AN ASSESSMENT OF RAINFALL QUALITY DURING THE ENSO EVENTS USING SATELLITE DERIVED RAINFALL ESTIMATE OF THE SUDANO-SAHELIAN REGION OF NIGERIA

BY

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DECLARATION

I, Abdullahi Isa, Muhammad, do declare that this thesis titled "An Assessment Rainfall Quality in the Sudano-Sahelian Belt of Nigeria during the El-Nino years using satellite-based rainfall estimate, is my work and has not been submitted at any University before to the best of my knowledge.

Referred materials both published and unpublished have been duly acknowledged.

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Date

CERTIFICATION

We the undersigned certify that this Project is an original work carried out by Abdullahi,I.M., of the Department of Geography, Federal University of Technology, Minna, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

To Allah,Whose Infinite Mercy and Beneficence are All-Encompassing,

To Dad and Mum, whose sincere guidance and nurturing are over-whelming,

To my wife, whose patient understanding and prayers is over-bearing,

To my children,Isa and Fatima, whose disarming innocence was compelling,

And, to the world, whose suffering is frustratingly challenging.

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ABSTRACT

El-Nino (and the associated La-Nina) episodes as atmospheric anomalies have their impacts on global environment with highly visible impact along the Tropical African environment, coastal areas of Peru, and the Southeast Pacific Asia.

Satellite-based rainfall estimate data for 6 years (1998 – 2003) for a total of 8 stations in the Nigeria's Sudano-Sahelian region were acquired and analysed using two tested techniques that are the Cumulative Pentade Onset (CPTD) and the Monsoon Monitoring Index (MMI) for ascertaining 'False' and 'Real' Onset of rains. Onset dates were remarkably observed to be generally earlier for all stations using these two techniques. Rainfall spread and distribution were equally observed to be better during the El-Nino years by analyzing onset differences between the real and false onset.

An Index for measuring rainfall quality, the Seasonal Rainfall Quality Index (SRQI) was also applied and the results discussed. A comparison of the El Nino and La-Nina years showed rainfall distribution and performance to be generally better during the El-Nino episode for all the stations studied.

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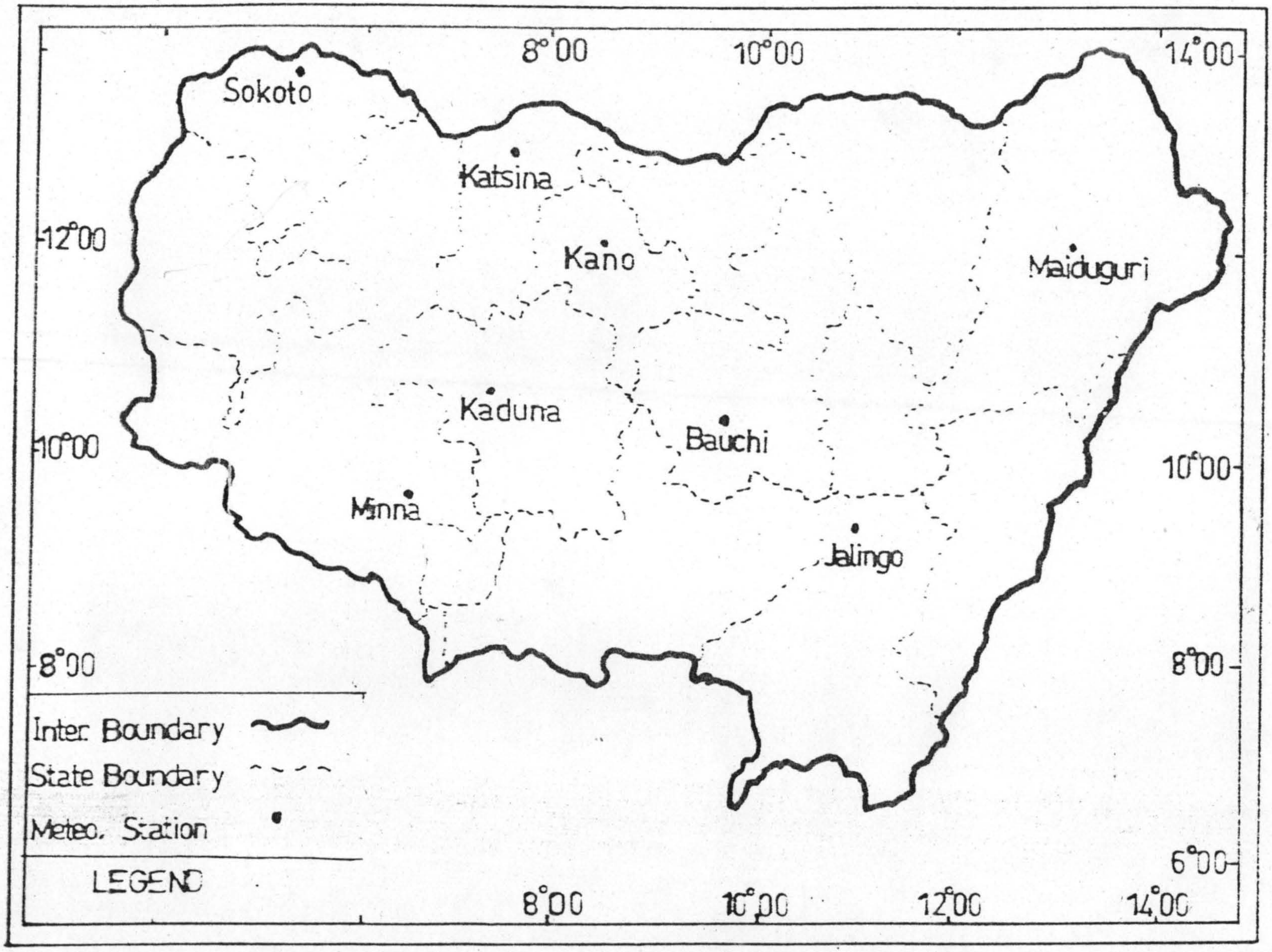

Figure: 1.1 MAP OF THE STUDY AREA ADAPTED FROM ZINNASS (2000)

CHAPTER ONE

1.1 RAINFALL AND ITS ANOMALIES

Rainfall has been the one consistent climatic variable that has tied its "umbilical cord" to sustenance of the mostly agrarian tropical and other climatic environment of the world. Its availability both in quantity and quality, has determined the proportion and growth of civilizations such as the Nile Valley in Egypt and the Golden Crescent of the Euphrates and Tigris, now present day Iraq, amongst many others. Its seasonal and annual variability has also shown the other worst case scenarios, as was the case in the elongated sahelian drought of the 1970; which desiccated the fragile environment (Adefolalu 1986) leaving in its wake a colossus of loss of lives of both human and livestock, and farm produce worth hundreds of millions of Naira (Zakariya'u, 2001; Zinnass,2000).

Annual trends of rainfall in the Sudano-Sahelian region have shown remarkable fluctuations (Adefolalu 1986) with downward variation observed from the turn of the 19th century. This has propelled researches for deriving meteorological/hydrological parameters that enable the threshold values of rainfall regimes to be computed to maximize the qualitative and quantitative harnessing of this rare nature's gift called rainfall.

Adefolalu (1985) observed that the 600mm rainfall isohyet for about a 70-year period of assessment of rainfall pattern has remained unchanged over the Sahel. Ilesanmi (1971) indicated that a pole ward decrease of rainfall was observed and hence the recession of vegetative cover thereby encroaching on the Sudan savanna, turning the environment to desert fringes in the Sahel.

Severe weather events both localized and on the mesoscale, has introduced anomalies of both types, such as flooding and drought which has occurred over many areas especially the savanna regions, with its intensity and severity on the exponential value causing hardship to both man and his immediate and distant environment. This was observed at the coastal fringes of Peru, East African region and the Archipelago of Indonesia during the 1997-98 El-Nino spell amongst many others.

Many an indices have been propounded for the understanding exploiting and harnessing of the rainfall resource for sustainable development of man in his environment within the ecosystem. These include those of, Griffith (1972), Obasi et al (1978) of recent, the Monsoon Monitoring Index (MMI) and the Monsoon Quality Index (SRQI) both by Usman (2000), which are to be applied to the Sudano-sahelian region to avert drought agriculturally, meteorologically, hydrological, and socio economically which are especially important because, tied to the variability in both amount received and distribution of rainfall, is the 'dry-spell' syndrome which can aggravate into drought (Zakariya'u, 2001) and at some point with man's negative intervention leads to desertification (Adefolalu, 1985).

1.2 PROBLEM STATEMENT

West African rainfall regime is highly variable in both quantity and quality over spatio-temporal realm. The region has witnessed severe fluctuations at extreme sides of the "normal" impacting greatly on the socio-economic activities such as rain-fed agriculture. The severe drought episodes of the early 1970/80s attest to this fact, as well as the almost annual occurrence of the flash flooding along the river channels of the sahel (De Maree, 1990).

Spatially, inadequate real-time station data has slowed the tempo of applied research especially with the respect to impact and vulnerability studies.

While the role of large scale circulation features, such as the the El Nino Southern Oscillation (ENSO) phenomenon is largely appreciated by de Blij et al (1993), but how they have modulated the variability in the agricultural quality of the rains locally is less well understood.

There remains the need to employ new angles to studying the inter-relationships between rainfall amount and spread to ascertain the impacts of features of circulation on rainfall variability especially as it relates to rainfall quality to attain food security, self-sufficiency and sustainable development.

1.3 AIM AND OBJECTIVES

The aim is to determine the pattern, trend and rainfall response in relation to its quality over the Sudano-sahelian region using the Seasonal Rainfall Quality Index and also a new angled approach of the difference between CPTD and MMI onset dates to cover a period of 6 years. (1998 – 2003), using the newly available rainfall data of the Tropical Rainfall Monsoon Mission supplied freely by the National Oceanic and Atmospheric Administration (NOAA) and integral part of National Aeronautical Space Agency (NASA) of the United State of America with the active participation of the Government of Japan.

The objectives pursued to achieve the aims are,

i) Compute the Onset dates of rains for all years using two tested techniques

ii) Compare the onset pattern of the two techniques (qualitative and quantitatively.).

iii) Assess the quality of the seasons using a Quality Index (SRQI).

iv) Relate the patterns in (ii) and (iii) to the available ENSO data through a new angled approach of onset differences (D).

v) Make deductions from (ii) and (iii) on the efficacy of the data for real time assessment of rainfall impacts on agriculture.

1.4 STUDY AREA

The study area covers an extensive area that is latitudinal displaced northwards, from latitude 9^0N of the Sudan savanna to latitude 14^0N at the Sahel savanna, and on longitudinal axis of between longitudes 4^0E to about longitude 14^0E eastwards.

Rainfall data of eight (8) stations for six (6) years were sourced to be analysed and, it is pertinent to note that all the eight stations fall within the climatic region that experiences two distinct seasons; the wet and dry seasons, which is attributed to the seasonal displacement of the Inter-Tropical Discontinuity belt and reversal of the monsoonal flow over the West African sub region.

The wet season lasts for about 5 – 6 months (May– September) whilst the dry season lasts for about 7 – 8 months (Oct. April).

