ADITUM
Enrich your Research

Journal of International Research and Reviews

Research Article

Rainfall Variability And Meteorological Drought In Tubah Subdivision, North-West Region, Cameroon

Muse Elvis Muno (Ph.D.)
National Polytechnic University Institute (NPUI), Bamenda, Cameroon.

Article Info

Received: November 15, 2026
Accepted: November 25, 2026
Published: November 27, 2026

Corresponding author: Muse Elvis Muno (Ph.D.), National Polytechnic University Institute (NPUI), Bamenda, Cameroon.

Citation: Muse E Muno. (2026) "Rainfall Variability And Meteorological Drought In TUBAH Subdivision, North-West Region, Cameroon", Journal of International Research and Reviews, 2(2); DOI: 10.61148/3068-370X/JIRR/028.

Copyright: © 2026. Muse Elvis Muno. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

Rainfall variability affects the timing and distribution of water availability, particularly in areas where agricultural activities depend largely on seasonal precipitation. This study examined rainfall variability and meteorological drought in Tubah Subdivision, Mezam Division, North-West Region of Cameroon, using Climate Hazards Group InfraRed Precipitation with Station Data (CHIRPS) estimates for 1981–2025. Daily precipitation data were aggregated into monthly totals to assess annual rainfall characteristics, monthly distribution and seasonal patterns. Annual trends were evaluated using the Mann–Kendall test and Sen's slope estimator, while the Standardized Precipitation Index (SPI) assessed precipitation deficits at three- and six-month accumulation periods. Mean annual rainfall was 2,036.63 mm, ranging from 1,819.35 mm to 2,345.97 mm, with a coefficient of variation of 6.35%. No statistically significant annual rainfall trend was detected ($p = 0.8068$; Kendall's tau = −0.0263), and Sen's slope was −0.4285 mm per year. July recorded the highest mean monthly rainfall (376.10 mm), while January recorded the lowest (5.54 mm). Approximately 97% of annual rainfall occurred between March and October. The findings highlight pronounced seasonal rainfall distribution and the importance of combining rainfall trend analysis with meteorological drought assessment to understand precipitation variability in Tubah.

Keywords: CHIRPS; rainfall variability; meteorological drought; Standardized Precipitation Index; Mann–Kendall test; Sen's slope; Tubah Subdivision; Cameroon

1. Introduction

Rainfall is an important climatic factor influencing agricultural production, water availability and the functioning of terrestrial ecosystems. Its influence is particularly important in areas where farming activities depend largely on natural precipitation. In such environments, the amount of rainfall received during a year matters, but its distribution across months and seasons is equally important. A location may receive a relatively high annual rainfall total and still experience periods of reduced precipitation when rainfall is poorly distributed or when dry spells occur during particular stages of the growing season.

Across sub-Saharan Africa, rainfall variability remains an important concern for agricultural systems and rural livelihoods. Differences in the timing, duration and intensity of rainfall can affect planting decisions, crop development, soil moisture conditions and the availability of surface water. These concerns are particularly relevant in highland environments, where differences in elevation, slope and local atmospheric conditions may produce variations in rainfall over relatively short distances.

Cameroon has a varied climatic setting, ranging from humid equatorial conditions in the south and coastal areas to more seasonal tropical conditions in the northern parts of the country.

The western highlands, which include the North-West Region, experience a marked alternation between wetter and drier periods. Rainfall is generally concentrated within the main rainy season, although its timing and distribution differ between locations. The varied relief of the region also contributes to local differences in climatic conditions. Ebodé (2022) examined the spatial and temporal variability of rainfall across Cameroon and showed the importance of considering geographical differences when interpreting rainfall patterns.

Research in the Bamenda Highlands has also considered rainfall variability, seasonal transitions and drought conditions. Tume and Mairomi (2021) examined the Standardized Precipitation Index in relation to seasonal transitions and pastoral adaptation in the highland environment. Other studies in the North-West Region have considered the relationship between rainfall conditions and agricultural production, including maize production in the Ndop Plain (Tume & Ngwa, 2022) and rainfall reliability in the Bamenda Highlands (Tume et al., 2024).

