IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 9, Issue 3 Ver. III (Mar. 2015), PP 38-44
www.iosrjournals.org

Comparative Analysis of Thunderstorm and Rainfall Occurrences over Nigeria

Alexander Chinago Budnuka
Department of Social Sciences Rivers State College of Arts and Science Rumuola, Port Harcourt

Abstract: *The study evaluates the relationship between Thunderstorm (TS) and Rainfall (RF) occurrence over Nigeria for a period of Thirty years (1970 - 1999), sixteen stations where selected based on availability of data. Three major areas were discussed; the annual, spatial and seasonal occurrences of TS and RF The variability of TS and RF over the study period were also discussed. To achieve these objectives, secondary data on climate (TS and RF) for 30 years was analyzed using descriptive and inferential Statistics. The results show among other things that there is no significant relationship between annual TS occurrence and annual RF occurrence at 95% significance levels. It also shows that TS and RF decreases from south to north. However, a station RF does not depend entirely on its TS activity. Finally, TS and RF are significant at 95% level of confidence in seasonal occurrence, all parts of Nigeria experience both TS and RF, but at different degree. The seasonal characteristics of TS and RF are similar, though TS has a double peak, the first in June, precedes, the mono peak of RF in July; the second occurs in September. TS occurrence is an indication that RF will soon occur especially during the late dry season and early rainy season.*
Key words: *Comparative Analysis, Nigeria, Occurrence, Rainfall (RF), Thunderstorm (TS) and Variation.*

I. Introduction

Rainfall provides most of the needed water for agriculture in the tropics. The role of moisture in agriculture is ever more spectacular in the tropics because of relatively high temperature throughout the year, and the rate of evaporation is constantly high. On the other hand, rainfall is highly seasonal over most of the tropics. Since temperature is high throughout the year, to ensure the growth of crops over most parts of the tropics with exception of few mountain areas, the growing season/harvest unlike in temperate region is determined by the availability of rainfall (Ayoade, 2004).

Thunderstorm (TS) and its related activities influence the lives of people in the tropics and of special concern is its relationship with rainfall (RF), which dictates the farming or agricultural calendar in the tropics. TS phenomenon is vital to geographers, especially the *climatologist* and *meteorologist* realizing *that* it *is* an *important* hazard to aviation industries (Awadesh, 1992; Alexander, 2005). The relationship which existed between TS and RF goes a long way in the forecasting and projection of onset, duration and cessation of RF. It is also useful to the Meteorologists, air force, naval personnel, and aviation firms.

Oladipo and Mornu (1985) stated that TS is an indication of atmospheric up drought, and the study of its diurnal pattern is an indication of the mean vertical movement of the atmosphere and by implication gives an indication of when rain may occur. The understanding of TS and its related activities is vital in the tropics.

The study of TS and RF occurrence is especially interesting in Nigeria, considering the fact that Nigeria has an estimated area of about 923,770km (Ukpong, 2009); with a population of over 150million. Nigeria lies between latitude 04°N -14°N covering a distance of about 1,100km from South to North, and longitude 03°E - 15°E about 1,300km in distance from West to East (Iwena, 2010). Figure 1 shows the area of study.

Nigeria's climate isinfluenced by two air masses - The Tropical Maritime air mass (South West trade wind) and the tropical continental air mass (North East trade wind). The boundary zone between these two air masses is called inter tropical Discontinuity (ITD) (Ayoade, 1988).

Many scholars have worked on TS and its related activities over Nigeria and outside. Muleru (19730 worked on seasonal distribution of TS days in Nigeria; Balogun (1981) examines seasonaland spatial variation of TS activity over Nigeria.Salau(1986) did a comparative analysis of TS and related phenomena (hail, squalland lightning) over Jos; Moid(2001) studied TS at Monhanbari Airport. Despite the contribution, most of the works cover discussion on TS or RF,while just few of the works compared TSand RF occurrence. Those that worked on comparative aspect include (Omotosho, 1984; Adelekan, 1998; Ologunorisa, 1999; Manohar et al, 1999; and Bielec, 2002).

