Raya	4,967.05	2.23	
Severely Dry	Banuhampu	2,715.84	1.22	64,083.80
Severely Dry	Baso	7,597.04	3.40	
Severely Dry	Canduang	5,544.98	2.48	
Severely Dry	IV Angkat Candung	3,183.93	1.43	
Severely Dry	IV Koto	7,416.87	3.32	
Severely Dry	Kamang Magek	1,398.02	0.63	
Severely Dry	Lubuk Basung	4,664.00	2.09	
Severely Dry	Malalak	2.85	0.001	
Severely Dry	Matur	5,818.18	2.61	
Severely Dry	Palupuh	49.11	0.02	
Severely Dry	Sungai Pua	3,997.66	1.79	
Severely Dry	Tanjung Mutiara	8,831.51	3.96	
Severely Dry	Tanjung Raya	7,564.31	3.39	
Severely Dry	Tilatang Kamang	5,299.50	2.37	
Moderately Dry	Baso	6.63	0.003	101,603.67
Moderately Dry	IV Nagari	19,928.30	8.93	
Moderately Dry	Kamang Magek	6,238.24	2.79	
Moderately Dry	Lubuk Basung	20,532.40	9.20	
Moderately Dry	Matur	3,286.67	1.47	
Moderately Dry	Palembayan	8,297.23	3.72	
Moderately Dry	Palupuh	17,754.70	7.95	
Moderately Dry	Tanjung Mutiara	16,076.70	7.20	
Moderately Dry	Tanjung Raya	8,682.03	3.89	
Moderately Dry	Tilatang Kamang	800.77	0.36	
Near Normal	IV Nagari	8,664.21	3.88	42,095.59
Near Normal	Palembayan	26,775.70	11.99	
Near Normal	Palupuh	4,240.55	1.90	
Near Normal	Tanjung Raya	2,415.13	1.08	
Total		**223,235.25**	**100**	**223,235.25**

The distribution of drought in the Agam Regency with the near normal category is 42,095.59, or 18.86% of the total area of the regency, with Palembayan District having the largest area of 26,7775.70 ha. The distribution of drought in the moderately dry category is 101,603.67 ha, with 45.51% of the total area of the regency, with Lubuk Basung District being the area with the extensive impact, namely 20,532.40 ha. The distribution of drought in the severely dry category is 64,083.80 ha, or 28.71% of the total area of the regency, with Tanjung Mutiara District being the area with the extensive potential for drought, namely 8,831.51 ha. Meanwhile, the distribution of drought has a extremely dry category with an area of 15,452.19 ha, or 6.92% of the total area of the district, with Malalak District having the expanded potential for drought, namely 9,870.68 ha. Table 3 provides an in-depth insight into drought distribution patterns in Agam Regency. By understanding the distribution of drought intensity, strategic measures can be designed to reduce its impact on the agricultural sector, increase farmers' productivity, and ensure food sustainability in the region.

3.5. Map of Potential Drought in Rice Fields

An analysis of potential drought in rice fields is needed to see if rice fields in Agam Regency are affected by drought (Irsyad *et al*., 2023). A map of rice field land use is required in this analysis to determine areas experiencing drought based on the SPI index value. The rice field map used is the 2018 rice field map of Agam Regency obtained from the Agriculture Service. Based on this map, the appliance of rice fields in Agam Regency has a total rice field area of 25,996.29 ha. The map is overlaid with a map of the distribution of drought in July as an illustration of land indicated by drought. The July drought was elected because it is the month with the lowest average rainfall. It is in the category of humid months. It can be the first indication of drought in Agam Regency based on the results that have been composed. The distribution of the potential for drought in July 2022 in the use of rice fields in the Agam Regency is Figure 4. It provides a spatial visualization of the potential for drought in rice fields in Agam Regency based on SPI analysis overlaid with land use data (rice fields). The results of the analysis showed four levels of drought potential: near normal, moderately dry, severly dry, and extremely dry. Areas with higher levels of drought have more intense or dark color distributions on the map. Rice fields in severly dry to extremely dry areas have a higher risk of crop failure and require immediate intervention. Rice fields with drought potential are moderately dry and still allow harvesting with the support of proper water management. The following is the distribution of the potential for drought in rice fields in each sub-district in Agam Regency presented in Table 4.