1.5 SCOPE AND LIMITATION.

Conventional rainfall data for the study area within the Sudan and Sahel savanna could not be reached. Satellite estimates (TRMM) were sought through the NASA/NOAA and NESDA offices of the American and Japanese government.

Estimates are based on cloud top brightness, which might give values that may not correspond with conventional data.

Minna's data could only be accessed for up to the year 2001, and so could not allow comparison could not be made of later years (2002– 2003).

1.6 JUSTIFICATION

In understanding the alarming reality of mass exodus of human and livestock resource in a very fragile environment where sustenance of life is difficult to sustain, succour should arrive at both the research outfit, and government intervention in the drive towards harnessing maximal benefit.

The Sahel being a region precariously tittering at rainfall fluctuations is quite prone to this unreliability, with an outright failure of rains at some cases, exposing the populace to massive starvation and/or death, further unbalancing the already unstable socio-economic order.

Indices used earlier on to compute the quality of rains are found to be ineffective in the Sudano-sahelian region, especially with the fact that in situ data acquisition mechanism is handicapped through complacency, inefficiency amongst others and on many occasions, cannot sustain research work.

Thus, the Seasonal Rainfall Quality Index (SRQI) also Monsoon Quality Index, which is used for assessing the short and long-term impacts of rainfall variability on agriculture, was adopted. It is to be utilized to measure the intensity and pattern of rainfall variability over the area of study to and to examine the trends of rainfall pattern particularly during the El-Nino years.

The conclusions would help in planning processes, especially by authorities concerned for the mitigating effects of climatic fluctuations.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Monsoonal circulation reflects the general atmospheric circulation and its interaction with the oceans' dynamic systems. The anomalies of these circulations bring about fluctuations in climates that constitute either the abundance or dearth of rainfall regimes and their seasonality. Ramage (1971) succinctly pointed out that the monsoon-prone regions are more susceptible to these interactive signatures since both the Hadley and Walker circulations influence monsoonal flow.

2.2 WEST AFRICAN RAINFALL REGIME

Two seasons are prominently witnessed in the West African sub-region namely; the summer monsoon and the winter monsoon (Isa, 2000). Summer monsoon is aptly named 'rainy season' by the locals, which is a season that witnesses a prevailing wind system called the southwesterly trade winds, or the tropical maritime (mT) air mass that incuses into the continental landmass from the Atlantic ocean, scooping the surface warm layer and pouring forth dominating, moist air mass. This displaces the Inter-Tropical Convergence Zone (ITCZ) band hinterland to the northwards latitudes.

The reversal of the wind system changes direction at about 3km above the ground that brings forth dry, stable air mass which displaces the ITCZ equator wards at south latitudes, at a particular time. This is geographically described as the period of low sun at the northern hemisphere. This ushers in a predominance of high-pressure centre of northern African origin known as the Libyan and Azores high-pressure cells. They greatly decimate the already weakened low pressure cell receding into the Atlantic Ocean. The attendant cool, dry wind, characterised by stability, is thus called the Northeast trades; and are referred to as the Harmattan. This is the dry season in the West African sub-region.

Ramage (1971) listed some principal features to satisfy the criterion for monsoonal flow, amongst others, to include, a change in the direction of prevailing winds between January and July by about 120^0,and its frequency averaging an excess of 40% between the periods (Usman 1999). Though the ITCZ marks a discontinuous zone and so named Inter Tropical Discontinuity, it is relatively shallow at 500hPa.

2.3 EL-NINO

An anomaly of normal of large-scale atmospheric circulation along the Pacific coast of South America that drifts westwards to the southeastern Pacific is called the El-Nino phenomenon, which happens particularly during the December Christmas period in the southeast Peruvian coast. El-Nino is "the boy child" after baby Christ in Maya Indian language.

During this phenomenon, the sea-surface temperature rises and consequently creates a region of predominant low pressure that brings an unstable air mass to rise aloft, joining and forming the Southeast trades across the south Pacific. Coastal areas of Peru, instead of achieving a rich harvest of anchovy fishes as usual, experience a warmer spell and high convective activities (Hoover, 1999) and dead fishes.

During an El-Nino episode, tropical rains usually influence wind patterns across the global. Most recent El-Nino years recorded include 1997/98, 1994/95, 1991/92, 1996/87, 1982/83 etc. with the 1997/98 episode being the strongest recorded event.

2.4 LA-NINA

The trade winds blowing westwards across the tropical Pacific pile up warm surface water in the West Pacific which raises the sea-surface height to about 50m about mean sea level (msl) creates an extraordinary cool pool at the ocean's surface of the South American coast creating an upwelling of nutrient rich surface which becomes a primary source of food for schools of anchovy fish, and subsequently allowing for bumper harvest of fish to be recorded.

This alternating cold spell, which is distinctively the reverse of an El-Nino episode, is called La-Nina (the girl child) phenomenon. They represent the, continuously localised and normalised global oceanic and atmospheric circulation (Adefolalu 2003).

2.5 EL-NINO SOUTHERN OSCILLATION (ENSO)

Southern Oscillation (SO) was named by Walker in the1920s after observing a two nodes of opposing sea level surface pressure (SSP) in the tropical Indo-Pacific basin, one centered at Tahiti, (an island in Southeast Pacific) and the other at Darwin in Northern Australia (Yarnal 1986). He also describes a fall in pressure at one end as bringing a rise in pressure at the other end. Bjerknes (1969) then attributed this phenomenon to ocean-atmospheric interaction that can be safely defined as "a periodic fluctuation of pressure differentials across the Pacific Ocean, measured by an index called the Southern Oscillation Index (SOI)".

Teleconnection between these phases, mentioned earlier, and climatic variation over West African can be attributed to the infringement of the Walker Circulation during the El-Nino episode at the upper level with an alternating cyclonic and anticyclonic flows, predominating at the equator, in the wind dynamic seeking system at the cooler higher altitudes thus affecting the mean – low level circulation (Usman 1999).

This joint action of El-Nino and Southern Oscillation (ENSO), exhibits a phenomenal yearly climatic variability, whose influence could be felt in tropical Africa, by leading to massive displacement of rainfall region of the tropics and, introducing drought or torrential rains to traditionally wet or arid regions respectively (Balogun 1987).

Adedokun (1978) has suggested that the "SO" through its influence on sea-surface temperature (SST) and sea-surface pressure (SSP), can cause extensive weakening or strengthening of the monsoonal circulation across West Africa and thus, determine the quality of the monsoon rains. But de Blij et al (1999) assert that this postulation is to be subjected to further probes especially for the sahelian and European environment, because Africa is a zone of air mass vertical ascent that also becomes a zone of cooler air mass descent in the Hadley circulation.

2.6 IMPACTS OF EL NINO

The El-Nino phenomenon influences strong westerlies winds at the upper atmosphere creating a strong vertical wind-shear that inhibits the development of potential storm, thus inviting a progressive episode of dry spell and mild drought to areas prone to rainfall abundance.

At the upper level, observation of the shifting in the track and trajectory of the jet stream and squall line are noticed because of the acute monsoonal moisture deficit that then inhibits consecutive system of convection.

Agriculture, being the main occupation of most inhabitants of the African continent, is positively influenced, especially at the Eastern African region. During the 1997 episode, Somalia, Ethiopia, and Djibouti received an improved rainfall regimes; these, ironically, are areas of traditional drought episodes over the years. The West African sub-region however, experienced to some extent, especially the sahelian region, a delayed onset and early cessation. For the purpose of this research the quality of rainfall regimes will be investigated and a possible connection ascertained.

CHAPTER THREE

METHODOLOGY

3.1 DATA DESCRIPTION

The data used in this research includes daily rainfall data sourced from the Tropical Rainfall Measurement Mission (TRMM) at NASA and NESDA as a joint effort between America and Japan, supplying the data free for research purposes.

The data set (ASCII Version) cover a period of 6 years; 1998 – 2003, which was collected for 8 stations in the Sudano-sahelian region of Nigeria to ensure spread in coverage.

These periods (1998 – 2003) were selected because it stands out uniquely within the recent history of observations in terms of extreme El-Nino and La-Nina events.

Table 3.1 Stations in the Sudano-Sahelian Zone with their Coordinates

STATION	CO-ORDINATES
Bauchi	Latitude 10°18′N
	Longitude 09°50′E
Jalingo	Latitude 08°51′N
	Longitude 11°20′E
Kaduna	Latitude 10°06′N
	Longitude 07°45′E
Minna	Latitude 09°37′N
	Longitude 06°32′E
Katsina	Latitude 13°01′N
	Longitude 07°41′E
Maiduguri	Latitude 11°51′N
	Longitude 13°05′E
Sokoto	Latitude 13°01′N
	Longitude 08°32′E
Kano	Latitude10°18′N
	Longitude10°18′N

3.2 DERIVED RAINFALL PARAMETERS

1. The raw daily rainfall data was processed into 5-day pentade values.

2. Values were calculated from January 1st -5th, (pentade 1)

   Jan. 6th – Jan. 10th (pentade 2) through to Dec. 27th – Dec. 31st(pentade 73).

3. The values of rainfall from pentade 1, is cumulatively totaled till pentade 73. Using this method breaks are smoothened over and onset is determined by the sharp rise of the orgive. The tangent is plotted to meet the pentade value that gives the onset (Obasi et al 1978). Classification is shown in Tables 4.1.

4. The same rainfall data were used to compute a new Monsoon Monitoring Index as follows:

$$MMI = \left[\frac{C^2}{r_{mm} \times Nbi \times 100}\right] - 1$$

Where C^2 = Cumulative rainfall since the end of April or the last pentade in the month of March (as the case may be).

r_{mm} = Highest pentade total rainfall since the beginning

Nb = Number of break(s); a break is a pentade value of <5mm

i = year identifier

100 =
-1 = } Constants

Classification is show in Table 4.2

5. The difference between heal onset (MMI) and false onset (CPTD) is sought for each station for all the years of study. Classification is shown in table 4.3.

6. The annual rainfall total was calculated by the summation for all individual pentade values from Jan. $1^{st} - 5^{th}$ (pentade 1) to Dec. $27^{th} - 31^{st}$ (pentade 73). Classification is shown in table 4.4

$$R = \sum_{i=1}^{n=73} pentade$$

Where n = number of pentades

ι = year identifier

R = Rainfall (annual) total

7. A quality index was then computed to ascertain the yearly quality of the rainfall regime with particular emphasis on amount, spread and distribution.

The formula used is as follows:

$$SRQI = \left(\frac{R^2}{r_{max}}\right) Nbi$$

Where R^2 = Highest rainfall value from the beginning

r_{max} = Total amount of rainfall in a season from beginning

Nb = Number of breaks

ι = Year identifier.

The classification of this index is given in table 4.5

3.3 SOFTWARE PACKAGES

The following Microsoft packages were used.

(a) Microsoft Word

(b) Microsoft Excel

(c) Microsoft photo draw

(d) Most importantly the Golden Surfer8 was used for gridded data analysis and 3-dimensional maps and charts presentation of data for all the stations. This was achieved through superimposition of the maps on the plotted surface using the gridded data to give a detailed 3-dimensional view of the study area with colour composite to indicate peculiarities of the patterns description.

