SEASONAL VARIATION OF LINESQUALLS AND THUNDERSTORM ACTIVITIES IN YOLA

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ABSTRACT

This study investigates the seasonal variation of linesqualls and thunderstorm activities with particular respect to the relationship between linesquall, thunderstorm and precipitation occurrence using correlation analysis. Data on linesquall and thunderstorm occurrence, rainfall amount associated with the occurrence of the two conditions and total annual precipitation for the period under review were obtained from the meteorological services department of the Ministry of Aviation, Yola. Questionnaires were administered to assess the level of awareness and the impact of the two systems on the people in the study area. While linesqualls were found to have a double maxima with the break occurring in August, thunderstorms on the other hand showed a single maximum regime with its peak occurrence in August. The result shows significant positive relationship between linesquall and thunderstorm. The results further show that 98% of rainfall occurrence in Yola is associated with linesquall and thunderstorm activities. 98% of the respondents are aware of its existence. 97% agreed that the two systems were natural phenomena while estimates of properties lost in damage runs into millions of naira. Appropriate recommendations were proffered in respect of the study area.

Keywords: linesquall, thunderstorm, correlation analysis, systems, impact, relationship, Yola.

INTRODUCTION

Omotosho (1985) said West African linesquall are not as violent as their United States counterparts. They are nonetheless studied because of their economic importance. Apart from contributing to more than half of the total annual precipitation where they occur, thunderstorm have been constituting a great threat to man especially in the areas of shelter, agriculture and aviation. Occurrence of turbulence and icing within well developed cumulo nimbus clouds, strong winds, heavy rains, hail and lightning constitute additional difficulties to both flights and humans.

Louis (1973) defines linesqualls as lines of thunderstorms. What is taken as linesquall differs from one worker to another depending on the statistics chosen. For example, Hamilton and Archbold (1945) consider only the longest-lived distance with squalls (maximum surface gust) of over 15m/sec as a genuine linesquall, whereas Eldridge (1957) cited in Oguntoyimbo (1978) and Obasi (1975) used the North South extent as well as the life of systems as the important criteria. Both are stormy conditions associated with heavy rains, but differ slightly in violent winds accompanying the later while thunder and lightening, accompany, the former. However, simultaneous occurrence of both is most common. This study will adopt the W. M. O. observing regulation of a sudden increase in the wind speed of at least 8m/sec with the speed rising to 11m/sec or more and lasting for at least one minute. This criterion is chosen mainly because all data on linesqualls and thunderstorms are from meteorological station records.

Trewartha and Horn (1980) reported a tremendous outbreak of severe thunderstorms on 3/4/1974 in the region between Mississippi river and the Appalachian Mountains in which 315 deaths, 6142 injuries and 650 million dollars in property damage was lost to the storm. Iloeje (1986) reported a particular destructive linesquall on 9/3/1961 in Umudike area of Umuahia in the East. In the same vein, Yola, Adamawa State capital experience a destructive thunderstorm on the 14/4/1997 in which the New Nigerian Newspaper reported thus "One man was reported killed while properties worth millions of naira have been destroyed by rainstorm in Jimeta - Yola, the Adamawa State capital on Monday evening. Worst hit areas are Demsawo, Doubeli, Rumde, Jambutu and Luggere wards where some electric poles were uprooted and destroyed. Walls of some houses including that of the temporary stadium were completely pulled down by the rainstorm, trees were also uprooted and many roads blocked trapping some vehicles and damaging others..." New Nigerian Newspaper. No. 10, 198 Thursday April, 17.

It is in the light of the foregoing that this research is necessary and important to understand the seasonal variation of linesqualls and thunderstorm activities and to examine its precipitation contribution in the study area. Over a period of ten years (1986 – 1995).

STUDY AREA

Yola (fig. 1) the study area is located on latitude 9°14'N and longitude 12°38'E with an altitude of 185 meters above sea level. Yola lies within the Benue trough consisting of undulating flood plains. It has an area of 8,068 sq/km and a population of 246,068 inhabitants according to the 1991 census figure (Adamawa State official dairy, 1991).

Yola lies within the Sudan Savannah Vegetation classification characterised by tall grasses and sparsely distributed trees mostly of economic value such as sheer butter, locus bean, baobab, gum arabic, balanite etc. In terms of climatic classification, Yola falls under the Koppen's Aw class, that is, tropical savannah climate. There is a distinct dry season in the low sun period. The dry season is strongly developed for about five months, beginning from October ending to late march.