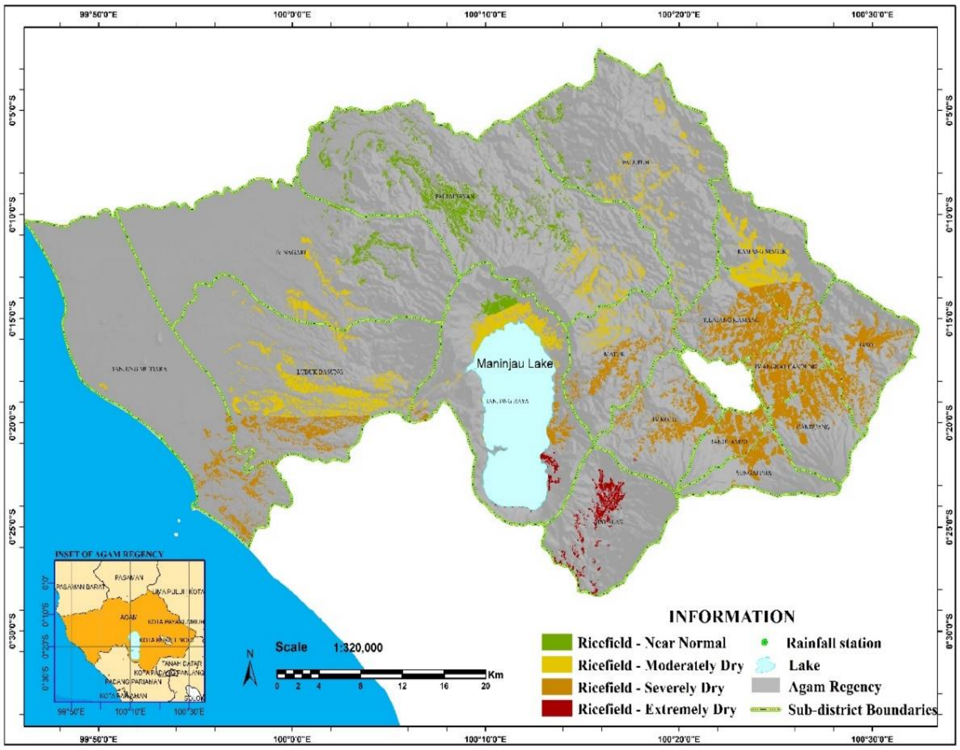

Figure 4. Map of potential drought in rice fields in Agam Regency

The potential level of drought in “severely dry” rice fields is spread across many sub-districts in the Agam Regency, with an area of 13,638.88 ha, or 52.47% of the total rice fields in the Agam Regency. Tilatang Kamang District has the highest potential for drought in rice fields, with an area of 2,058.15 ha. The potential level of drought in the “extremely dry” rice fields area is 902.68 ha or 3.47% of the total area of rice fields in Agam Regency. The drought is advancing across several sub-districts, with Malalak District having the highest potential area of 750.48 ha.

Rice fields acquire the potential for drought in the dry categories, which means that the area has an extreme rainfall deficit, so the available water cannot appropriate plant water (Arlius *et al*., 2017). So, more attention is needed to overcome this. A well-designed mitigation and preparedness plan can help decision-makers reduce the impact of drought (Dutta *et al*., 2015). In this context, monitoring the onset, duration, intensity, and extent of drought is crucial to managing the adverse effects of drought (Irsyad *et al*., 2023). In an effort to overcome the impact of drought that occurs in areas that have a wide drought potential, it is recommended to meet the water shortage that occurs in rice fields by utilizing rivers, irrigation and reservoirs in the area. While areas that have the potential for drought with a fairly small area, it is recommended to adjust the planting pattern to avoid drought months, and plant other types of plants that are tolerant of little water. In the mitigation plan efforts, the results of this study can be one of the guidelines for decision-makers or local governments to see the distribution of potential droughts that occur.