CHAPTER FOUR

DATA PRESENTATION AND RESULT DISCUSSIONS

4.1 SRQI – SEASONAL RAINFALL QUALITY INDEX (also SRQI)

This index developed by Usman (2000) measures the quality of the rains in terms of both annual amount and seasonal spread. It is computed for each season independently, hence long term measure, mean and standard deviation are removed. Inter-annual variability is then ascertained by comparing the values for the years being studied.

SRQI application bothers on the calculated value of the index. If the index value is small as a final figure, the probable explanation is that the annual amount of rainfall is high and not concentrated in one particular month. Rainfall spread is said to be good, and therefore, the better the quality of the season agriculturally (since it is tied down to amount and spread of rains).

However if the index value is higher for a particular year, the probable explanation then bothers on the concentration of rains at a particular month with the annual total being poor, therefore unlikely to be productive agriculturally.The numbers of the break are used to highlight any problem in the distribution, while squaring the denominator is to remove the possibility of any bias before the year.

The importance of rains over the Sahel cannot be over-emphasized especially in its direct bearing to agricultural activities. These effective means must be evolved to assess the quality of the rains, problem of drought and possible postulation of mitigating planning.

The SRQI can be used even if a new station with only a year's data is involved which can equally be computed as soon as the rains are over, thence an operation assessment of distributional pattern of rainfall made. The SRQI is classified as seen in Table 4.5 and the result Table 4.6

4.2 ANALYSIS OF THE CUMULATIVE ONSET PENTADE DATES FOR ALL THE STATIONS (1998-2003).

The 1998 onset for most part of the Sudan savanna (Fig 4.1) shows a remarkable pattern of very early to early onset especially at the Kaduna through Minna to Jalingo, while Kano and Maiduguri as part of the Sahel experiences late onset.

However, with the 1999 onset (Fig 4.2), Bauchi and surprisingly Sokoto had normal onset with a northwards displacement engulfing some more parts of the sahelian region, which is interestingly displaced westwards. The points of interest of the 1999 onset are that, it has the extreme values for both the very early and the very late onset for the years of study (1998-2003) especially along the western region. Late onset at Kano but did not exceed to Maiduguri at the eastern fringes of the Sahel.

But during the year 2000 onset (Fig 4.3), evolved a pattern that shows the onset determined by northwards latitudinal shift with Minna enjoying very early onset, while Kano, Katsina, Maiduguri and Sokoto experiences very late onset. The scenario became interesting to note that during the2001 (Fig 4.4) rainy season the trend became reversed, where Sokoto and the Sudan environment predominantly experienced early onset with only Kano and Katisna being the only two stations that had very late onset.

Conclusively, Fig. 4.5 and Fig 4.6 represent representing the years 2002 and 2003 respectively, show an onset pattern that are quite identical, with a highlighted difference only in the "twin-peak" very early onset engulfing parts of Minna and Bauchi. Very late onset was occasioned at the extreme location of the Sahel.

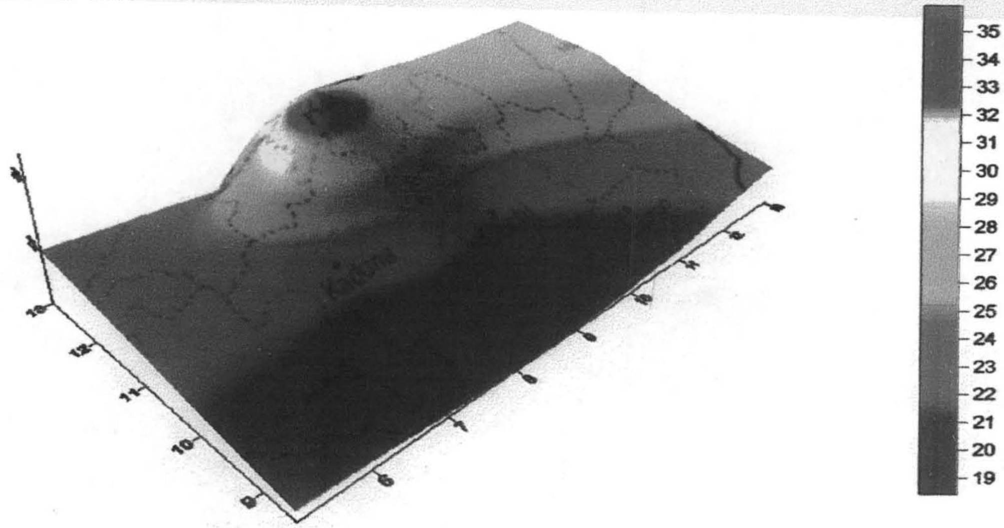

Figure 4.1 Cumulative Onset Pentade Dates (1998)

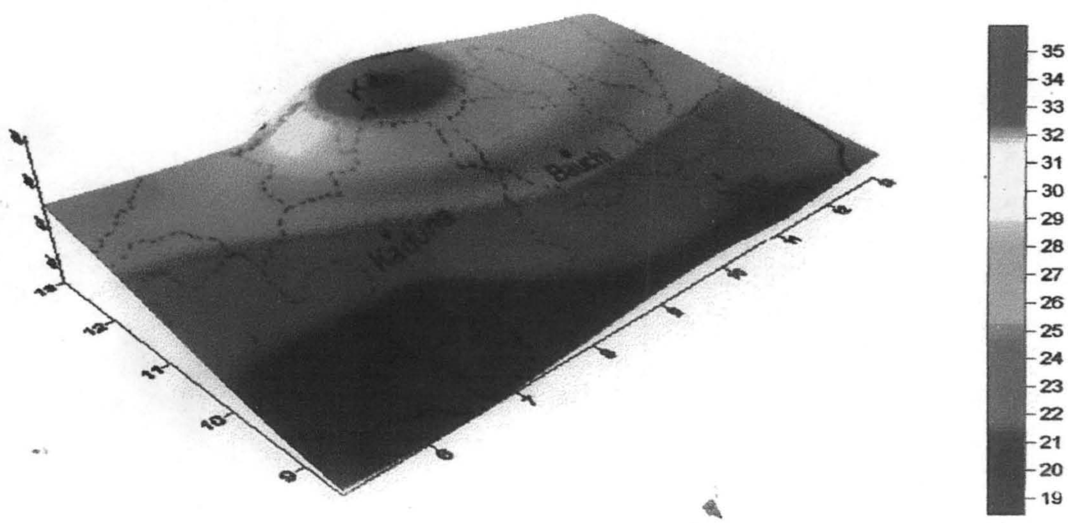

Figure 4.2 Cummulative Onset Pentade Dates (1999)

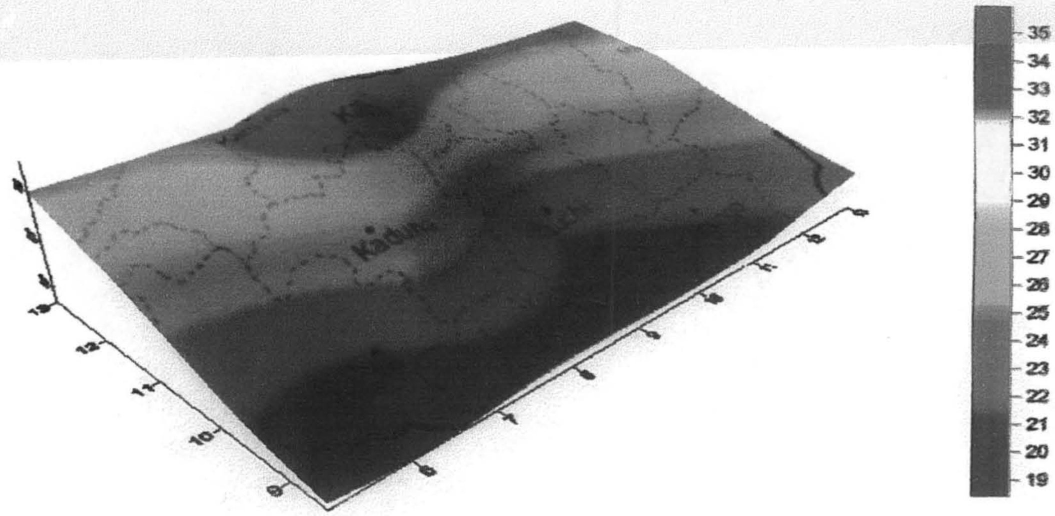

Figure 4.3 Cumulative Onset Pentade Dates (2000)

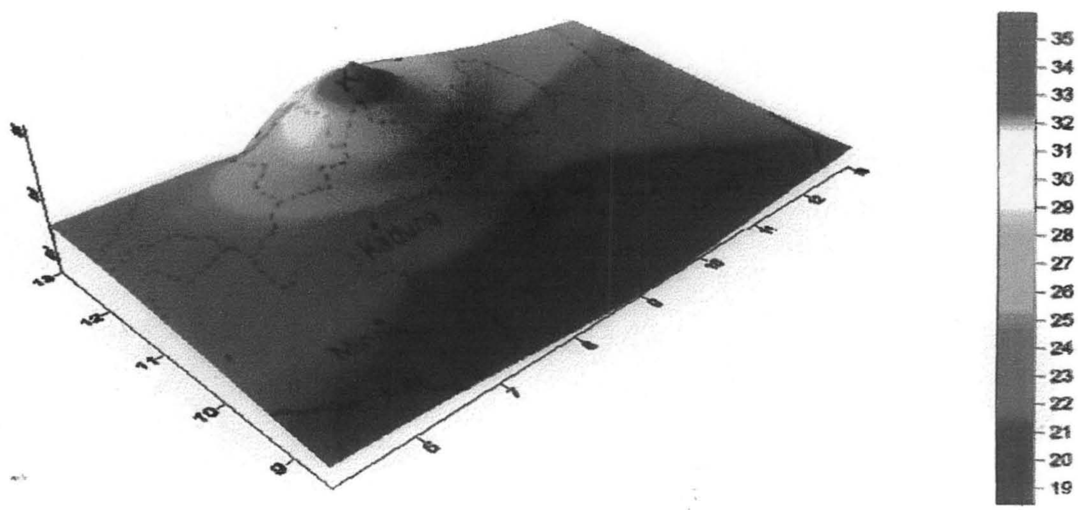

Figure 4.4 Cumulative Onset Pentade Dates (2001)

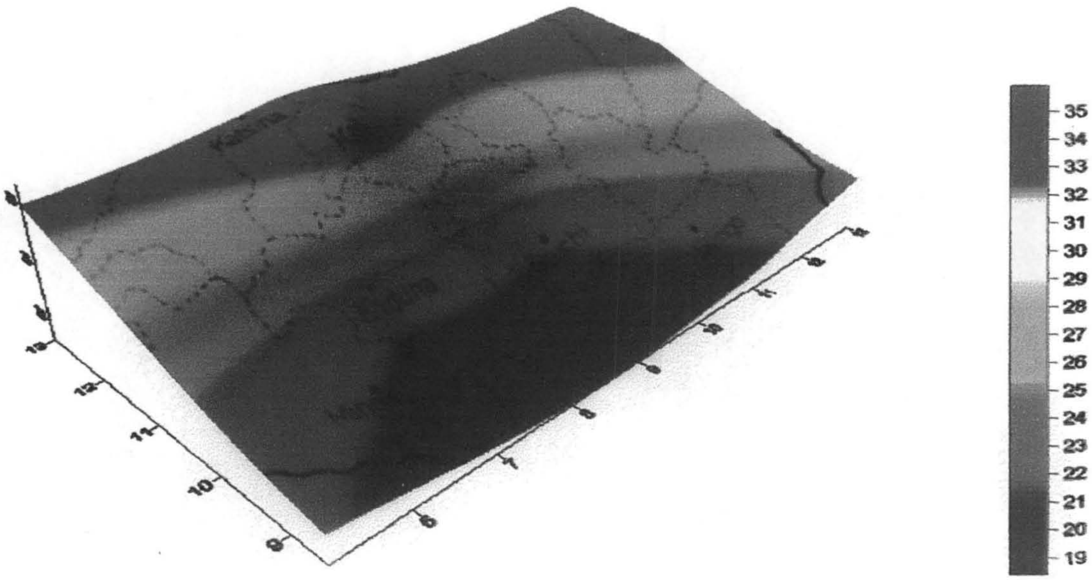

Figure 4.5 Cumulative Onset Pentade Dates (2002)