Rainfall is about 958.99mm per annum with highest down pour occurring between August/September. Yola has an average minimum temperature of 15.2°C and an average maximum of 39.7°C. The hottest months are March/April with maximum temperature of 42.7°C while the coldest months are November/December with minimum temperature of 11.11°C.

Agriculture and cattle rearing are among the major economic activities of the people in the study area. Crops grown include Cotton, Groundnuts, Rice, Millet, Maize, Beans and Guinea corn. Cows, Sheep and Goats are reared while the River Benue is exploited for fishing and dry season cultivation.

MATERIALS AND METHODS

Data on linesquall and thunderstorm occurrence, rainfall amount associated with the occurrence of the two conditions and total annual precipitation for the period of ten years (1986 – 1995) were obtained from the meteorological services department of the Ministry of Aviation Yola. The Nigerian Meteorological Station Yola was commissioned in 1942 with station number 65167 and an attitude of 190.5meters above sea level. Meteorologically, if a rain commences 30 minutes before or after arrival of the two systems, the rain is recorded for either of the system. Where the associated systems changed to ordinary rain, the rain is still put against linesquall or thunderstorm provided the time is not more than six hours after the arrival time of the systems. Beyond six hours any further precipitation is recorded as monsoon rain. The time of occurrence of linesquall and thunderstorms are indicated and they are coded symbolically in the weather form. Duration of their occurrence is also stated.

Primarily a thousand questionnaires were administered equally to each of the ten wards in order to assess the level of awareness and the impact of linesquall and thunderstorm on the life and properties of the people in the study area. Secondary

Graphs, percentage and product moment correlation analysis was employed for the data processing. The perceptual level of the people was assessed on percentage basis while correlation analysis was used to test the type of relationship and contribution.

RESULTS AND DISCUSSION

Table 1 and figure 2 show that Yola has 209 squall days and 743 thunderstorm days within the period of study (1986-95). Both concentrated within a period of 9 months (March – November). The variation shows that while linesquall increases steadily up to June, it dropped slightly in July/August to rise again in September and die out in November. This finding supports Nnodu (1983) who demonstrated that a double maxima exist in linesquall occurrence for inland areas of 8^{0}N and above using 28 stations in Nigeria (Yola is located on 9^{0}14'N). Omotosho (1985) also agreed that the double maxima is valid to 12^{0}N with single annual peak confined only to the extreme North of the country. The July/August break is attributed to the movement of the ITD, which is at its Northern most position of 22^{0}N, (Omotosho, 1985).

Table 1. Linesquall and thunderstorm frequency on Monthly bases for ten years (1986-95)

Variables	J	F	M	A	M	J	J	A	S	O	N	D	∑
Linesquall	0	0	2	27	41	45	23	22	34	14	1	0	209
Thunderstorm	0	0	4	56	100	108	133	149	119	68	5	0	743

Source: Nigerian Meteorological Station Yola (1997)

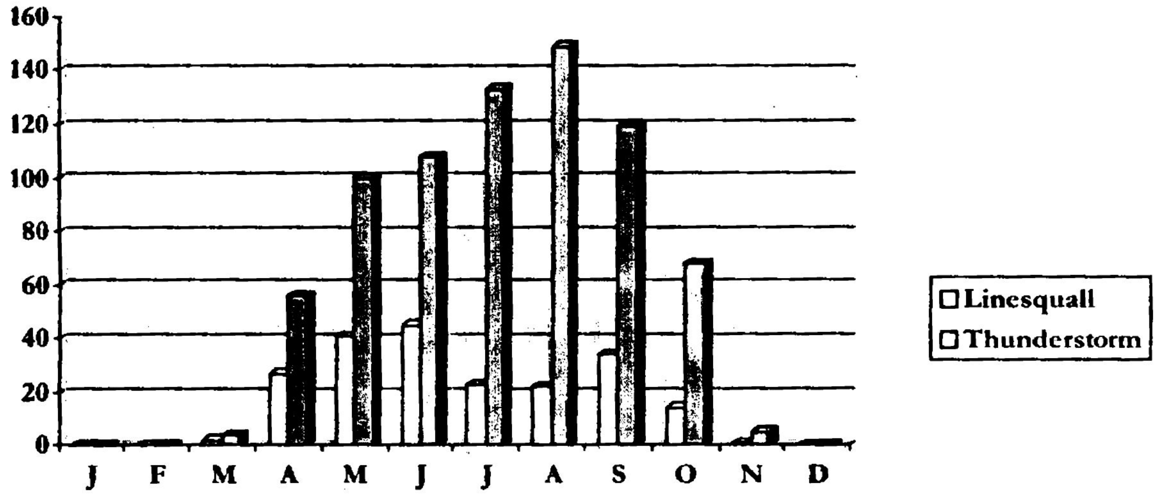

Fig. 2. Linesquall and Thunderstorm frequency on monthly bases for ten years (1986-95)