In the case ofNigerian no real attempt has been made to compare oranalyze relationship of TS on RF occurrence over a long period, and the actual effect of TS on RF. For instance, dose a year of high TS indicate a high RF year? Does spatial distribution of TS correspond to RF distribution? In other word, does a station with high TS indicate high RF? This study will seek to answer the above questions, besides; the study will compare the characteristics of TS and RF in three aspects (a) Temporal, (b) Spatial and (c) seasonal.

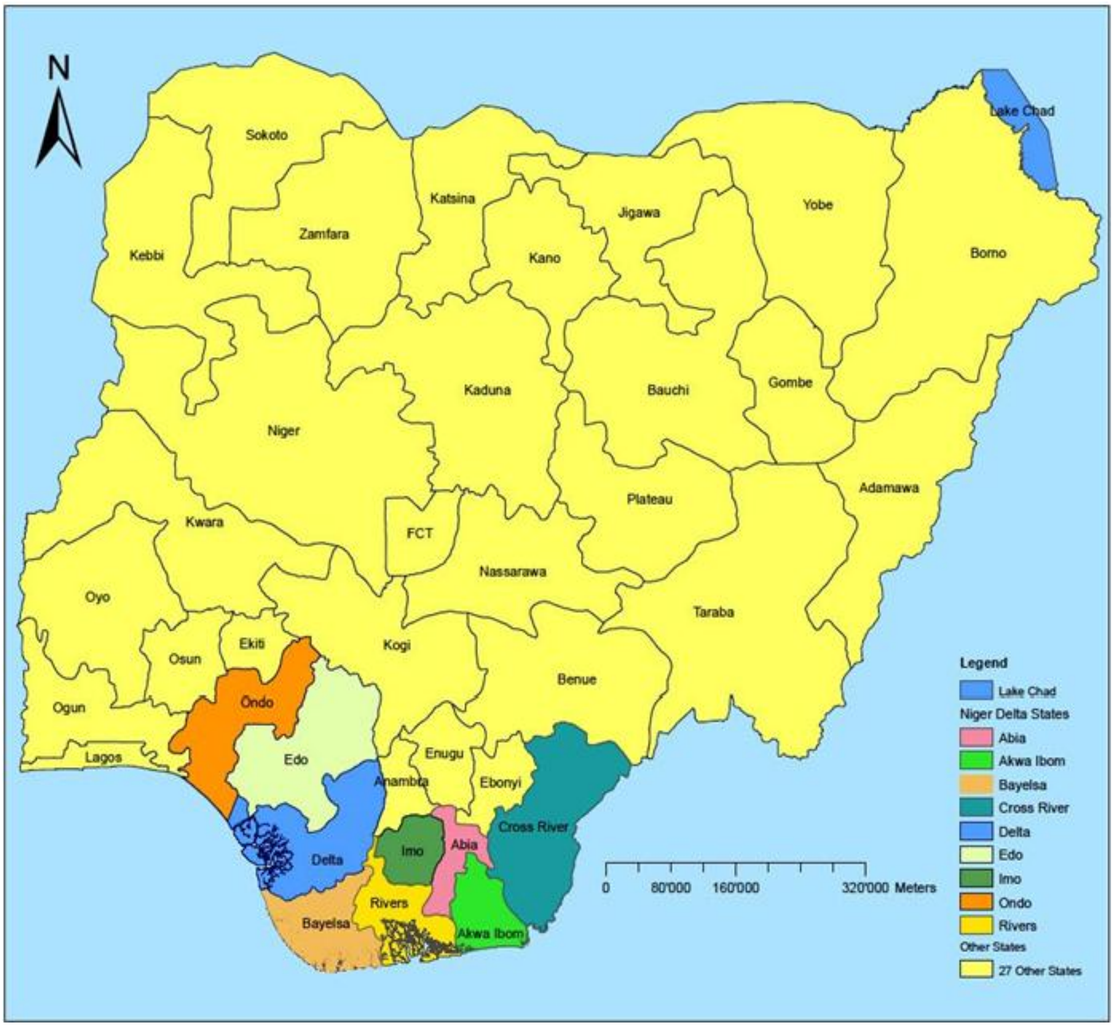

Figure 1: Map of Nigeria (The Study Area).