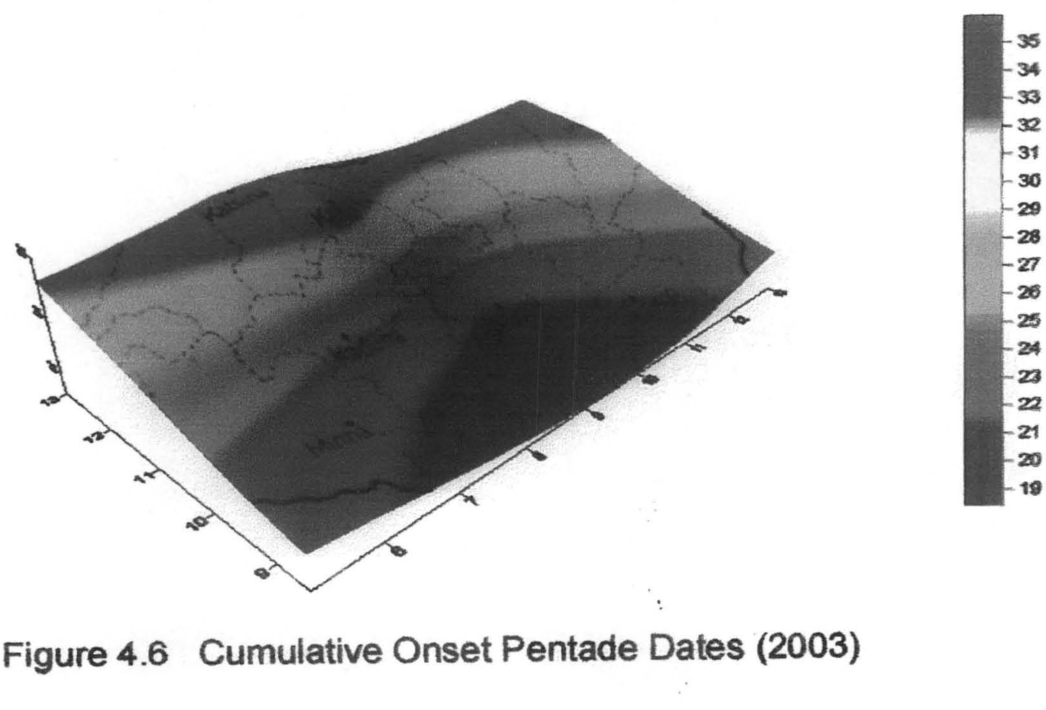

Figure 4.6 Cumulative Onset Pentade Dates (2003)

Table 4.1: Cumulative Onset Pentade Date Classification.

CPTD Class	CPTD Value	Onset Pattern
1	< 22	Very Early
2	> 22 < 26	Early
3	≥ 26 < 30	Normal
4	≥ 30 < 35	Late
5	> 35	Very Late

Summarily, the highly variable nature of the Sudano-Sahelian rainfall is evidently visualized, though the 3-dimensional views of the plotted study area and onsets were generally early between the 1998 that was an El-Nino year and 2001 rainy seasons. 1998 El-Nino years was the strongest every recorded and was followed by the La-Nina episode of 2000, which in this research shows a proliferation of layered latitudinal onset pattern, an identity shared by the 2002 and 2003 rainy seasons.

Deductions can be made particularly of this onset technique, that, they only suggest the early onset of the rainy season during the El-Nino episode that was evidently noted. Teleconnections cannot be ruled out, but the signatures are only vaguely understood. It is also interesting to note that during the La-Nina episodes, a pattern of layered onset indicating "normal" events were observed.

4.3 ANALYSIS OF THE MONSOON MONITORING INDEX ONSET PENTADE DATES FOR ALL THE STATIONS (1998-2003)

Monsoon Monitoring Index Onset is an index that establishes effective onset based on a computational mechanism (as discussed in Chapter 3). It highlights the performance of rains based on the amount and spread, hence could give a fair representation of rainfall regime.

Fig 4.7 (1998) shows that, onset is fairly distributed in latitudinal order taking a smooth transition from Minna, Bauchi and Jalingo that witnessed a very early onset through to Kano (late), and Katsina which had the later onset. Both locations however are at the Sahel.

During the 1999 season, (Fig 4.8), Kano and Sokoto experienced a very late onset and subsequently an equator wards displacement of onset in a descending pattern is apparent. This observed pattern was almost repeated in 2000 (Fig.4.9) with the exception of Kano, which has a "late onset". But at the Sudan environment, an enclosure of very early onset is notice at the southern axis.

Fig 4.10 through to Fig 4.12 (2001-2003), witnessed a same pattern of onset but this time around the Sudan zone enjoyed the predominating "very early" onset especially in the year 2003.

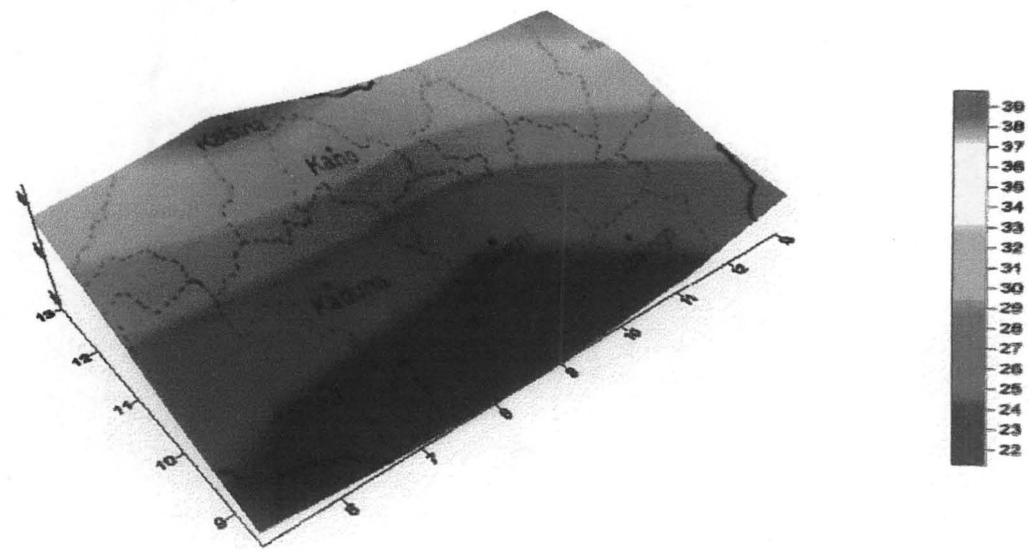

Figure 4.7 1998 MMI pentade Onset Dates

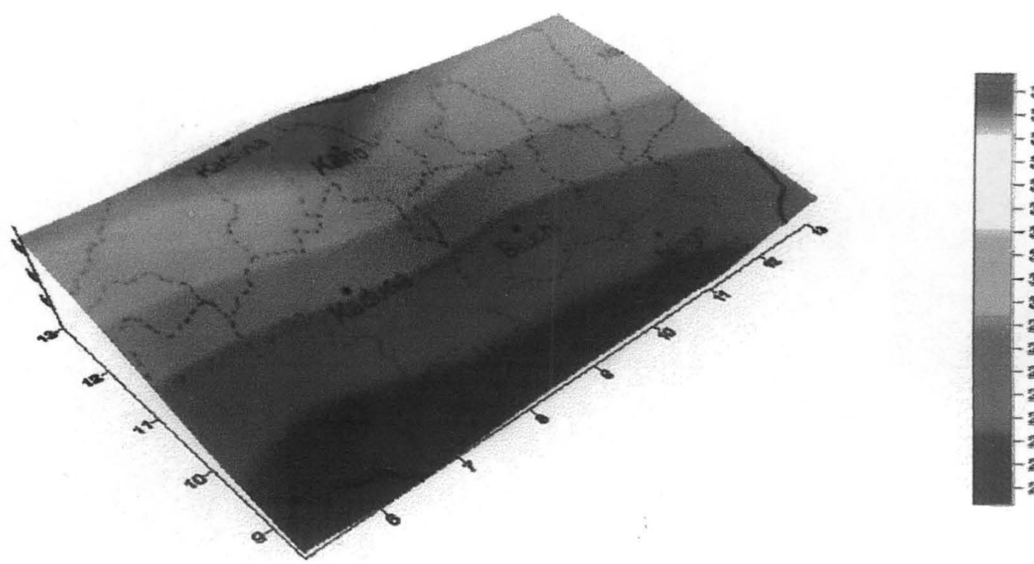

Figure 4.8 MMI Pentade Onset Dates (1999)

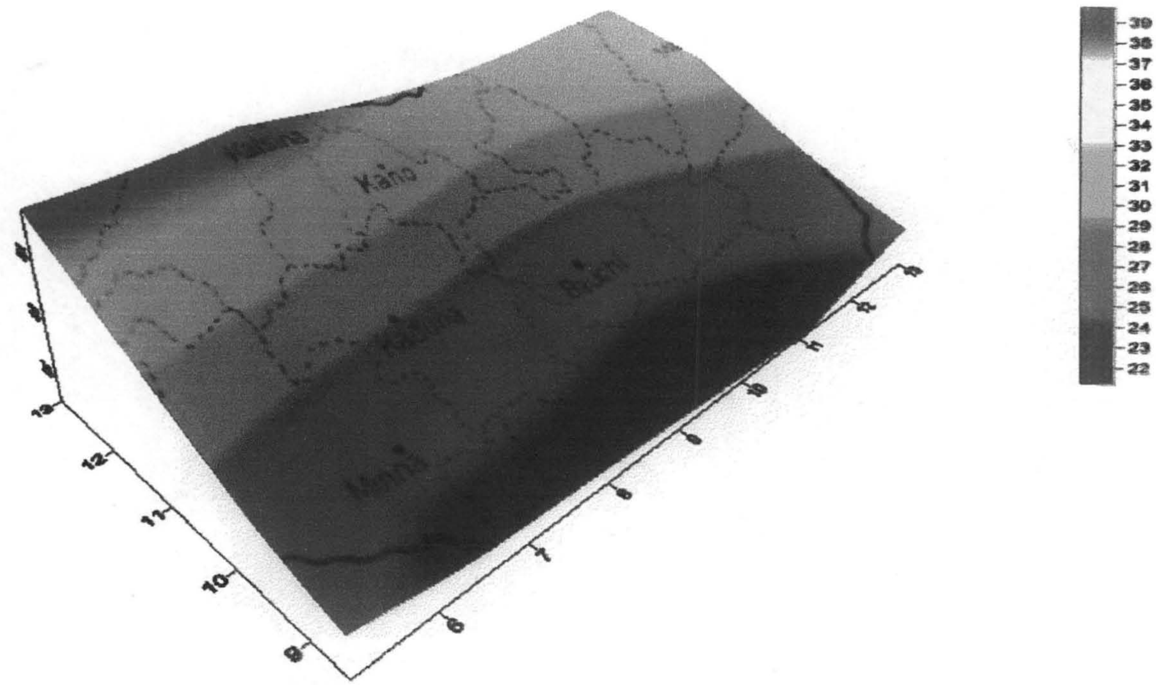

Figure 4.9 MMI Onset Pentade Dates(2000)