Thunderstorm showed a single maximum with its peak occurring in August. This indicates that the seasonal variation in thunderstorm in Yola is directly related to the movement of the ITD. When the ITD is at its northernmost position of 22^{0}N that is when the northern part of the country receives their highest rainfall courtesy of the meeting of the two air masses {Tm and Tc}. By the nature of Yola's topography these air masses are further lifted to encourage rapid condensation hence the stormy nature of rains in Adamawa and Obudu areas.

Table 2. Rainfall amount associated with linesquall/thunderstorm and Total precipitation per month for Ten years {1986-1995)

Variables	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
L/sq/Thds	0	0	1.5	385.0	752.2	631.3	1450.8	1662.4	1013.6	442.3	6.6	0	6346.2
TMP	0	0	27.6	413.8	1082.3	1105.3	1954.2	2208.9	1532.3	647.7	13.6	0	8979.9
Percentage%	0	0	5.4	92.0	69.5	57.1	74.2	75.2	66.6	68.3	48.5	0	70.6

Source: Nigerian Meteorological Station Yola {1997}

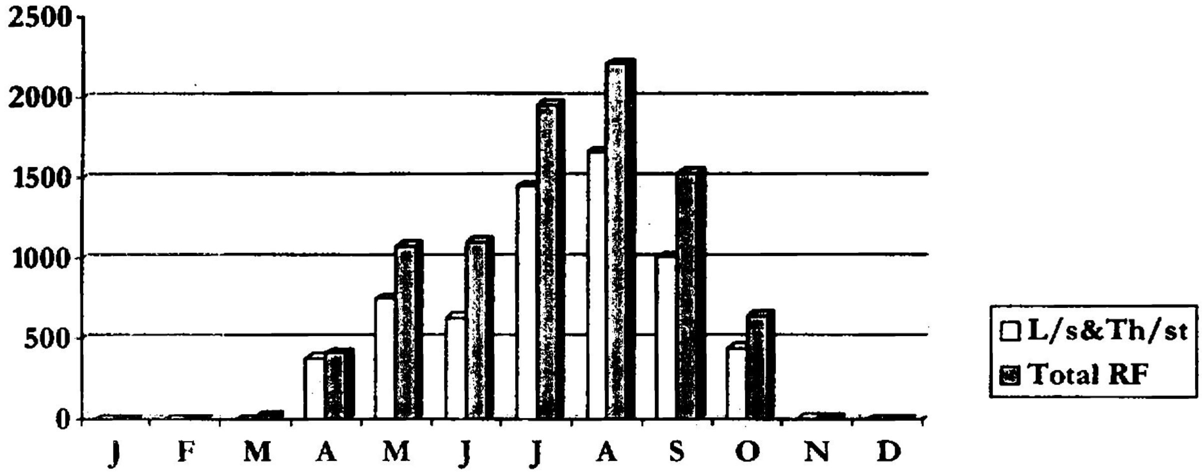

Fig. 3. Showing Rainfall contributed by the two systems on monthly basis.

Table 2 shows that linesquall and thunderstorm contribute quite a substantial amount of the rain occurring over Yola. The two systems contribute 92% of the April rains, which is higher than the 55% reported by Eldridge in Oguntoyinbo *et al*{1978} for early and late summer rains in Ghana. Obasi{1965}reported 62% for March/April rains over Lagos in 1962, while Omotosho{1985} reported 70% or even higher for areas north of 11°N. The overall contribution of precipitation as a result of linesquall and thunderstorm to the annual precipitation received over Yola stands at 70.67%. The implication here is that seasonal and geographical variations in thunderstorm frequency are excellent indicators of the effect of insolation as modified by the shift in the large scale circulation pattern.

Annual variation

The annual pattern shows that while linesquall is declining from 40 incidences in 1986 to 10 in 1995, thunderstorm on the other hand shows a slight increase in frequencies .The difference between frequencies of the two systems remains almost steady throughout the period of observation, being one linesquall to three thunderstorms between 1986 to 1989 and then increasing to a ratio of about 1:4 for the remaining period as shown in Table 3 and figure 4. Table 4 shows that the pattern of annual rainfall contribution by linesquall and thunderstorm has been relatively constant within the study period. . It has been contributing above mean (70.69) with the exception of 1986, 1992, 1994 and 1995. Subsequent years have been recording increase in contribution up to a peak of 81.1% in 1993 as shown in Table 4 and Figure 5.