II. Materials And Methods

The annual and monthly occurrence of TS and RF for the sixteen (16) synoptic stations, for the period of thirty (30) years (1970-1999) were used for this study; and needed information were extracted from Nigerian Meteorological Agency form 100/3. The selected stations as listed in table 1 was based on availability of data and regional representation.

Descriptive and inferential statistics were used for analyzes. The descriptive statistics used include percentage (%), coefficient of variation (CV) and mean. The following inferential statistics were employed, Pearson Product Moment Correlation (PPMC) for analyses of annual and seasonal relationship in TS and RF occurrences. Student test and coefficient of determination were also used as a check to the result. Friedman test was used in analyzing spatial relationship between TS and RF in one hand and the relationship between latitudinal location and TS and RF occurrence on the other hand. Microsoft excel will be used for the graphs in this work.

Table 1 :Selected Stations,

S/N	Station	Latitude	Longitude	Attit(m)
1	Port Harcourt	04°51"	07°51"	19.51
2	Calabar	04°58"	08°01"	61.87
3	Warri	05°31"	05°44"	6.01
4	Benin	06°19"	05°36"	77.72
5	Lagos(roof)	06°27"	03°24"	14.33
6	Enugu	06°28"	07°33"	141.73
7	Ondo	07°05"	04°50"	286.51
8	Ibadan	07°26"	03°54"	227.08
9	Yola	09°14"	12°28"	185.98
10	Minna	09°37"	06°12"	258.47
11	Bauchi	10°17"	09°46"	609.03
12	Kaduna	10°36"	07°27"	644.96
13	Maiduguri	10°51"	13°05"	353.57
14	Gusau	12°10"	06°42"	453.6
15	Katsina	13°01"	07°41"	517.25
16	Sokoto	13°01"	05°15"	350.52

III. Result and Discussion

Figure 2 shows the annual occurrence of TS and RF over the study period in Nigeria. The mean TS occurrence is 283 peals. Fourteen (14) of the years recorded TS greater than the mean, and fourteen (14) of the years also recorded TS less than the mean value. Two of the years has TS = the mean value. The 14 years of TS occurrence greater than the mean value accounted for 54% of the mean value while the 14 years with TS occurrence less than the mean value contributed to 39%, the 2 years with TS occurrence = the mean value represented 7% of the total occurrence.

Majority of the heavy TS years fall within the 1970s and the lower TS years are within the 1990s. This implies that TS is decreasing.

The mean (б) RF is 1950.7. Sixteen (16) of the years recorded RF value greater than the mean value, these accounted for 58% of the total RF occurrence during the study period. The remaining 42% represented the 14 years, with RF value less than the mean value.

Figure 2 show that TS decreases over the years, while RF increases. The revelation, that RF was increasing over the years contrast the finding of Odjugo (2005) and Dibie (2001). This could be as a result of the effect of the selected stations or the pronounced effect of the coastal stations. IPPC (2007) stated that one effect of climate change is the increase in rainfall of coastal stations. The finding agrees with the stated fact. A detailed analysis using five years running mean for both variables is shown in figure 3. It shows that TS decrease but RF. Increase over the years. This agrees with the result of the inferential statistics applied.