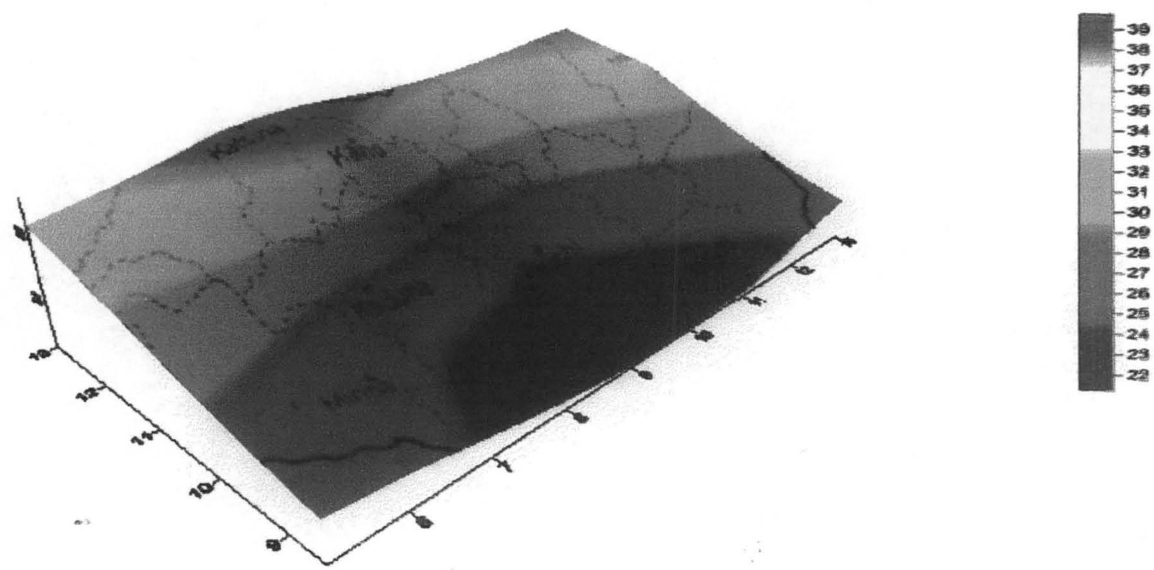

Figure 4.10 MMI Onset Pentade Dates(2001)

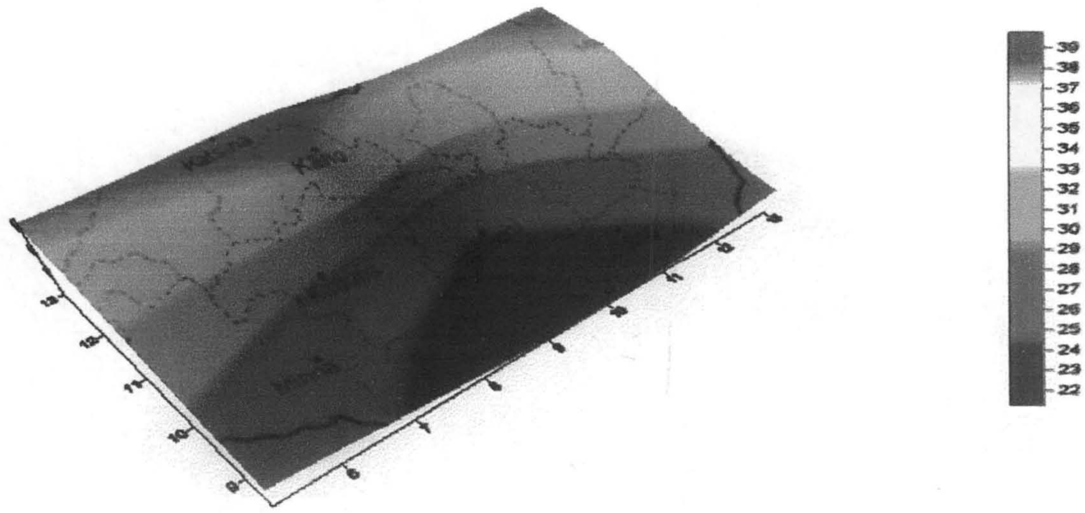

Figure 4.11 MMI Onset Pentade Dates(2002)

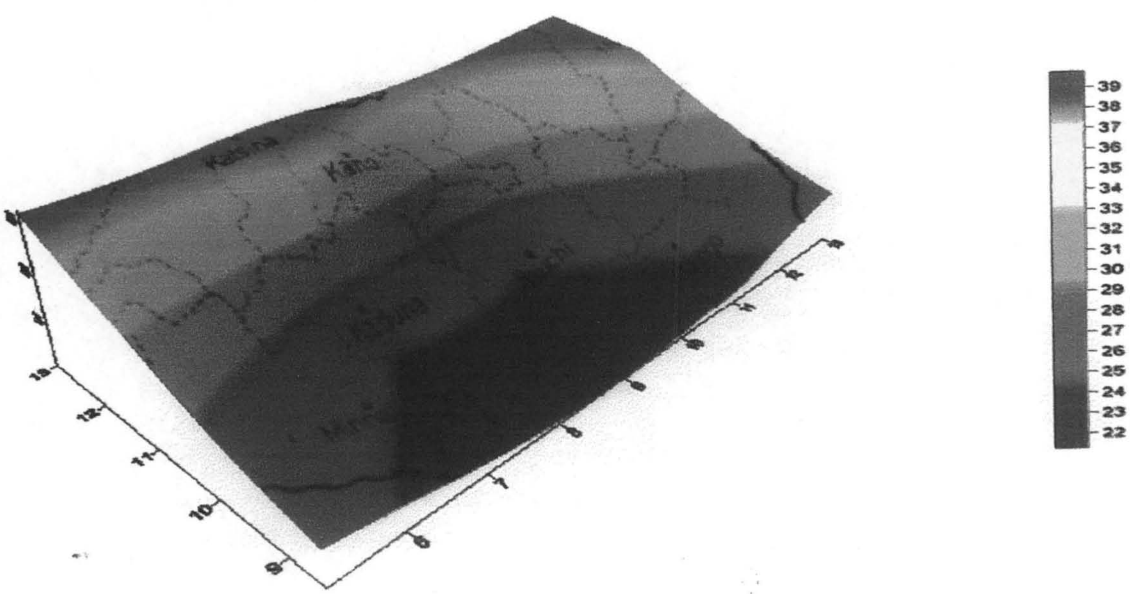

Figure 4.12 MMI Onset Pentade dates (2003)

Table 4.2: MMI Onset Pentade Dates Classification

MMI Class	MMI Value	Onset Pattern
1	< 25	Very Early
2	> 25 < 29	Early
3	$\geq$ 29 < 33	Normal
4	$\geq$ 33 < 37	Late
5	> 37	Very Late

Summarily, deductions can be made using the MMI onset dates, that during the El-Nino years, 1998, onset was fairer for all stations especially along the extreme fringes of the Sahel. This displacement made Katisna to experience the later than normal late onset while Kano witnessed a "late onset", but fairer when compared to the trends exhibited by the CPTD onset pattern discussed in section 4.2. The Sudan region comprising of Minna, Jalingo, Kaduna and Bauchi, predominantly registered very good onset years of rainfall. They are considered to have had a fairer season rainfall-wise and are more possibly productive agriculturally.

4.4 ONSET PENTADE DIFFERENCES BETWEEN MMI and CPTD (D) FOR ALL THE STATIONS (1998-2003).

This is a latest attempt to describe the pattern of differential fluctuations between the two tested techniques of the MMI and CPTD. The assumption is that the spacing between the onset dates using the two techniques influences and determines the amount and distribution of the rain in a particular year. That if the spacing is closely packed as illustrated by the contours, it registers the depth in spread and amount of the rains of that particular year. See table 4.3 for classes of difference.

Variability of both inter- and intra- annual performances of rainfall region would be possible. Observation, especially of the pattern during the El-Nino years will be given due recognition for it is the case study of interest.

Observing Fig 4.13 representing 1998 that was a strong El-Nino year, the difference between the MMI and CPTD was not so pronounced. In other words, the actual onset of the rains represented by the MMI was close to the 'false' onset represented by the CPTD. The beginning of the first rainfall event was characterized by good amount and spatial spread which would pass for a good rainfall onset during that year. This compared with 1999 rainfall year (Fig 4.14), showed a displacement of the trends majored around the Sudan with the extremes at the sahelian locations showing an indication of poor trends for the year.

The year 2000 represented by (Fig 4.15), showed a trend that is quite interesting because, only locations displaced in the northwestern axis are occasioned by poor showings. The northeastern region through the north central region of the study area has a decisive pattern of good rainfall year. The same pattern was almost repeated during the 2001 (Fig 4.16) but only the southern fringes of the Sahel was displaced eastwards and westwards and had poor showing. The Sudan axis however, recorded a fair distribution.

The trend for the 2002 rainfall year (Fig 4.17) showed an uneven distribution for almost all the stations in the Sudan region, with the exception of Jalingo and its immediate environment which looks like a worse case scenario compared to other years of interest in the study. Interestingly they are years of La-Nina events.

However, the 2003, (Fig 4.18) which were recorded as a slight El-Nino year, exhibit a trend of gradual fairer distribution and depth of rains.