These studies provide useful information about rainfall behaviour in Cameroon and the western highlands. However, findings obtained at national, regional or individual station scales cannot automatically be applied to every subdivision. Regional averages may conceal local differences in rainfall amounts and seasonal distribution. A more geographically focused assessment is therefore needed to describe rainfall characteristics and identify periods of unusually low precipitation at the subdivision level.

Tubah Subdivision, located in Mezam Division of the North-West Region, forms part of the Bamenda Highlands. Agricultural activities in the area depend partly on seasonal rainfall, while the timing and consistency of precipitation are relevant to farming operations and local water availability. Understanding the long-term distribution of rainfall is therefore important for describing the climatic conditions of the subdivision.

One difficulty associated with long-term rainfall analysis in parts of Central Africa is the limited availability of continuous, quality-controlled meteorological station records. Gridded precipitation products provide an alternative source of information in locations where ground observations are limited. The Climate Hazards Group InfraRed Precipitation with Station Data (CHIRPS) product combines satellite observations, climatological information and station-based data to provide rainfall estimates over land areas (Funk et al., 2015). Its long temporal coverage makes it useful for examining historical rainfall variability and meteorological drought, although the estimates may contain uncertainties associated with satellite retrievals, station availability and local terrain.

Rainfall totals alone do not provide a complete description of meteorological drought. The Standardized Precipitation Index (SPI) allows precipitation deficits to be examined over different accumulation periods. It provides a standardised measure of wet and dry conditions using precipitation data. SPI-3 represents accumulated rainfall over three months, while SPI-6 represents accumulated rainfall over six months. These different accumulation periods provide complementary information about short- and medium-term precipitation conditions (McKee et al., 1993; World Meteorological Organization, 2012).

Despite previous studies of rainfall variability in Cameroon and the Bamenda Highlands, a long-term subdivision-level assessment of rainfall distribution and meteorological drought in Tubah remains necessary. In particular, examining annual rainfall trends alongside monthly and seasonal patterns can help establish whether relatively stable annual totals conceal periods of unusually low precipitation. This study examines rainfall variability and meteorological drought in Tubah Subdivision using CHIRPS rainfall estimates covering 1981–2025.

2. Materials and Methods

2.1. Description of the Study Area

Tubah Subdivision is located in Mezam Division of the North-West Region of Cameroon (Figure 1). It lies approximately around 6°28′N latitude and 10°26′E longitude, corresponding to about 6.47°N and 10.44°E. The subdivision forms part of the western highlands, an area characterised by elevated terrain, undulating landscapes and a distinct seasonal rainfall regime. North-West Region generally experiences two major seasons: a rainy season and a dry season. The rainy season commonly begins around March and extends into October or November, while the dry season occupies the

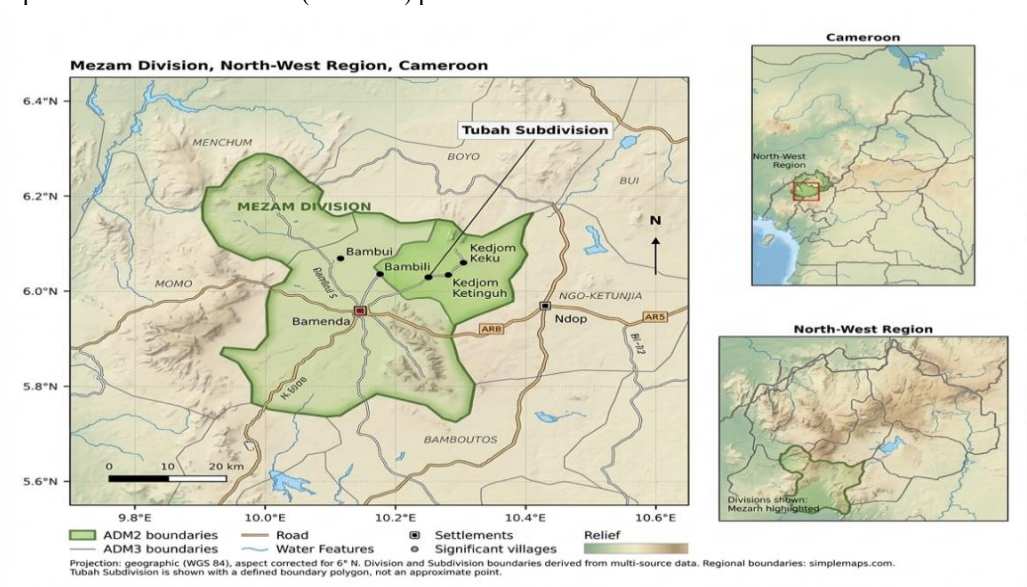

Figure 1. Location of Tubah Subdivision in Mezam Division, North-West Region of Cameroon.