Table 4. Potential area of dry rice fields for each district in Agam Regency.

Drought Index	Subdistrict	Area		Total (ha)
		ha	%	
Extremely Dry	IV Koto	3.97	0.02	902.68
Extremely Dry	Malalak	750.48	2.89	
Extremely Dry	Tanjung Raya	148.23	0.57	
Severely Dry	Banuhampu	930.84	3.58	13,638.88
Severely Dry	Baso	1,820.31	7.00	
Severely Dry	Canduang	1,347.93	5.19	
Severely Dry	IV Angkat Candung	1,614.65	6.21	
Severely Dry	IV Koto	1,325.80	5.10	
Severely Dry	Kamang Magek	623.81	2.40	
Severely Dry	Lubuk Basung	1,126.09	4.33	
Severely Dry	Matur	919.32	3.54	
Severely Dry	Sungai Pua	546.67	2.10	
Severely Dry	Tanjung Mutiara	914.52	3.52	
Severely Dry	Tanjung Raya	410.79	1.58	
Severely Dry	Tilatang Kamang	2,058.15	7.92	
Moderately Dry	IV Nagari	642.36	2.47	7,627.66
Moderately Dry	Kamang Magek	1,262.58	4.86	
Moderately Dry	Lubuk Basung	2,518.61	9.69	
Moderately Dry	Matur	418.82	1.61	
Moderately Dry	Palembayan	666.29	2.56	
Moderately Dry	Palupuh	737.38	2.84	
Moderately Dry	Tanjung Mutiara	19.70	0.08	
Moderately Dry	Tanjung Raya	1,253.50	4.82	
Moderately Dry	Tilatang Kamang	108.41	0.42	
Near Normal	IV Nagari	478.64	1.84	3,823.39
Near Normal	Palembayan	2,703.99	10.40	
Near Normal	Palupuh	283.75	1.09	
Near Normal	Tanjung Raya	357.00	1.37	
Total		**25,992.60**	**100**	**25,992.60**

4. CONCLUSION

Agam Regency experiences a significant drought season, especially in the middle of the year (May to September). This condition hurts agricultural production and the availability of water resources. In July 2022, the potential area of rice fields that are vulnerable to drought in Agam Regency with a extremely dry category in July 2022 was 902.68 ha or 3.47%, and the severely dry category was 13,638.88 ha or 52.47% of the rice field area in Agam Regency. The most likely to be affected by drought in the dry category is Tilatang Kamang District at 2058.15 ha, and the very dry category is Malalak District at 750.48 ha. In an effort to overcome the impact of drought that occurs in areas that have a wide drought potential, it is recommended to meet the water shortage that occurs in rice fields by utilizing rivers, irrigation and reservoirs in the area. Similar research can be applied in other regions that have complete rainfall data to predict droughts, which have a role for irrigation management and determination of rice planting patterns.

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REFERENCES

Aprilliyanti, T., & Zainuddin, M. (2017). Pemetaan potensi kekeringan lahan se-pulau batam menggunakan teknik sistem informasi geografis (SIG) dan penginderaan jauh. *Majalah Geografi Indonesia*, ***31***(1), 90-94. https://doi.org/10.22146/mgi.24251

Arlius, F., Irsyad, F., & Yanti, D. (2017). Analisis daya dukung lahan untuk sawah tadah hujan di Kabupaten Pasaman Barat. *Rona Teknik Pertanian*, ***10***(1), 23–33. https://doi.org/10.17969/rtp.v10i1.7246

Awalina, R., Yanti, D., & Irsyad, F. (2021). Analisis faktor yang mempengaruhi produksi padi salibu Daerah Sumatera Barat. *Jurnal Teknologi Pertanian Andalas*, ***25***(1), 90. https://doi.org/10.25077/jtpa.25.1.90-95.2021

Dutta, D., Kundu, A., Patel, N.R., Saha, S.K., & Siddiqui, A.R. (2015). Assessment of agricultural drought in Rajasthan (India) using remote sensing derived vegetation condition index (VCI) and standardized precipitation index (SPI). *The Egyptian Journal of Remote Sensing and Space Science*, ***18***(1), 53–63. https://doi.org/10.1016/j.ejrs.2015.03.006

Firmansyah, Y. (2021). Analisis data curah hujan yang hilang dengan menggunakan metode rasional dan metode inversed square distance di Stasiun Cipaku, Cipeusing, dan Cisampih. [*Undergraduate Thesis*], Itenas.