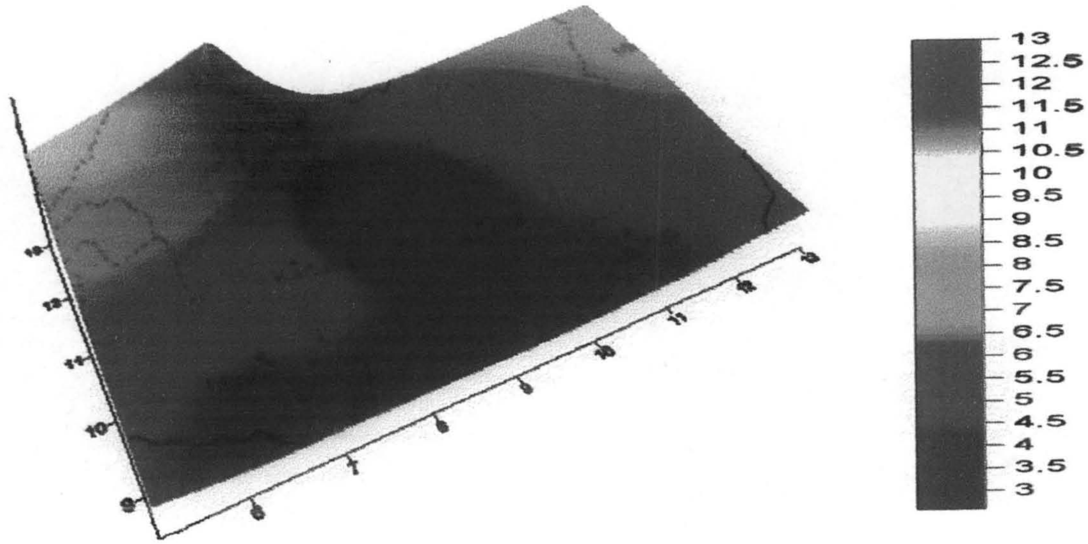

Figure 4.13: Onset Pentade Differences between MMI and CPTD (1998)

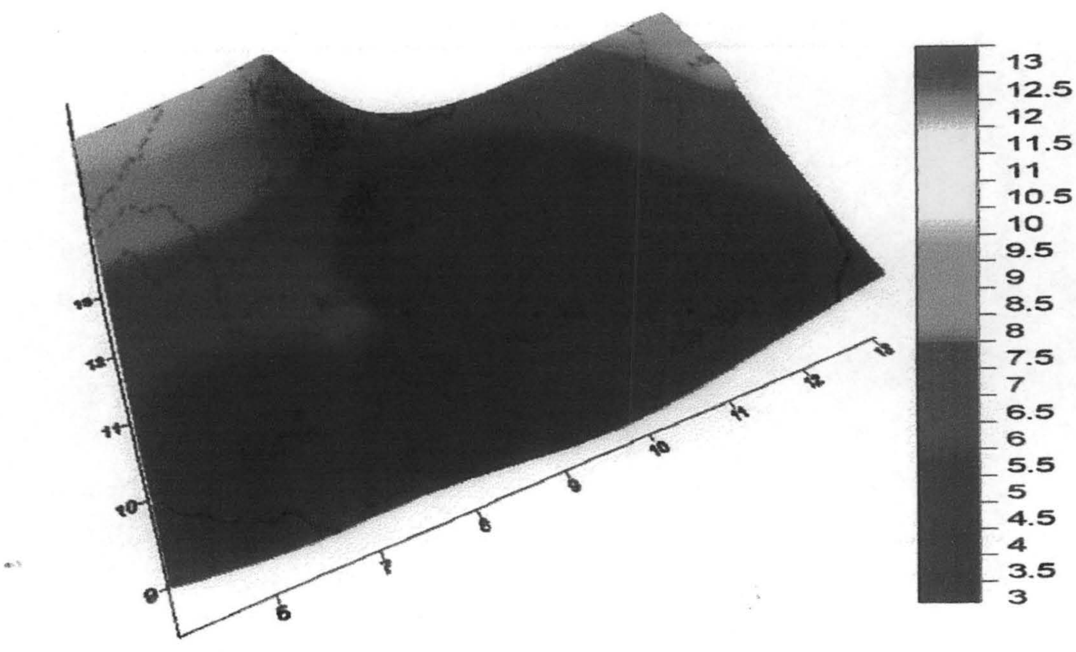

FIGURE 4.14 ONSET PENTADE DIFFERENCES BETWEEN MMI AND CPTD (1999)

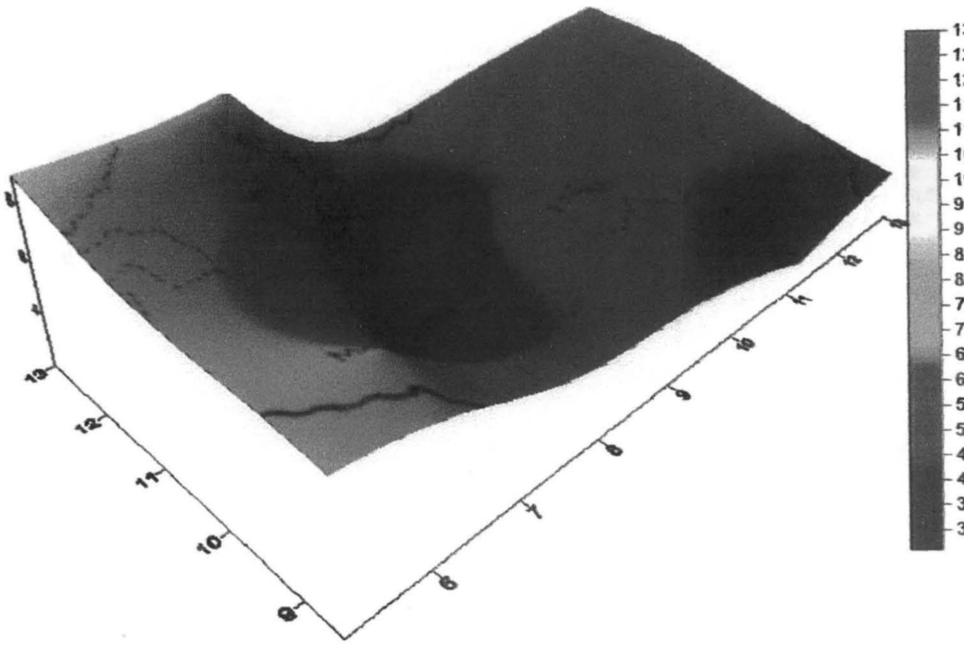

Figure 4.15 Onset Pentade Differences between MMI and CPTD (2000)

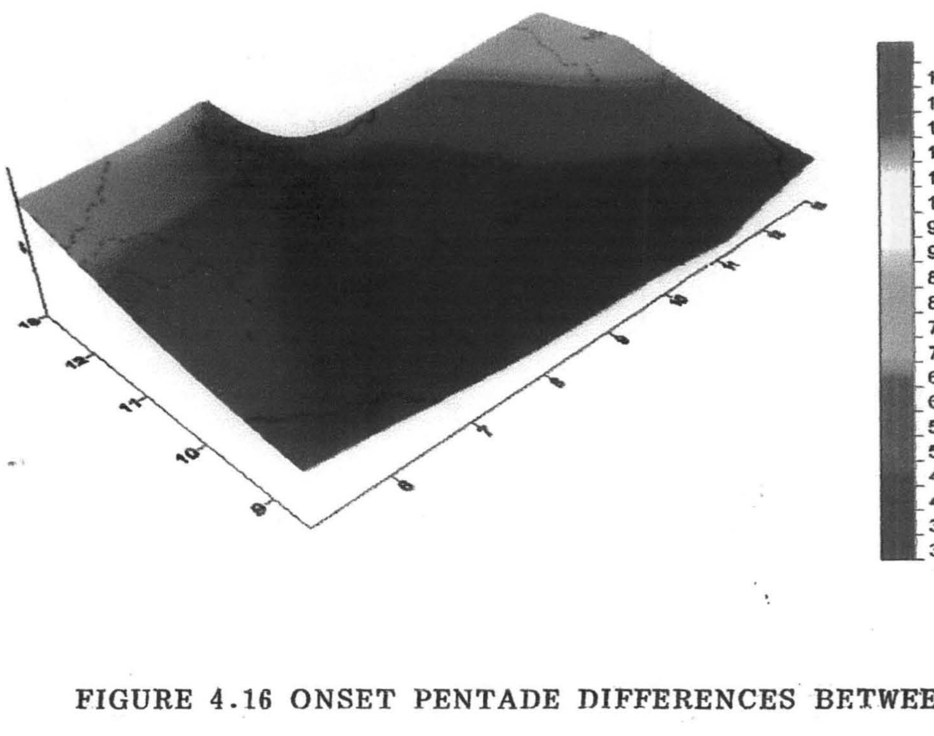

FIGURE 4.16 ONSET PENTADE DIFFERENCES BETWEEN MMI AND CPTD (2001)

Table 4.3: Onset Pentade Differences (D) Classification

Onset D Class	Onset D Values	Difference (D) Pattern
1	< 2.6	Good
2	> 2.6 < 5.3	Fair
3	≥ 5.3< 7.9	Poor
4	≥ 7.9 < 10.5	Very Poor
5	> 10.5	Extremely Poor

Summarily, rainfall spread and distribution being key factors in proliferating agricultural production had patterns indicating good spread and distribution of rainfall during the El-Nino years. This is noted with interest as the 1998 (Fig. 4.13) rainfall year shows a more depth of distribution, which contrasts sharply with the 2002 trend, which as earlier noted was a La-Nina episode. Agriculturally, the El-Nino years could prove quite productive, with the influencing contribution of the other factors. They are, however, prone for further research to link in further teleconnections.

4.6 ANALYSIS OF QUALITY PERFORMANCE OF SRQI PATTERN FROM 1998-2003 FOR ALL STATIONS.

The Seasonal Rainfall Quality Index (SRQI) developed by Usman (2000) measures the quality of the rains in terms of both annual amount and seasonal spread. Inter-annual variability is ascertained by comparing the values for the years under observation and study.

In applying the SRQI, if the index value is small, then it is evidently clear that the rains are not concentrated on any one month, which inadvertently indicates a quality- prone rainy season, agriculturally.

SRQI can, if applied to any year's data, shows a poor rainfall performance when the index value is large and the season is agriculturally unviable. Agricultural harnessing, quantitatively and qualitatively, is moreover tied down to spread and amount of rainfall as well as availability of soil moisture surplus most especially at the early stages of the season.

Figures 4.19 to 4.24, representing 1998 – 2003 conditions illustrates fluctuations in the pattern of quality, which occurred at different times and stations.

As at 1998 (Fig 4.19), the quality performance of the rains was very good as observed from the regular hue of colour in the legend for most part of the study area throughout the year. Katsina was the only station that has an exceptionally poor performance that was also peaked at "poor "for the sahelian stations during the 1999 rainfall (Fig. 4.20) season.

In the 2000 rainfall season (Fig.4.21), Minna and Jalingo show a very good performance during that year. But the 2001 (Fig 4.22) season showed a highly stratified rainfall quality pattern along the northeastern axis of the study area with Maiduguri, Kano and Jalingo showed a "good" performance, and "extremely good" performance was recorded for Sokoto, which is highly displaced to the extreme northwestern region. This same pattern of good performance was recorded for Minna, Kaduna and Bauchi, all at the sudan savanna.

Pointedly, performances for 2003 represented by (Fig.4.24), showed a remarkable regaining of spread and distribution of the rains, especially for the northeastern axis, which is at the extreme location showed poor performance at Katsina and Sokoto in 2002 (Fig.4.23).