Table 3. Annual Variation in Linesquall and Thunderstorm Occurrence (1986-95)

Variable	1986	'87	'88	'89	'90	'91	'92	93	'94	'95	Σ	X
Linesquall	40	21	29	21	20	24	14	14	16	10	209	20.9
Th/storm	72	59	75	71	83	85	75	81	79	62	742	74.2

Source: Nigerian Meteorological Station Yola, 1997.

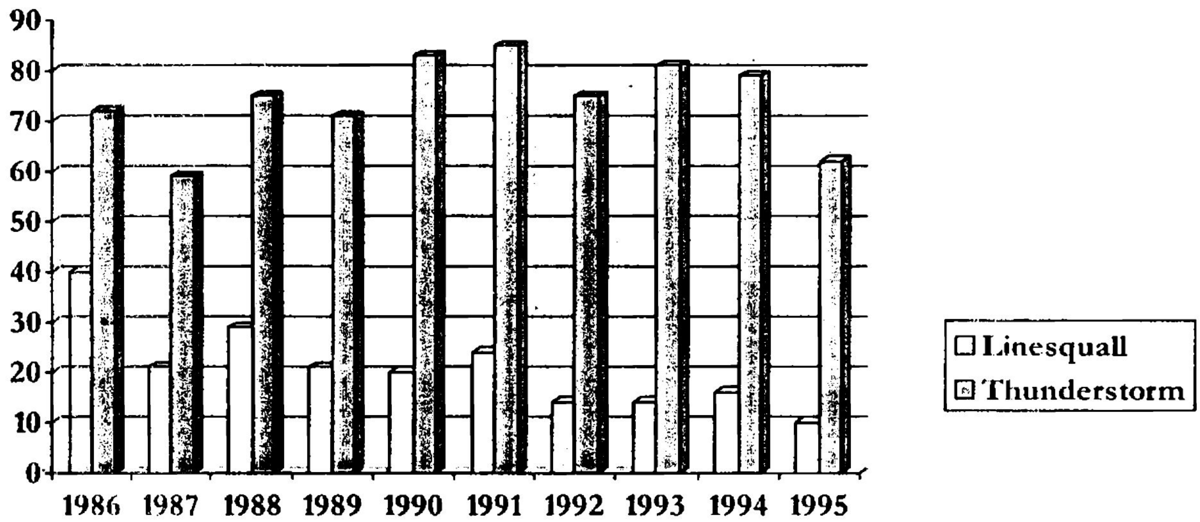

Fig. 4. Annual variation in Linesqualls and thunderstorm occurrence (1986-95)

Table 4. Annual Variation of Rainfall Contributed by the two system (1986-95)

Variables	1986	'87	'88	'89	'90	'91	'92	'93	'94	'95	Σ
Ls/Thst	585.5	498.7	878.1	509.9	646.8	595.0	655.4	791.4	545.6	539.5	634.6
Total RF	971.0	701.1	1101.1	855.9	868.7	745.1	945.5	975.8	839.7	982.1	8979.9
Perc (%)	*60.3*	***71.1***	***79.7***	***71.3***	***74.5***	***79.9***	***69.5***	***81.1***	***65.2***	***54.9***	***70.59***

Source: Nigerian Meteorological Station Yola, 1997.