Hidayat, Y.M., Harlan, D., & Winskayati. (2014). Analisis penggunaan air irigasi dengan teknik analytical hierarchy process di Wanir Kabupaten Bandung. *Jurnal Sumber Daya Air*, ***10***(1), 1–12.

Hidayati, R. (2017). Klasifikasi iklim oldeman dan aplikasinya di Indonesia. [*Undergraduate Thesis*], Institut Pertanian Bogor.

Irsyad, F., & Oue, H. (2021). Predicting future dry season periods for irrigation management in West Sumatra, Indonesia. *Paddy and Water Environment,* ***19***, 683–697. https://doi.org/10.1007/s10333-021-00867-2

Irsyad, F., Oue, H., Utami, A.S., & Ekaputra, E.G. (2023). Impacts of the dry season on rice production using landsat 8 in West Sumatra. *Paddy and Water Environment*, ***21***, 205–217. https://doi.org/10.1007/s10333-022-00922-6

Kurnia, K.D. (2019). Analisis Potensi kekeringan lahan sawah dengan menggunakan metode normalized differency drought index (NDDI) dan thermal vegetation index (TVI) (Studi kasus: Kabupaten Bantul). [*Undergraduate Thesis*], ITN Malang. http://eprints.itn.ac.id/id/eprint/4039

Lee, H., Calvin. K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P., Trisos, C., Romero, J., Aldunce, P., Barrett, K., Blanco, G., Cheung, W.W.L., Connors, S.L., Denton, F., Diongue-Niang, A., Dodman, D., Garschagen, M., Geden, O., Hayward, B., Jones, C., Jotzo, F., Krug, T., Lasco, R., Lee, J-Y. Masson-Delmotte, V., Meinshausen, M., Mintenbeck, K., Mokssit, A., Otto, F.E.L., Pathak, M., Pirani, A., Poloczanska, E., Pörtner, H-O., Revi, A., Roberts, D.C., Roy, J., Ruane, A.C., Skea, J., Shukla, P.R., Slade, R., Slangen, A., Sokona, Y., Sörensson, A.A., Tignor, M., van Vuuren, D., Wei, Y-M., Winkler, H., Zhai, P., & Zommers, Z. (2023). *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change.

Lotfirad, M., Gisavandani, H.E., & Adib, A. (2022). Drought monitoring and prediction using SPI, SPEI, and random forest model in various climates of Iran. *Water and Climate Change*, ***13***(2), 383–406. https://doi.org/10.2166/wcc.2021.287

Malini, C., Halik, G., & Agung Wiyono, R.U. (2021). Analisis kekeringan meteorologi menggunakan metode standardized preciptation index (SPI) di DAS Bedadung Kabupaten Jember. *Teras Jurnal*, ***11***(2), 307. https://doi.org/10.29103/tj.v11i2.483

Masruroh, D., & Bowo, C. (2022). Drought analysis by using standardized precipitation index (SPI) method and their effects on rice and maize productivity. *Jurnal Tanah dan Sumberdaya Lahan*, ***9***(2), 277–284. https://doi.org/10.21776/ub.jtsl.2022.009.2.8

Maulina, S.M., Christiana, R., & Widodo, M.L. (2022). Analisis curah hujan untuk pendugaan debit banjir dan debit andalan dengan metode FJ Mock (Studi kasus: Sungai Kapuas Kecamatan Tayan Hilir Kabupaten Sanggau). *Jurnal Ilmu Teknik*, ***3***(2). https://doi.org/10.37058/aks.v3i2.4580

Mckee, T.B., Doesken, N.J., & Kleist, J. (1993). The Relationship of Drought Frequency and Duration to Time Scale. *8th Conference on Applied Climatology,* 179-184. https://doi.org/10.1002/jso.23002