Copyright © Muse Elvis Muno

2.2 Rainfall data source

The study used rainfall estimates from the Climate Hazards Group InfraRed Precipitation with Station Data (CHIRPS) dataset. CHIRPS is a gridded precipitation product developed to support drought monitoring and climate analysis. It combines infrared satellite observations with climatological information and station data to generate rainfall estimates over land areas (Funk et al., 2015). The daily CHIRPS dataset available through Google Earth Engine under the collection identifier UCSB-CHG/CHIRPS/DAILY was used for the analysis. The product has a spatial resolution of approximately 0.05 degrees and provides rainfall information from 1981 onwards. Daily precipitation observations were used to obtain monthly rainfall totals for the period January 1981 to December 2025. This period covers 45 complete calendar years and provides 540 monthly observations. The exported monthly rainfall series contained no missing monthly observations.

2.3 Extraction and processing of rainfall data

Rainfall extraction was carried out in Google Earth Engine using the CHIRPS daily image collection. The Tubah Subdivision boundary was used as the geographical region of interest. Daily precipitation observations were filtered for the period from 1 January 1981 to 31 December 2025 and aggregated into monthly rainfall totals.

The monthly rainfall images were reduced over the Tubah boundary to obtain a representative rainfall value for the subdivision. The resulting monthly rainfall series was exported for statistical analysis using Python. The monthly rainfall series was subsequently used to calculate annual rainfall totals, monthly climatological statistics, seasonal rainfall summaries and drought indices.

2.4 Annual rainfall characteristics and variability

Annual rainfall was calculated by summing the twelve monthly rainfall totals for each calendar year:

$$P_y = \sum_{m=1}^{12} P_{y,m}$$

where:

P_y represents total annual rainfall for year y.

$P_{y,m}$ represents rainfall recorded in month m of year y.

The long-term mean annual rainfall was calculated as:

$$\overline{P} = \frac{1}{n}\sum_{y=1}^{n} P_y$$

where n represents the number of complete years in the rainfall series.

The coefficient of variation (CV) was used to assess interannual rainfall variability:

$$CV = \frac{\sigma}{\overline{P}} \times 100$$

where:

σ is the standard deviation of annual rainfall.

$\overline{P}$ is the mean annual rainfall.

A higher coefficient of variation indicates greater relative variability, while a lower value indicates that annual rainfall totals are more consistent around the long-term mean.

2.5 Monthly and seasonal rainfall analysis

Monthly rainfall climatology was calculated by averaging rainfall for each calendar month across the 45-year study period. The monthly means were used to identify the wettest and driest months and to examine the annual distribution of rainfall.

Monthly variability was examined using the standard deviation and coefficient of variation for each calendar month. These statistics were used to compare the relative variability of rainfall between months.

For seasonal analysis, the year was divided into two periods:

- Wet season: March to October.
- Dry season: November to February.

These periods were adopted to describe the observed seasonal rainfall distribution in the study area. The long-term mean seasonal rainfall was estimated by summing the monthly climatological means for the months belonging to each season.

The seasonal totals presented in this study therefore represent sums of long-term monthly climatological means. They are not independent annual seasonal totals and should not be interpreted as measures of year-to-year seasonal variability.

2.6 Rainfall trend analysis

The Mann–Kendall non-parametric test was used to examine whether annual rainfall exhibited a statistically significant monotonic trend over the study period. The test is commonly applied in hydrological and climatological studies because it does not require the rainfall observations to follow a normal distribution (Mann, 1945; Kendall, 1975).