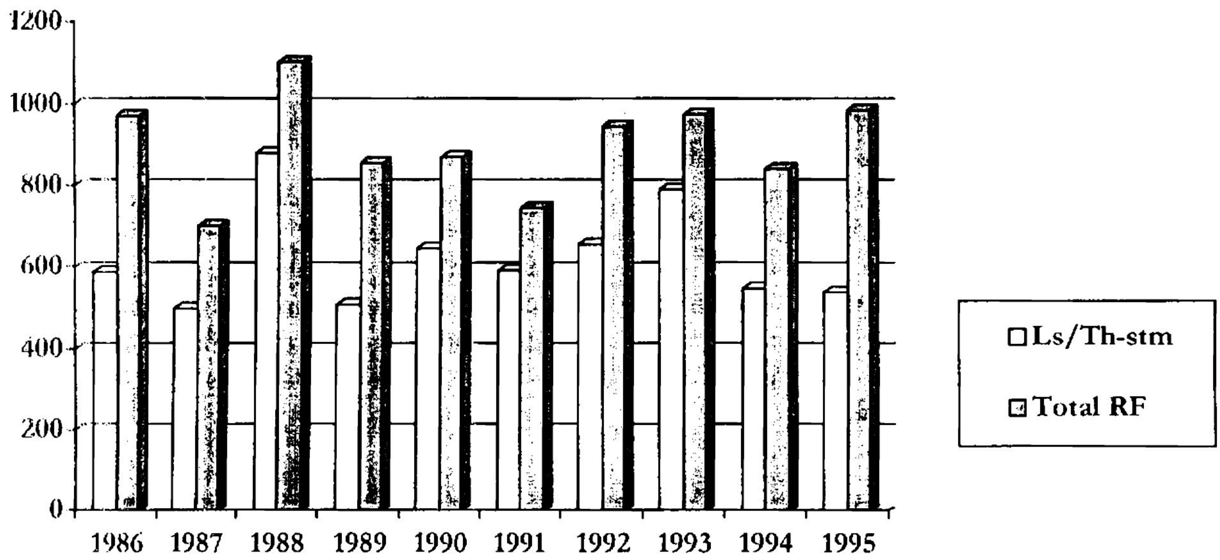

Fig. 5. Annual variation in Rainfall contributed by the two systems to Total Precipitation.

The revelation in these observations maybe that there is improvement in the quality of meteorological data collection because the meteorological department has engaged in retraining programme whereby staff are more dedicated and can work with the modern equipment available at most met stations. Unlike in the past were properly trained meteorologist were rare.

Linesquall-thunderstorm correlation

Table 5. Relationship between linesquall and thunderstorm occurrence

R	r^2	df	tc	Remarks
0.8152	0.6648	10	4.43	Sig. at 0.01

The result in Table 5 indicates that there is a linear positive relationship between linesquall and thunderstorm with a correlation coefficient (r) value of 0.81. The coefficient of determination (r^2) shows that 66% of thunderstorm occurrence is associated with linesquall phenomena. This finding is significant at the 99% confidence level, meaning that there is 99% probability of each squall occurrence being accompanied by thunderstorm.

Table 6. Relationship between linesquall and thunderstorm precipitation and Total annual precipitation

R	r^2	df	tc	Remarks
0.99	0.9801	10	4.92	Sig. at 0.01

Table 6 also shows a linear positive relationship, meaning that an increase in linesquall and thunderstorm activities will subsequently lead to an increase in total annual precipitation. The coefficient of determination (r^2) shows that 98% of the annual precipitation over Yola is as a result of the two systems. This finding supports Balogun (1984) who postulated that the contribution of linesquall to rainfall increases from the lower latitudes to the middle latitude.

Awareness and impact analysis

Base on the even spatial coverage of questionnaires administered, responses shows that 98% of respondents are aware of the existence of linesquall and thunderstorm. 60% agreed it occurs mostly at the beginning of the rains. There was a 100% positive response in respect of impact/effect of the two systems, though 40% claimed indirect effect. Being specific on the nature of effects, 57% said it has removed their roofing sheets and damaged their building, 19% said it collapsed their fence. 20% said it felled electricity poles around their vicinity, while 4% claimed lost of life (human/animals). This lends credence to the New Nigerian report of 17th April, which reported one person killed and the destruction of properties worth millions of Naira in the storm of 14/4/1997. A greater percentage of the respondents (81%) agreed that 1997 was their year of worst experience. Estimates of properties lost in damage runs into millions of naira. 97% of the respondent agreed that linesquall and thunderstorm were natural phenomena and therefore advised the government to plant more trees to act as shelter against high winds.

Implication of findings

The implications of these findings are that the double maxima in linesquall show that they are not only destructive at the beginning of the rains but also towards the end. Because of the exposed nature of the northern environment, the first blast of squalls tend to blow away top soil, while the second peak which occurs after the August break constitute a great threat to trees and crops.

The economic importance of linesquall and thunderstorm which is reflected in precipitation has an implication for soils in Yola. 92% of the April rain is as a result of the two systems. Since the dry season ends in March, the April rains falls on completely dry soils, the fall maybe so heavy and intensive that the soil is unable to absorb anything like the quantity of water available. Generally sheet flow occurs across the surface, becoming turbulent, and therefore erosive on encountering potential channels, however shallow. Tyre tracks on a road may develop into parallel streams inches deep and if unchecked such scar can rapidly destroy the road surface and lead to gulling.

CONCLUSION

This study has examined the relationship between linesquall and thunderstorm, their precipitation contribution and their impact in the study area. This preliminary work is not exhaustive; more researches could be carried out in different aspects of linesquall and thunderstorm activities.

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