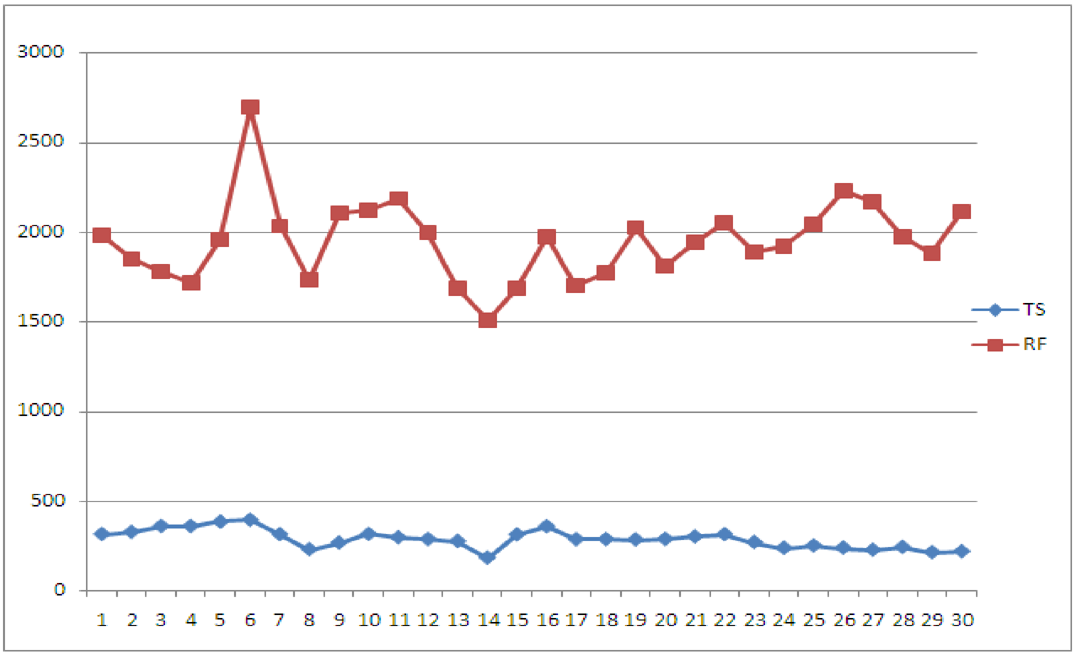

Figure 2: Annual Occurrence of Thunderstorm and Rainfall over Nigeria (1970-19990.

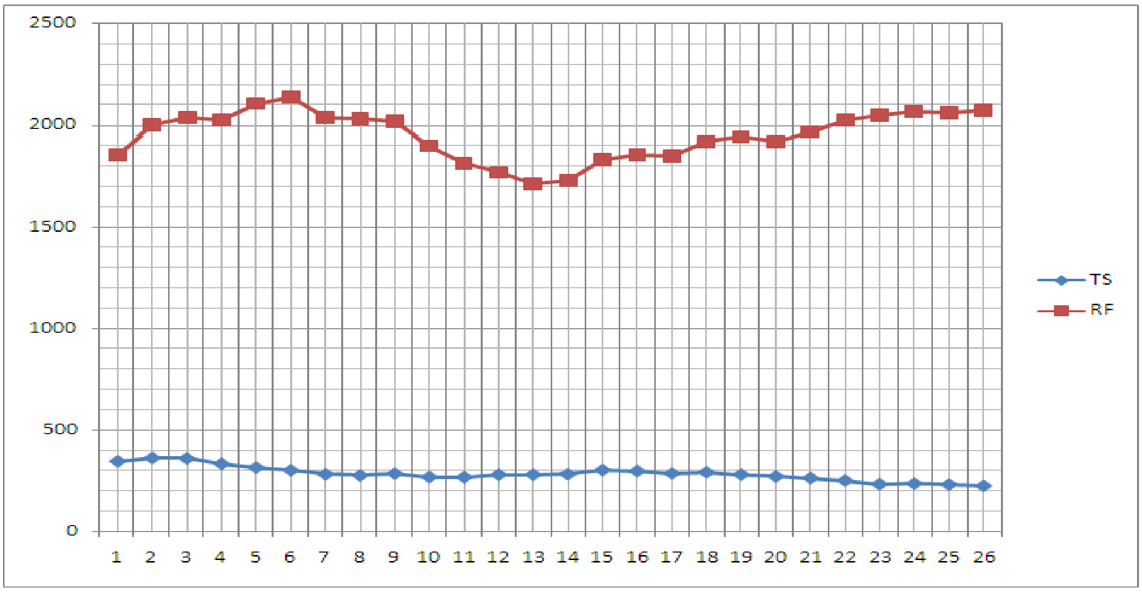

Figure3: The Running Mean of TS and RF (1970-1999).