The test statistic is expressed as:

$$S = \sum_{i=1}^{n-1}\sum_{j=i+1}^{n} \operatorname{sgn}\left(P_j - P_i\right)$$

where:

$$\operatorname{sgn}\left(P_j - P_i\right) = \begin{cases} +1, & P_j - P_i > 0 \\ 0, & P_j - P_i = 0 \\ -1, & P_j - P_i < 0 \end{cases}$$

A positive test statistic indicates an upward tendency, while a negative statistic indicates a downward tendency. Statistical significance was assessed using a significance level of 0.05.

Sen's slope estimator was used to determine the magnitude and direction of the annual rainfall trend. The estimator is calculated as the median of the slopes between all possible pairs of observations:

$$Q = \operatorname{median}\left(\frac{P_j - P_i}{j - i}\right), \quad j > i$$

A positive slope indicates an increase in rainfall, while a negative slope indicates a decrease. The slope is expressed in millimetres per year (Sen, 1968).

Serial autocorrelation was also assessed because dependence between successive rainfall observations can affect the significance of the Mann–Kendall test. The user confirmed that an autocorrelation assessment and correction were applied.

2.7 Standardized Precipitation Index

Meteorological drought conditions were examined using the Standardized Precipitation Index at three- and six-month accumulation periods. The SPI was developed to quantify precipitation deficits over different accumulation periods and to provide a standardised measure of wet and dry conditions (McKee et al., 1993).

For this study, monthly precipitation was accumulated over three- and six-month periods to obtain SPI-3 and SPI-6. The manuscript's original calculation description identifies the gamma probability

Copyright © Muse Elvis Muno

distribution as the distribution used to fit accumulated precipitation values. The resulting cumulative probabilities were transformed into standard normal values to obtain the SPI series. The interpretation of the index follows the commonly used SPI classification:

SPI value	Interpretation
2.00 and above	Extremely wet
1.50 to 1.99	Severely wet
1.00 to 1.49	Moderately wet
−0.99 to 0.99	Near normal
−1.00 to −1.49	Moderately dry
−1.50 to −1.99	Severely dry
−2.00 and below	Extremely dry

Negative SPI values represent below-normal precipitation, while positive values indicate wetter-than-normal conditions. SPI-3 provides information about precipitation accumulated over a shorter period, whereas SPI-6 represents a longer accumulation period.

For drought assessment, SPI values below −1 were considered drought-related observations. These observations were counted separately for SPI-3 and SPI-6. The counts represent monthly index observations and should not be interpreted as the number of independent drought events because consecutive months may belong to the same drought episode.

3. Results

3.1 Annual rainfall characteristics

The analysis of CHIRPS rainfall estimates for Tubah Subdivision between 1981 and 2025 produced a mean annual rainfall of 2,036.63 mm. The minimum annual rainfall recorded in the series was 1,819.35 mm, while the maximum was 2,345.97 mm. The coefficient of variation was 6.35%, indicating relatively low interannual variability in annual rainfall totals during the study period. The difference between the minimum and maximum annual totals shows that rainfall amounts varied from year to year, although the overall variability around the long-term mean was comparatively limited (Table 1).

Table 1. Summary of annual rainfall characteristics in Tubah Subdivision, 1981–2025.

Indicator	Value
Study period	1981–2025
Number of complete years	45
Mean annual rainfall	2,036.63 mm
Minimum annual rainfall	1,819.35 mm
Maximum annual rainfall	2,345.97 mm
Coefficient of variation	6.35%
Missing monthly observations	0

The results indicate that Tubah experienced substantial rainfall throughout the study period. However, the annual mean alone does not fully describe the distribution of rainfall within the year. The monthly analysis provides a clearer picture of the seasonal concentration of precipitation.

3.2 Monthly rainfall distribution

The monthly rainfall climatology reveals a distinct seasonal pattern, with rainfall increasing from the beginning of the rainy season and reaching its highest monthly average in July. July recorded the highest mean monthly rainfall of 376.10 mm, followed by September with 343.68 mm. August also received substantial rainfall, with a mean of 287.30 mm, while June recorded 260.70 mm. October received an average of 245.53 mm, indicating that considerable rainfall continued towards the end of the wet season. Rainfall was considerably lower between November and February. January was the driest month, with a mean rainfall of 5.54 mm, followed by December with 6.62 mm. February recorded 20.42 mm, while November received 29.01 mm. March marked the transition towards the wetter part of the year, with a mean rainfall of 136.16 mm. Rainfall increased further in April and May, reaching 161.49 mm and 164.07 mm, respectively (Table 2).