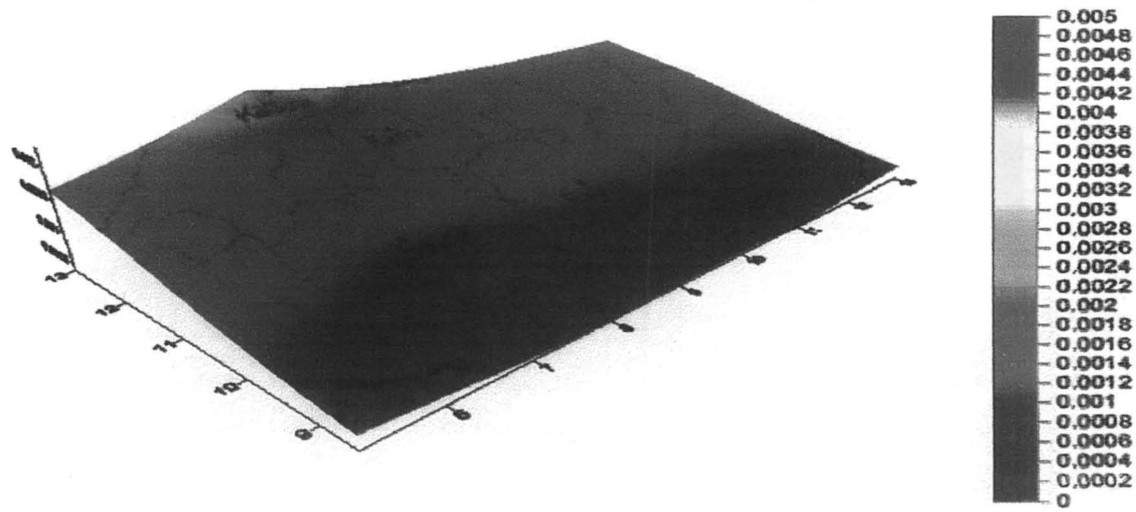

Figure 4.19 Monsoon Quality Index (1998)

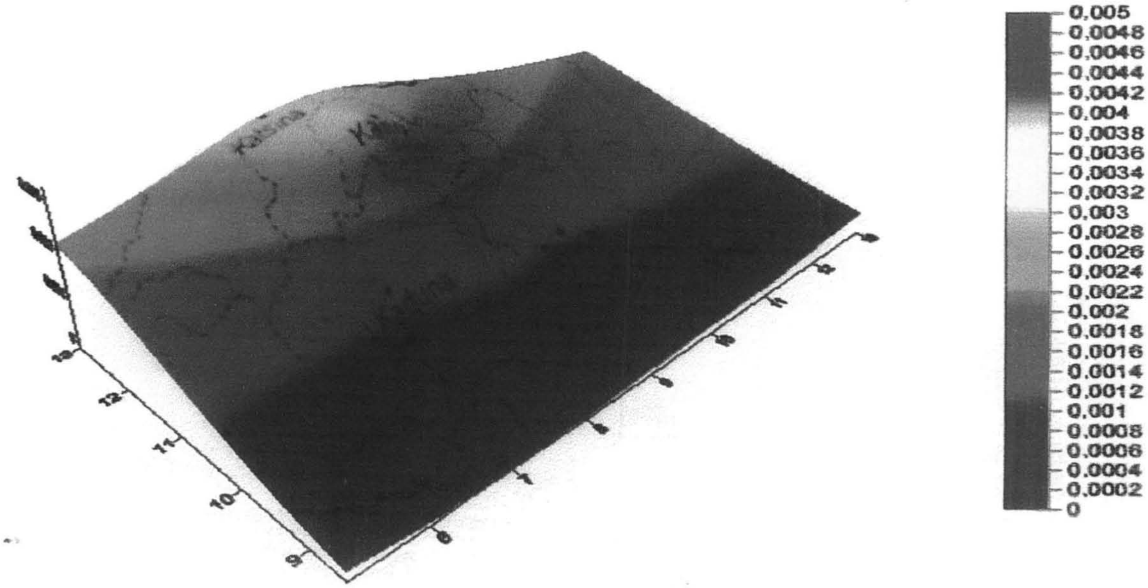

Figure 4.20 Monsoon Quality Index (1999)

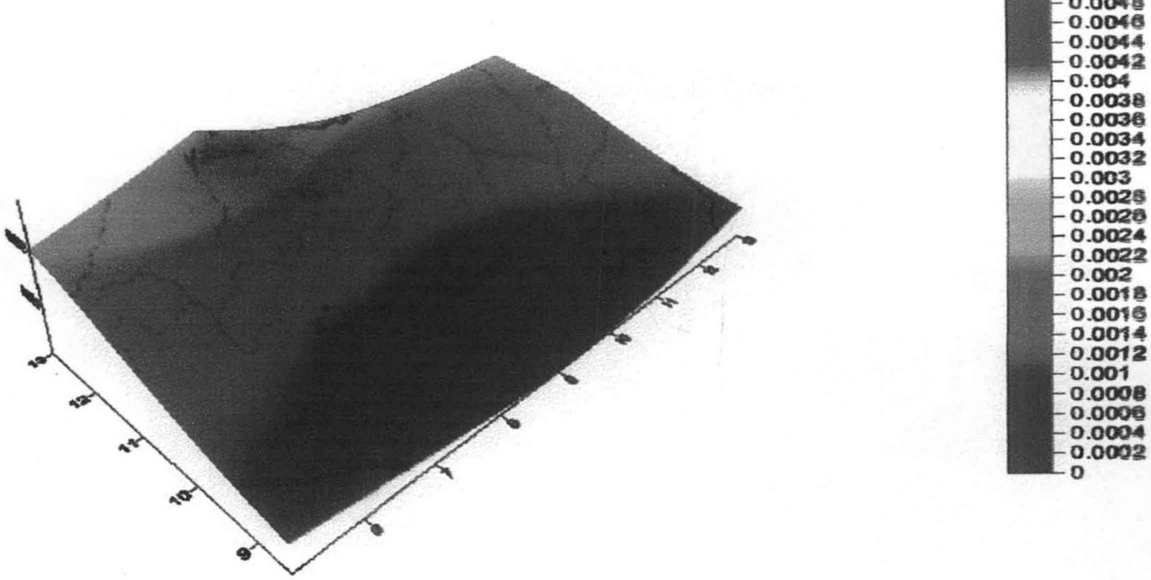

Figure 4.23 Monsoon Quality Index (2002)

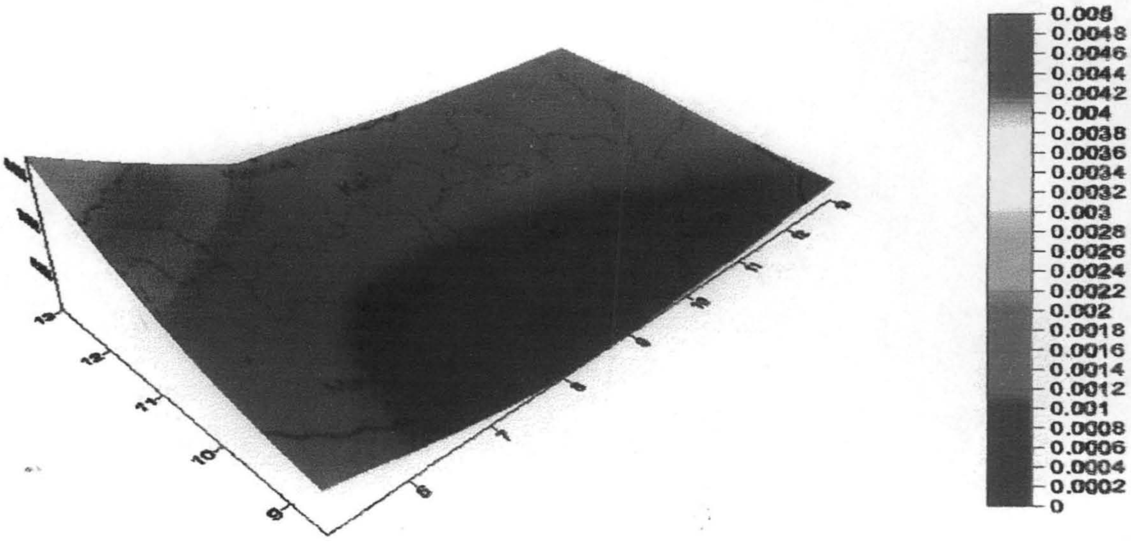

Figure 4.24 Monsoon Quality Index (2003)

Table 4.4: SRQI Classification

SRQI Class	SRQI Value	SRQI Patterns
1	0 < 0.001	Good
2	>0.0001< 0.002	Fair
3	$\geq$ 0.002 < 0.003	Poor
4	$\geq$ 0.003 < 0.004	Very poor
5	> 0.004	Extremely Poor

Summarily, performance of the rains as observe during the years of the study showed characteristic fluctuations ranging from the extremes on both sides of the divide which was generally better during the 1998 season. This poses an interesting familiarity because it has shown this propensity during the El-Nino year for all observations. This also applies to the 2003 season, which witnessed a mild El-Nino episode that highly contrasted with trends observed during the 2001 La-Nina episode

Deduction can be drawn that quality of rain improves tremendously during an anomalous episode of El-Nino, probably induced by the teleconnections patterns which might be local in nature but whose correct identity could not be ascertained as part of this study. Detailed comparison must be engaged upon in future researches once again to ascertain the degree of involvement of these atmospheric signatures to quality and distributions of rains.

CHAPTER FIVE.

SUMMARY, CONCLUSION, AND RECOMMENDATION.

5.1 SUMMARY

Rainfall in tropical environment of West Africa has being highly variable, in terms of both quality and quantity, especially with the devastating early 1970s drought episode and attendant cyclical episodes of atmospheric teleconnections to anomaly, has prompted researches into important atmospheric mechanisms that might have led to the catastrophic failure of the region's precipitation and the resulting colossal loss of human lives, livestock and property worth billion of naira with and the declining rainfall spread and amount due to anomalous rainfall patterns since 1977 – 78 drought suggests a dangerous trends in mean condition taking place .

Satellite-based rainfall data estimates for six years (1998-2003) of the study area were sought because they stand out uniquely within recent history of extreme El-Nino and La-Nina events. Indices of the CPTD and MMI were used to observe the onset dates of all the stations in the study area to ascertain the 'false' and 'real' onset dates. Comparisons were made to determine the difference between the two techniques and values plotted to observe the transition between them. Seasonal Rainfall Quality Index was also applied to observe the spread and distribution of the rains.

Analysis result showed early onset dates for almost all the stations in the study based on the two tested and applied techniques (CPTD and MMI) with very few irregularities. Rainfall quality was also observed to be remarkably well spread and highly distributed most especially during the El-Nino years and the reverse was the case for La-Nina years and pattern of distribution indicated good spread after analysis of onset differences between MMI and CPTD (D).

5.2 CONCLUSION

This study has shown that the years experiencing the El-Nino phenomenons are years with early onset and good rainfall quality in the study area, while the opposite is the case for years experiencing the La-Nina phenomenon. Ordinary years in between are just moderate with certain exceptions.

Usually, fluctuations of onset dates and uncertain quality of the rains have been highly prevalent problems in the Sudano-Sahelian zone. However, the results of this study, if properly harnessed, could prove beneficial to agricultural productivity especially to the inhabitants of this region in particular, and the Nigerian nation at large..

5.3 RECOMMENDATIONS:

a) Government of the Sudano-Sahelian regions should engage in more researches to harness rainfall resources especially during the period before and after atmospheric anomalies.

b) Climatic data acquisition mechanism especially conventional data should be encouraged and engaged on by government, research and academic institutions in the developing economies, to allow comparisons to be made with satellite derived rainfall estimates a for proper assessment of the amount and distribution of rains.

c) Models should be developed for proper understanding and formulation of derived rainfall parameters by institutions with vested interest, to take into cognizance extreme events of atmospheric mechanism and, hence, to find applicability for high variability prone environments.

d) There is need to further research work to understand major signatures of the atmospheric Teleconnections and their attendant consequences to the fragile Sudano-Sahelian environment.