The PPMC shows that the correction value r = 0.24. The coefficient of determination (r^2 x 100) =5.6%. This explained a weak correlation. It implies that TS occurrence explained, accounted or is responsible for just 5.6% of the total annual RF (3,277.2) during the study period. 94.4% of the annual RF is explained by other-factors.

The student test shows the table value of 2.76 and the calculated value = 1.31. This shows that there is no significance relationship between annual TS and RF occurrence. So any relationship that existed is by chance. Table 2 shows the statistical analysis of annual TS and RF relationship.

Table 2: Analysis of Annual TS and RF Relationship.

Correlation r	STD TS	STD RF	V Table value	V calculated Value	Coefficient Of determ r^2 x 100	C.V TS	C.V RF
0.24	53.18	224.51	2.76	1.31	5.6	18.77	11.57

Figure 4 shows the spatial occurrences of TS and RF over Nigeria. TS and RF seems to increase from north to south. The coastal stations of the south accounted for 40.2% of TS and 42.5% of RF as against the core northern stations with 15.6% and 10.65% of TS and RF respectively. The result agrees with the work of Ologunorisa and Alexander (2004) and Omotosho (1984) that TS occurrence increases from the north to south.

The migration of Intertropical Discontinuity (ITD) north ward from Atlantic Ocean in the south explains the reason for decreasing of TS and RF northward, except for isolated highlands such as Jos Plateau which are breeding ground for the generation of TS. That accounts for relative high TS and RF in places like Kaduna Bauchi and Minna.

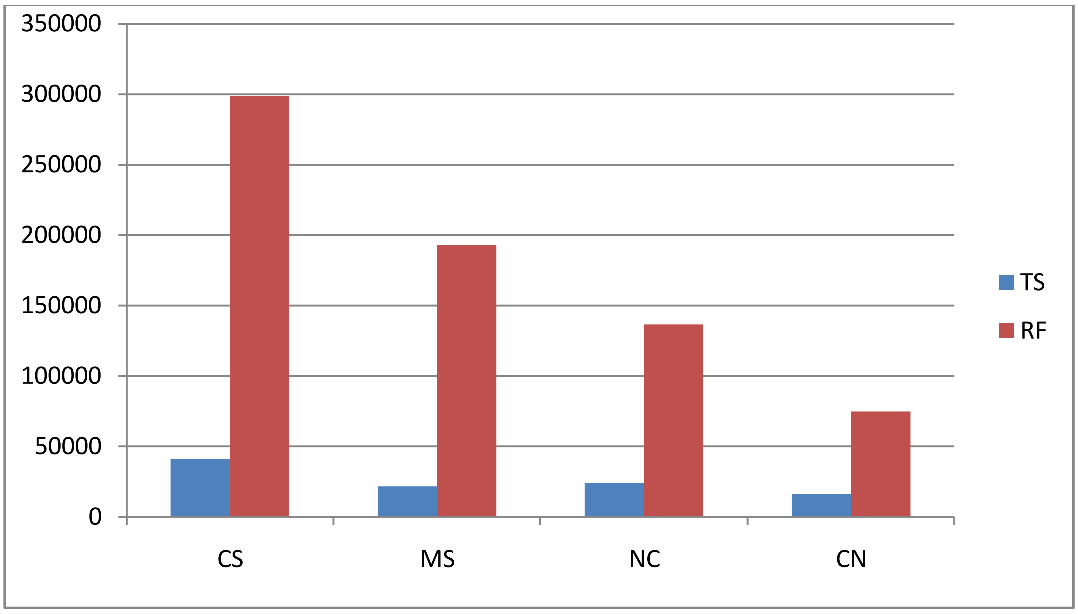

Figure4: Spatial Occurrence of TS and RF over Nigeria (1970-1999).

CS ……………………………………….Core South
MS ……………………………………….South Hinterland
NC ……………………………………….North Central
CN ……………………………………….Core North.

Friedman test (χ^2) using the column shows that χ^2 calculated value >χ^2 table value at 5% significance level. V = C - 1 = 2. Since the χ^2cal>χ^2critical, the conclusion is that latitudinal location affects TS and RF occurrence at 5% significance level.