Copyright © Muse Elvis Muno

Table 2. Monthly rainfall climatology for Tubah Subdivision, 1981–2025.

Month	Mean rainfall (mm)	Standard deviation (mm)	CV (%)
January	5.54	3.58	64.52
February	20.42	14.39	70.48
March	136.16	61.00	44.80
April	161.49	28.63	17.73
May	164.07	27.45	16.73
June	260.70	34.85	13.37
July	376.10	61.13	16.25
August	287.30	38.79	13.50
September	343.68	46.26	13.46
October	245.53	49.37	20.11
November	29.01	14.85	51.20
December	6.62	4.98	75.21

The monthly coefficient of variation shows that rainfall was relatively more variable during the dry months than during the main rainy season. December had the highest monthly coefficient of variation at 75.21%, followed by February at 70.48% and January at 64.52%. In contrast, June, August and September recorded lower coefficients of variation. This pattern indicates that rainfall during the main wet season was comparatively more consistent than rainfall during the dry months. The high relative variability during the dry season should, however, be interpreted alongside the small average rainfall amounts recorded during those months.

3.3 Seasonal rainfall distribution

The seasonal analysis confirms the strong concentration of rainfall within the wet season. The average monthly rainfall for March–October was 246.88 mm, compared with 15.40 mm for November–February. When the monthly climatological means are summed across the respective seasons, the estimated mean wet-season rainfall is approximately 1,975.04 mm, while the corresponding dry-season accumulation is approximately 61.60 mm. The wet season therefore accounts for approximately 97% of the mean annual rainfall, while the dry season contributes about 3% (Table 2).

Table 3. Seasonal rainfall distribution in Tubah Subdivision.

Season	Months	Mean monthly rainfall (mm)	Estimated seasonal rainfall (mm)	Approximate share
Wet season	March–October	246.88	1,975.04	97%
Dry season	November–February	15.40	61.60	3%

The results show that rainfall availability is strongly dependent on the season. The wet season provides most of the annual precipitation, whereas the dry season is characterised by very limited rainfall. This seasonal contrast is important for understanding agricultural water availability and the timing of farming operations.

3.4 Long-term annual rainfall trend

The Mann–Kendall test detected no statistically significant monotonic trend in annual rainfall over the 1981–2025 period. The calculated p-value was 0.8068, which is considerably higher than the adopted significance threshold of 0.05. Kendall's tau was −0.0263, indicating a very weak negative association between annual rainfall and time. Sen's slope was estimated at −0.4285 mm per year. Although the slope is negative, its magnitude is small and the Mann–Kendall test does not provide evidence of a statistically significant long-term trend (Table 2).

Table 4. Mann–Kendall and Sen's slope results for annual rainfall.

Statistical indicator	Result
Number of years	45
Mean annual rainfall	2,036.63 mm
Mann–Kendall trend	No significant trend
Mann–Kendall p-value	0.8068

Copyright © Muse Elvis Muno

Kendall's tau	−0.0263
Sen's slope	−0.4285 mm/year

The results suggest that annual rainfall totals in Tubah did not undergo a statistically significant monotonic increase or decrease during the study period. The slight negative slope should therefore not be interpreted as evidence of a sustained decline in annual rainfall (Figure 2).