Narulita, I., Rahayu, R., Kusratmoko, E., Supritna, &, Djuwansah, M. (2019). Ancaman kekeringan meteorologis di pulau kecil tropis akibat pengaruh El-Nino dan Indian ocean dipole (IOD) positif, studi kasus: Pulau Bintan. *Jurnal Lingkungan dan Bencana Geologi*, ***10***(3), 127–138. http://dx.doi.org/10.34126/jlbg.v10i3.252

Naylor, R.L., Battisti, D.S., Vimont, D.J., Falcon, W.P., & Burke, M.B. (2007). Assessing risks of climate variability and climate change for Indonesian rice agriculture. *Proceedings of the National Academy of Sciences of the United States of America*, ***104***, 7752–7757. https://doi.org/10.1073/pnas.0701825104

Novita, F., Harisuseno, D., & Suhartanto, E. (2021). Analisis kekeringan meteorologi dengan menggunakan metode standardized precipitation (SPI) dan reconnaissance drought index (RDI) di DAS Lekso Kabupaten Blitar. *Jurnal Teknologi dan Rekayasa Sumber Daya Air*, ***1***(2), 672–685.

Nurhasanah., Fauzi, M., & Trimaijon. (2018). Analisis indeks kekeringan daerah aliran sungai Batang Anai dengan menggunakan metode standardized precipitation index (SPI). *Jom FTEKNIK*, 5(1).

Pramono, G.H. (2008). Akurasi metode IDW dan kriging untuk interpolasi sebaran sedimen tersuspensi di Maros, Sulawesi Selatan. *Forum Geografi*, ***22***(2), 145–158. https://doi.org/10.23917/forgeo.v22i2.4988

Rahmalina, W., & Novreta. (2020). Peramalan indeks kekeringan kelayang menggunakan metode sarima dan SPI. *Potensi : Jurnal Sipil Politeknik*, ***22***(1), 64–75. https://doi.org/10.35313/potensi.v22i1.1824

Ruminta. (2016). Analisis penurunan produksi tanaman padi akibat perubahan iklim di Kabupaten Bandung Jawa Barat. *Jurnal Kultivasi*, ***15***(1), 37–45. https://doi.org/10.24198/kultivasi.v15i1.12006

Ruminta., Rosniawaty, S., & Wahyudin, A. (2016). Pengujian sensitivias kekeringan dan daya adaptasi tujuh varieas padi di wilayah dataran medium Jatinangor. *Jurnal Kultivasi*, ***15***(2), 114–120. https://doi.org/10.24198/kultivasi.v15i2.11909

Saada, N., & Abu-Romman, A. (2017). Multi-site modeling and simulation of the standardized precipitation index (SPI) in Jordan. *Journal of Hydrology: Regional Studies*, ***14***, 83–91. https://doi.org/10.1016/j.ejrh.2017.11.002

Shah, R., Bharadiya, N., & Manekar, V. (2015). Drought index computation using standardized precipitation index (SPI) method for Surat District, Gujarat. *Aquatic Procedia*, ***4***, 1243–1249. https://doi.org/10.1016/j.aqpro.2015.02.162

Supadi. (2009). Pengkajian penanganan pemberian air irigasi di petak terisolir ujung saluran irigasi pada musim kemarau. *Media Komunikasi Teknik Sipil*, ***17***(1), 1–8.

Surmaini, E., Runtunuwu, E., & Las, I. (2011). Upaya sektor pertanian dalam menghadapi perubahan iklim. *Jurnal litbang pertanian*, ***30***(1), 1–7.

Wahyudi, S. (2018). Pengelolaan Iklim dan Tanaman Pangan. [*Undergraduate Thesis*], Universitas Gadjah Mada.

Widyastuti, R., Tambunan, M.P., & Tambunan, R.P. (2020). Pola sebaran kekeringan di Kecamatan Simpenan menggunakan metode SPI (standardized precipitation index). *Jurnal Geosaintek*, ***6***(1), 19–24. http://dx.doi.org/10.12962/j25023659.v6i1.6272