Similarly, using row for analysis, it was observed that χ^2cal = 6.2 and χ^2 table value = 25 at 5% significant level. V = r = 1 = 15. This implies that TS occurrences had no relationship with RF occurrence spatially speaking. The locations have different degree of effect on TS and RF that explains why station with high TS does not necessarily translates to a high RF. Table 3 show the statistical analyses of location on TS and RF occurrence on one hand and the relationship of TS and RF on the other hand

Table 3: Spatial Effect of Location on TS and RF

	χ^2 Critical	χ^2 calculated	Implication
Column V= c – 1 = 2	5.99	32	Positive effect
Column V= r—1 = 15	25	6.2	Negative effect

Figure 5 explain the seasonal occurrences of TS and RF over Nigeria. The graph shows that the months of April to September has very high TS and RF distribution, almost 75% and 80% respectively. These months constitute the wet season in Nigeria. In reality, the wet seasons in the south coastal states last for nine months, and in the core north about four to five months. Theoretically we adopt equal months.

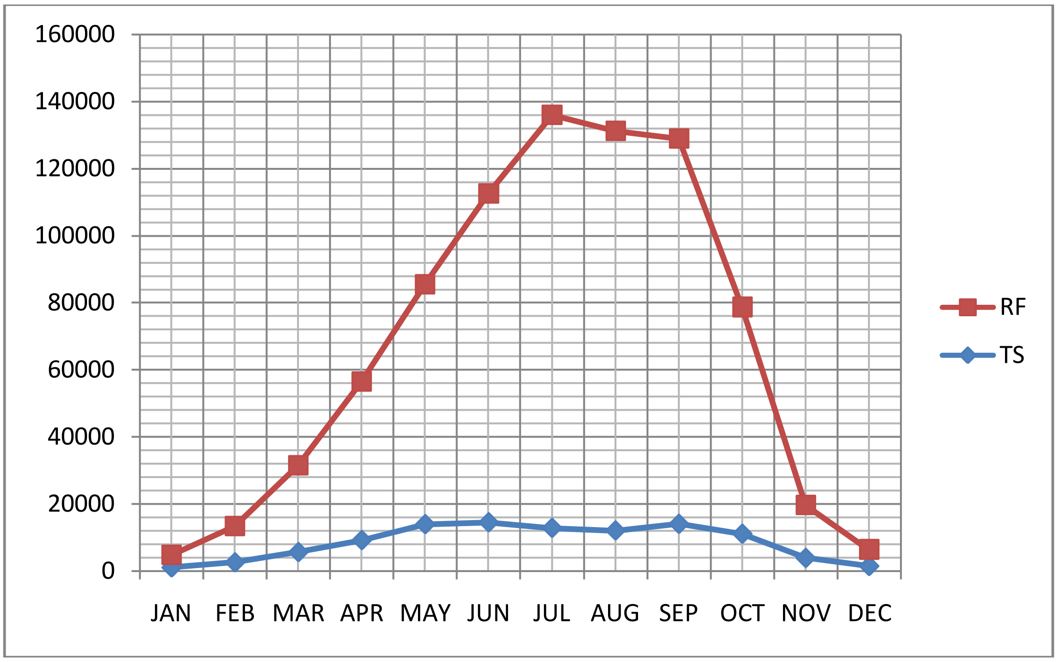

Figure5: Seasonal Occurrence of Thunderstorm and Rainfall.

The seasonal C.V for both variables TS and RF are moderate 61.6% and 79.7% respectively. The seasonal characteristics of TS and RF agree with an earlier study carried out by Balogun (1981), he observed that coastal distribution of thunderstorm has double peak. Figure 5 shows double peak for seasonal TS occurrence, while RF have a Mono Peak in July. The first TS Peak occurs in June, a month earlier than the RF peak. The second peak occur in September, this trigger torrential RF in October and set the end of wet season. Table 4 shows the statistical analysis.