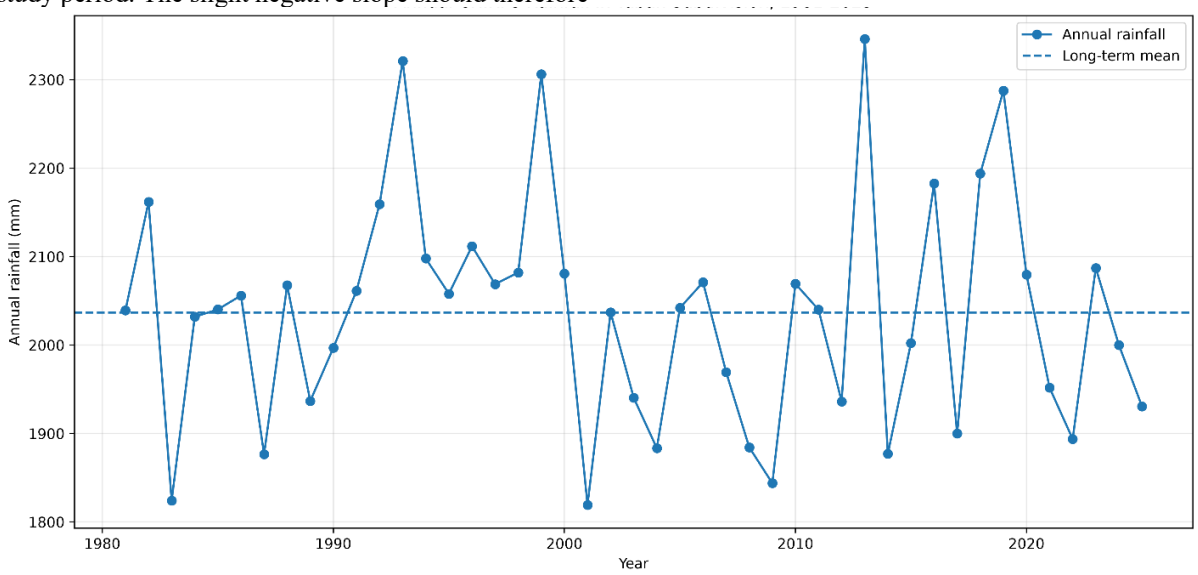

Figure 2. Annual rainfall trend in Tubah Subdivision, 1981–2025.

3.5 Meteorological drought characteristics based on SPI-3 and SPI-6

The Standardized Precipitation Index results provide additional information about rainfall conditions that cannot be fully understood from annual totals alone.

For SPI-3, 538 valid observations were obtained. The index ranged from −3.51 to 2.85, with a mean of approximately zero and a standard deviation of 1.00. For SPI-6, 535 valid observations were available, with values ranging from −3.44 to 2.78. The mean and standard deviation were also approximately zero and one, respectively.

The number of monthly SPI-3 observations below −1 was 91, while SPI-6 recorded 87 observations below the same threshold (Table 5).

Table 5. Descriptive statistics of SPI-3 and SPI-6 in Tubah Subdivision.

Statistical indicator	SPI-3	SPI-6
Valid observations	538	535
Mean	0.00	0.00
Standard deviation	1.00	1.00
Minimum	−3.51	−3.44
First quartile	−0.70	−0.67
Median	0.07	−0.01
Third quartile	0.72	0.72
Maximum	2.85	2.78
Observations below −1	91	87

The minimum SPI values indicate that some periods experienced substantial rainfall deficits. Values below −2 fall within the extremely dry category under the commonly used SPI classification. The maximum values, which were above 2, indicate that some periods also experienced exceptionally wet conditions.

The number of observations below −1 indicates that rainfall deficits were present at both accumulation timescales. However, the counts should not be treated as the number of separate drought events because consecutive months may belong to the same drought episode.

The SPI-3 results provide information on shorter-term rainfall deficits, while SPI-6 reflects accumulated precipitation conditions

Copyright © Muse Elvis Muno

over a longer period. Together, they demonstrate the importance of examining rainfall conditions at different timescales when assessing meteorological drought (Figure 3)