PPMC Correlation r = 0.92. This indicates a high correlation between TS and RF seasonal occurrence. The coefficient of determination (C.D) (r2 x 100) = 84.8%.This implies that TS is responsible for about 85% of the total seasonal rainfall during the study period. Student test critical value critical value =2.05 and the calculated value = 12.5, at 95% significance level, using two tail test there is a significant relationship between TS and RF seasonal occurrence. This finding agrees with the work of Wallace (1975). There are other factors that can trigger RF, outside TS, and there are other factors outside RF that triggers TS.

Table 4: Statistical Analysis of TS and RF.

Correlation R	STD TS	STD RF	V Table Value	V calculated Value	Coefficient of determ r^2 x 100	C.V TS	C.V RF
0.92	5234.6	46772.8	2.05	84.8%	61.6	79.9	12.5

IV. Recommendation

a) We suggest that farmers should observe the emergence of TS, since it is an indication of onset of RF.
b) The time lag between the first TS peak and the last should be utilized especially by those in the north to harvest RF. Road Construction should be avoided during this period.
c) The incidence of TS strike can be avoided if children and workers stay indoors during the onset of TS and end of TS especially during the late afternoons.

V. Conclusion

The study of comparative analyses of TS and RF occurrence over Nigeria for a period of 30 years (1970 — 1999) shows that TS and RF occurs in all parts of Nigeria. The study shows that the coastal states have favourable climate for TS and RF. This explains why Calabar, Port Harcourt and Warri recorded very high TS and RF occurrence.

The annual trend shows that TS occurrence decreases over the years, while RF tends to increase over the years, this is a pointer, indicating that in future, rainfall will also drop, because the RF that results from TS will cease (i.e. RF that emanate from TS will reduce as TS decreases).

The reason for reduced TS could be as a result of receding water level especially in the north. Around the Lake Chad region for instance, the amount of water vapour in the cloud is reduced. This leads to stable condition which is not favourable for TS occurrence. There are other factors that trigger TS in Nigeria — Altitude and differential temperature as shown in Jos Plateau area "breeding ground for TS."

It was observed that the seasonal characteristics of TS and RF are similar, except that TS has a double peak and RF one. Wet months accounted for highest TS occurrence. The migration of ITD is responsible for the high TS and RF occurrence during wet season.

TS activity influences seasonal RF. TS first peak occurs a month before RF peak. The emergence of TS is, an indication that RF is about to occur. Finally, the latitudinal location of areas affects both TS and RF.