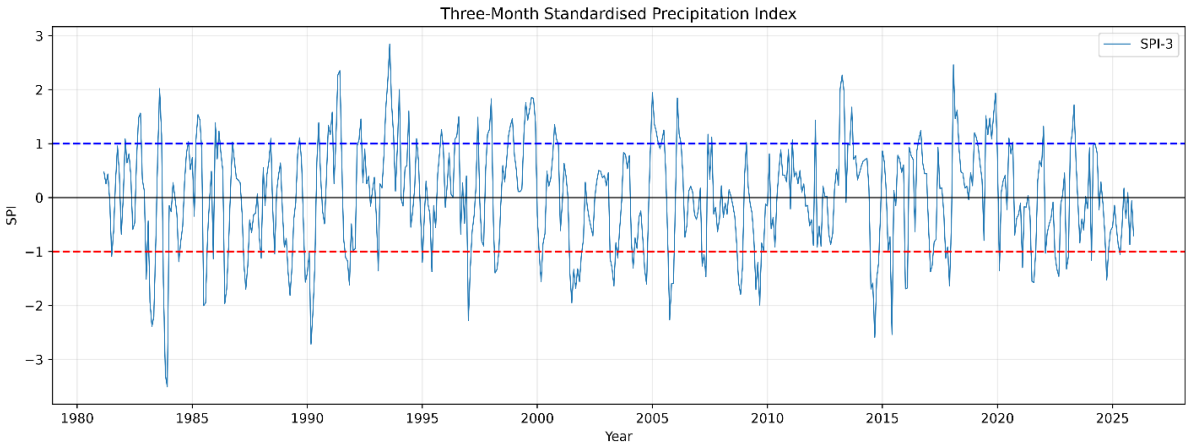

Figure 3. Temporal distribution of SPI-3 values in Tubah Subdivision, 1981–2025.

4. Discussion of results

The mean annual rainfall of 2,036.63 mm recorded in Tubah between 1981 and 2025 indicates a relatively wet climatic environment. The coefficient of variation of 6.35% suggests low interannual variability, although annual rainfall ranged from 1,819.35 mm to 2,345.97 mm. The Mann-Kendall test revealed no statistically significant trend ($\tau = -0.0263$, $p = 0.8068$), while Sen's slope indicated a slight decrease of 0.43 mm per year. This suggests that annual rainfall remained relatively stable during the study period. This finding differs from Ebodé (2022), who identified declining rainfall trends across several regions of Cameroon, including the western highlands. It also contrasts with Mairomi and Tume (2021), who reported a decreasing SPI trend at Tubah station in their assessment of the Bamenda Highlands. These differences may be explained by variations in observation periods, rainfall datasets and analytical methods. While the earlier studies examined broader regional conditions and station-based drought indicators, the present study assesses spatially averaged CHIRPS annual rainfall over Tubah. The findings therefore demonstrate the importance of local-scale rainfall assessment rather than assuming that regional trends apply uniformly to every locality.

The monthly rainfall pattern reveals a clear seasonal distribution, with the highest rainfall occurring in July (376.10 mm), followed by September (343.68 mm), while January (5.54 mm) and December (6.62 mm) recorded the lowest values. Rainfall is concentrated between March and October, followed by a sharp reduction towards November. This pattern agrees with Mairomi and Tume (2021), who identified a rainy season extending from approximately mid-March to October in the Bamenda Highlands. It also supports Ebodé's (2022) description of the two-season rainfall regime in western Cameroon.

The high coefficients of variation recorded during the dry months, particularly December (75.21%) and February (70.48%), indicate greater relative rainfall fluctuations during periods of low precipitation. In contrast, June, August and September recorded lower variability. Similar differences in rainfall reliability across the Bamenda Highlands were reported by Tume, Mairomi and Awazi (2024). These findings means that agricultural planning in Tubah should consider the timing and distribution of rainfall rather than relying exclusively on annual rainfall totals.

The SPI-3 values ranged from −3.51 to 2.85, indicating the occurrence of both exceptionally dry and wet three-month periods. A total of 91 out of 538 valid SPI-3 observations fell below −1, representing approximately 16.9% of the record. At the six-month scale, 87 out of 535 observations were below this threshold. These results demonstrate that rainfall deficiencies occurred despite the absence of a significant annual rainfall trend.

The findings are consistent with Mairomi and Tume (2021), who identified meteorological drought episodes across the Bamenda Highlands using SPI. They also support the work of Tume, Mairomi and Awazi (2024), which showed that rainfall reliability varied across the highlands. As explained by McKee, Doesken and Kleist (1993), drought characteristics depend on the accumulation period used. SPI-3 captures shorter-term rainfall deficiencies, whereas SPI-6 and SPI-12 provide information on more persistent precipitation deficits. However, the number of observations below −1 should not be confused with the number of drought events because consecutive dry months may form a single drought episode.