Reference

[1]. Adelekan, 1.O. (1998) Spatio- Temporal Variation in Thunderstorm Rainfall over Nigeria.Inter. Journal of Climatology 18, 1273 — 1283.
[2]. Ahrens, D.C (1998) Essentials of Meteorohegy: An Invitation to the atmosphere. New York. Wasdsworth publishing company.
[3]. Alexander, B.C (2005) Spatio-Temporal Variation of Thunderstorm Activity Over Nigeria unpublished, M.Sc Thesis.
[4]. Atkinson, G.D (1967) Thunderstorm in South East Asia. 1 Weather Wind Technical Study.
[5]. Awadesh, K. (1992) A Climatologically Study of thunderstorm at Lucknow airport.Mausam, 43, 441-444.
[6]. Ayoade, J.O. (1988) Introduction to Climatology for the Tropics Spectrum Publisher, Ibadan.
[7]. Balogun, E.E (1981) Seasonal and Spatial Variation of Thunderstorm Activity over Nigeria. Weather 36, 192-196.
[8]. Barry R.G. and R.J. Chorley (1992) Atmosphere, Weather and Climate. London. Longman Group publish.
[9]. Bielec, B.Z. (2002) Long-time variability of thunderstorm and thunderstorm precipitation occurrence in Cracow, Poland in the period 1860-1995.atmos. Res. 56,161-170.
[10]. Brief, G.W and Simpson (1969) Tropical Cloudiness and Rainfall related to pressure and tidal variation. Quart. J.R. Met. Soc. 120-147.
[11]. Chaudhury, A.K. (1961) Premonsoon thunderstorms in Assam, Tripora and Manipure.Indian J.Met.Geophys., 121, 33-36.
[12]. Dibie, N.S. (2001) Climate Fluctuation in Nigeria Journal of Energy and Environment Vol. 14(2) pp.
[13]. Gray, W.M and Jacobson, R.W (1977) Diurnal variation of deep cumulus convention. Mon. Wea. Rev. 105, 1171-1188.
[14]. Hammond, R. and McCullagh, p. (1975) Quantitative Techniques in Georgraphy — An introduction Oxford University Press.
[15]. Holton, JR. (1968) The diurnal boundary-layer wind oscillation above sloping terrain, Tellus. 19,199-205.
[16]. Kandalgaornkar, L. (1996). Thunderstorms in the Area of Circulation, ZeszytyInstytutuGeografiliPrzetrzenne.
[17]. Kolendowicz, L. (1998) Thunderstorms in Poland and Synoptically Conditions, BguckiWydawnictwoNaukowe, Poznan.
[18]. Lettau, H. (1967) Small to Large feature of the boundary layer structure over mountain slopes. Proc. Symposium on mountain meteorology, Dept., of Atm. Soc. Colorado.
[19]. Moid S.A. (2001) A climatological study of thunderstorm at Mohanbari Airport, Mausam, 46, 202-204.
[20]. Mulero, M.A. (1973) Seasonal Distribution of thunderstorm Days in Nigeria.Quarterly, Meteorology, May 3, 73-78.
[21]. Nleuwolt, S. (1977) Tropical Climatology: Introduction to Climate of low latitudes, London.John Wiley and Sons.
[22]. Odjugo, A.P. (2005) The Impact of Climate Change on Water Resources: Global and Regional Analysis 47th Annual ANG Conference Paper Presented.
[23]. Oladipo, E.O. and Mornu, M. (1985). Characteristics of Thunderstorms in Zaira, Nigeria Weather 40, 316-321.
[24]. Ologunorisa, E.T. (1999) Diurnal and Seasonal Variation of Thunderstorm in Ondo State, Nigeria Geo Research, Vol. 2(2): 47-51.
[25]. Ologunorisa, E.T. and Alexander, B.C. (2004).Annual thunderstorm Trends and Fluctuations in Nigeria. J. Met. UK, 29, 286, 39-44.
[26]. Ologunorisa, E.T. and Alexander, B.C. (2007) The Diurnal Variation of Thunderstorm Activity over Nigeria. The mt. 3.Met UK. 32, 315, 19-29.
[27]. Olson, L. (1983). Desertification Climate Change? Investigation Regarding the Relationship Between and Degradation and Climate in the Central Sudan, Land Studies in Geography Series Physicla Geography 60, 1-35.
[28]. Omotosho, 3.8.(1984) the Separate Contribution of Line Squalls, Thunderstorm and Monsoons to Rainfall in Nigeria. 3. Clim 5, 543-555.
[29]. Roa, K.N., Daniel, C.E., and Pejabi, K.G. (1971) India Met. Dept. Pre-public. Sci. Rep. No. 154.
[30]. Singh, N. and N.A. Sontakke (1999) On the Variability and Prediction of Rainfall in the Post-Monsoon Season Over India, mt. 3. Climatol, 19, 309-339.
[31]. Salau, O.A. (1986) Temporal and Comparative Analysis of Thunderstorms and Some Related Phenomena in Zaira, Jos and Kaduna, Nigeria Int. 3. of Theory and Apple Clim, 37, 220-232.
[32]. Ukong, I.E. (2009) Perspectives on Environmental Management.Environmental Systems Club Inc. Uyo, Nigeria.
[33]. Walker, A. (1992) GrossraumigeAustauschprozesse Atmosphere alsUrsache Von Starkgive Witten, PhischeGeographie, 35 Zurich.
[34]. Wallace, J.M. (1975) Diurnal Variation in Precipitation and Thunderstorm Frequency Over the Conterminous United State Mon. Wea. Rev. 103, 406-419.
[35]. Williams, S.D. (1961) Frequency of Thunderstorms in said India, India. J. Meteorol. Geophys., 12, 131-133.