The concentration of rainfall between March and October provides favourable conditions for rain-fed agriculture in Tubah. However, the sharp reduction in rainfall towards the end of the year and the occurrence of negative SPI values suggest that farmers may experience temporary water shortages during crop development. Tume and Ngwa (2022), in their study of rainfall variability and maize production in the Ndop Plain, similarly highlighted the importance of rainfall conditions for agricultural production in the North-West Region. Tume, Mairomi and Awazi (2024) also emphasised the need for climate-smart agricultural practices in the Bamenda Highlands. For Tubah, the findings support the need for appropriate planting calendars, rainwater harvesting, soil-moisture conservation and supplementary irrigation where feasible. Monitoring SPI at different accumulation periods could also support early identification of rainfall deficiencies. Nevertheless, these are potential adaptation measures. The present study assesses meteorological drought and does not directly quantify crop losses or soil-moisture deficits.

6. Conclusion

The study examined rainfall variability and meteorological drought in Tubah Subdivision using CHIRPS rainfall data covering 1981–2025. The findings show that annual rainfall totals alone do not adequately describe rainfall conditions in the area. The strong

Copyright © Muse Elvis Muno

seasonal concentration of rainfall and the occurrence of dry periods within the rainfall record are important considerations, particularly for farming activities that depend on seasonal precipitation. Although the analysis did not establish a statistically significant long-term trend in annual rainfall, this does not rule out the effects of rainfall shortages during particular months or seasons. The SPI analysis further shows why drought assessment should consider rainfall accumulated over different periods rather than rely only on annual totals. In Tubah, the main concern is therefore not simply whether annual rainfall is increasing or decreasing, but whether rainfall occurs at the time it is needed. This is particularly relevant to planting decisions and the management of water during periods of limited rainfall.

References

1. Ebodé, V. B. (2022). Analysis of the spatio-temporal rainfall variability in Cameroon over the period 1950 to 2019. *Atmosphere, 13*(11), Article 1769. https://doi.org/10.3390/atmos13111769
2. Funk, C., Peterson, P., Landsfeld, M., Pedreros, D., Verdin, J., Shukla, S., Husak, G., Rowland, J., Harrison, L., Hoell, A., & Michaelsen, J. (2015). The climate hazards infrared precipitation with stations: A new environmental record for monitoring extremes. *Scientific Data, 2*, Article 150066. https://doi.org/10.1038/sdata.2015.66
3. Kendall, M. G. (1975). *Rank correlation methods* (4th ed.). Charles Griffin.
4. Mairomi, H. W., & Tume, S. J. P. (2021). **Correction needed:** The publisher's record lists Tume before Mairomi, not Mairomi before Tume. Use the following reference and correct the in-text citation accordingly:
5. Mann, H. B. (1945). Nonparametric tests against trend. *Econometrica, 13*(3), 245–259. https://doi.org/10.2307/1907187
6. McKee, T. B., Doesken, N. J., & Kleist, J. (1993). The relationship of drought frequency and duration to time scales. In *Proceedings of the Eighth Conference on Applied Climatology* (pp. 179–184). American Meteorological Society.
7. Sen, P. K. (1968). Estimates of the regression coefficient based on Kendall's tau. *Journal of the American Statistical Association, 63*(324), 1379–1389. https://doi.org/10.1080/01621459.1968.10480934
8. Svoboda, M., Hayes, M., & Wood, D. (2012). *Standardized precipitation index user guide* (WMO-No. 1090). World Meteorological Organization. https://public.wmo.int/en/resources/library/standardized-precipitation-index-user-guide
9. Tume, S. J. P., & Ngwa, C. A. (2022). Impact of rainfall variability on maize production in the NDOP Plain, North West Region of Cameroon (1990–2015). *Journal of Ecology & Natural Resources, 6*(1), 1–6. https://doi.org/10.23880/jenr-16000265
10. Tume, S. J. P., & Mairomi, H. W. (2021). Standardized precipitation index valuation of seasonal transitions and adaptation of pastoralist to climate variability in rangelands of the Bamenda Highlands of Cameroon. *Journal of Ecology & Natural Resources, 5*(1), 1–20. https://doi.org/10.23880/jenr-16000229

Copyright © Muse Elvis Muno