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APPENDIX A

BAUCHI PENTADE VALUE

pentade	1998	1999	2000	2001	2002	2003
1	0	0	0	0.2248	0	0
2	0.1919	0	0.174	0.4156	0.0921	0
3	0	0	2.4586	0	0	5.4069
4	0	3.2201	0.1179	0	0	1.2741
5	0	2.5407	1.8299	0	0	0.0183
6	0	0.0236	0	0	0	4.9923
7	0.005	2.6575	0	2.8918	0	0
8	0	0.2844	2.6961	0	0	0
9	0.0449	0	0	0.2137	0.105	0
10	0	1.5953	0	0.256	0	2.5936
11	0	0.1733	0	0.9583	0	0.7353
12	0.1846	0	0	1.9672	5.7936	1.9554
13	0	1.3467	0	0	0.8457	0.0877
14	0.1416	1.4423	0	0.3856	15.2152	0.0548
15	3.1405	8.8494	0	1.2215	0	0.1371
16	0	1.0134	12.4671	1.2359	4.0714	0.3426
17	0.0318	2.4268	1.1817	0.3387	4.0565	1.6527
18	0.0029	1.2541	0.0057	3.4735	3.7121	0.2247
19	0.4297	11.8105	0.0811	26.5968	0.5944	19.7733
20	1.3086	3.5599	2.0375	2.8579	18.7682	15.4062
21	0.0449	4.85	15.9405	7.9582	29.1472	32.6038
22	14.5674	13.2399	4.2337	24.6299	14.3202	16.7456
23	23.1789	14.2666	22.0848	25.6228	21.472	16.495
24	37.1082	14.9179	11.8903	19.9259	8.7187	6.1871
25	31.1643	1.2739	24.3174	24.6474	16.5518	0.7268
26	46.1698	50.7339	16.507	25.0247	11.3597	2.2322
27	18.2495	63.0678	10.7927	39.3904	8.6614	9.5737
28	22.086	28.9751	29.1385	6.3556	10.6877	45.8952
29	37.2655	19.6309	20.6907	15.5099	12.1409	25.3076
30	40.6299	34.483	33.9333	22.9891	14.8017	36.8236
31	24.248	19.7036	31.4349	26.449	18.271	44.8097
32	28.516	21.5462	43.7081	24.2156	26.8976	26.7041
33	31.2597	23.1869	22.9735	15.7361	13.349	44.1389
34	18.313	29.5283	22.4016	21.381	35.8303	25.8398
35	25.1724	7.0711	13.2982	53.4119	19.8274	41.5599
36	6.636	37.236	23.0966	25.4547	45.1952	12.9235
37	24.7527	28.6433	23.2374	28.9893	30.5097	22.0863
38	32.6779	27.7795	26.7786	23.1534	26.7461	30.9956
39	21.6732	25.9005	26.8326	10.2133	20.824	14.7931
40	19.9226	30.5788	36.3484	44.1892	10.0011	37.8155
41	32.9657	39.6515	37.7464	23.1299	19.6167	33.7435
42	23.5828	36.3605	40.7895	35.1872	39.8692	23.4852
43	23.7154	51.2924	48.7341	38.561	48.3085	21.7728
44	35.9997	47.1496	20.5575	20.4997	23.7168	49.3449
45	51.1415	33.2877	33.6966	29.4404	16.3827	27.4396
46	34.7976	40.071	45.9819	36.549	16.7656	22.3113
47	56.149	46.9942	33.8599	27.1961	55.1587	14.5316
48	26.1759	42.7828	44.8742	61.1252	54.3345	30.6708
49	36.3758	58.2117	13.811	34.7024	13.6716	45.5587

50	54.4332	34.75	37.2957	22.176	36.1453	14.4185
51	18.1666	25.4235	42.4176	57.0855	40.1245	31.5215
52.	62.226	15.4564	21.3377	32.2828	21.8687	40.5784
53	58.8898	17.4323	13.533	8.7454	22.2017	30.5265
54	61.4779	36.6449	25.3306	47.5553	34.1058	26.2294
55	11.8014	31.4674	26.7733	22.9608	43.4659	26.538
56	33.4151	15.4632	20.4035	9.0373	5.0325	
57	6.0346	36.8247	42.5669	21.1954	18.3125	
58	29.7878	32.4944	16.8838	25.7175	14.8855	
59	33.0958	1.8831	1.7598	1.3056	2.4581	
60	0.524	16.8735	2.3167	1.7769	6.6213	
61	0.786	2.5219	4.4066	0	3.5144	
62	0.0768	0.1563	0.9777	0.6432	7.612	
63	0.5797	1.7919	0.7676	0	0.4799	
64	3.7734	0	0.8322	0	0	
65	0	0	0.1758	0	0	
66	0.2464	0	0	0.0811	1.1643	
67	0	0	0.1677	0.05	0.0584	
68	0	0	0	0	0	
69	0	0	8.4516	0	1.3736	
70	0.0465	0	0.3979	0.8242	0	
71	0	0	0	0.0788	0.0182	
72	0	0.3317	0.0283	0.0061	0.0242	
73	0	0.425	0	0	0	
74	0	0.3317	0.0283	0.0061	0.0242	
75'	0	0.425	0	0	0	

JALINGO PENTADE VALUE

pentade	1998	1999	2000	2001	2002	2003
1	0	0.1567	0.1564	0.4242	0	0
2	0.4707	0	0.0104	0.0202	0.0108	0
3	0	0	0.0156	0	0	2.9196
4	0	0.4915	0.7454	0	0	1.6427
5	0	2.4924	0.5499	0	0	0
6	0	2.4782	0	0	0	0
7	0	0.2903	0	1.1878	1.8361	0
8	0	1.8766	0.3806	0	0.5642	0
9	0.6538	0.1192	0	0.3091	0.7866	0
10	0	12.3322	0	0.1939	0	0.4808
11	0	0	0	0.5211	0	0.2202
12	0.181	0.0156	1.3701	1.7163	1.0248	0.0606
13	0.2573	0.6596	0	0.0161	1.1106	0.7649
14	0.0141	2.3466	0	0	0.9411	0.5676
15	0.7932	15.0183	1.1661	0.6316	0.0446	0.5008
16	0.5499	1.9356	9.4631	0	10.9767	0.4796
17	0.839	0.6799	0.268	1.3034	1.1687	1.5511
18	0.342	2.5192	0.0402	0.3178	2.9349	3.4968
19	5.6442	15.9087	3.9627	24.2778	2.6521	14.1909
20	1.3681	9.5954	14.3574	0	30.292	34.3558
21	0.308	9.5858	31.3061	28.4088	24.9254	35.6767
22	8.3267	12.3724	21.0845	40.4298	21.6315	33.6904
23	23.6908	18.3509	28.2801	25.4263	23.2175	37.2245
24	40.183	18.0614	24.0683	13.192	9.6576	9.5132
25	24.8936	7.2167	35.0188	28.3943	34.1379	0.0939
26	16.5358	42.4976	19.713	31.5342	28.8856	1.0333
27	26.2638	86.3635	11.4883	34.4622	13.1238	17.2288
28	28.9398	46.1825	40.3907	14.0044	24.7022	48.4828
29	23.6305	35.365	31.5081	27.5511	21.4715	42.2042
30	18.6423	14.6934	33.8572	25.2883	24.1701	30.9475
31	30.2774	32.3096	40.3113	28.8089	34.4392	67.2224
32	28.1589	11.4241	42.046	27.1015	41.348	31.6328
33	22.1376	41.5484	23.9122	26.7854	33.2969	34.3031
34	31.4737	39.6753	46.1196	35.8323	40.1871	42.3696
35	25.3134	13.1674	35.5629	66.2679	27.5602	56.5901
36	29.1093	36.195	39.9788	32.8455	33.221	18.3303
37	9.1936	26.447	54.2376	56.1174	48.1323	56.7331
38	28.9836	37.3299	41.3992	31.4599	32.5958	45.4911
39	35.9103	43.6863	37.6193	8.6588	41.0325	49.5632
40	42.398	32.193	24.9489	53.8027	27.9328	60.4331
41	44.6741	23.2799	31.5128	34.6685	50.4704	38.6204
42	23.0273	26.2294	40.4033	38.9769	51.0534	16.6211
43	20.9272	28.1297	76.4547	27.5147	36.8157	35.4629
44	16.3775	9.81	39.0847	13.5265	57.0076	50.0481
45	66.284	26.1029	60.0935	29.4578	13.9828	55.2013
46	74.6442	67.1358	46.0076	24.194	21.1918	23.9783
47	54.8204	42.3882	55.7743	19.5016	60.5898	24.1462
48	37.8925	63.3637	61.7286	64.1873	52.3565	48.0558
49	35.4555	51.7877	37.654	20.2243	54.9302	45.1253

50	59.7242	84.7484	29.7259	29.5883	41.8232	45.2139
51	34.3007	48.3146	44.2465	41.2591	77.3368	50.3771
52	61.8011	47.7314	48.4481	40.9436	36.693	57.5379
53	66.6865	26.5838	30.7111	28.223	63.3688	43.2318
54	45.5406	62.8521	44.3971	89.6603	32.2998	52.3826
55	39.7153	44.792	39.6063	26.2122	38.1056	34.5196
56	37.302	51.0215	39.683	23.3698	20.8549	
57	34.7289	56.405	53.1723	49.7591	30.4199	
58	43.1825	40.22	20.5268	57.7077	26.0958	
59	61.5398	27.0557	12.3884	9.336	23.5391	
60	3.2725	25.7834	14.8675	4.678	4.8864	
61	0.1209	23.3514	1.4474	0	5.6142	
62	0.2746	0.5049	0.0247	0	16.3885	
63	0.245	0.8179	5.7608	0	0.2379	
64	7.8356	0	3.1743	0	1.41	
65	1.6889	0	0	0.4885	0	
66	1.5255	0.1627	0	0.272	0	
67	0.2079	0	0.2252	0	0.7223	
68	0.0089	0	0.0129	0	0.0989	
69	0	0	2.1285	0	0.0829	
70	1.6757	0	0.4287	0	0.0687	
71	0	0	0.6323	0.38	0.3151	
72	0.003	0.2921	0	0	0.1434	
73	0	0	0	0	0	
74	0.003	0.2921	0	0	0.1434	
75	0	0	0	0	0	

KADUNA PENTADE VALUE

pentade	1998	1999	2000	2001	2002	2003
1	0	0.0239	0	0.6685	0	0.4694
2	0.163	0	0.1865	0.071	0	0
3	2.8544	0	0	0	0	1.0339
4	0	0.2445	0.4721	0	0	0.7308
5	0	0.2924	0	0	0	0.612
6	0	0.0744	0	0	0.0202	0.6714
7	0.0597	0.3038	0	0.0285	0.1212	0
8	0	0	0	0.0127	0	0
9	0.0434	0.1883	0	0	0.7249	0
10	0	2.503	0	0	0	3.6886
11	0	0	0	1.5484	0	0.3919
12	0	0.0061	0	0.1298	5.9509	0.002
13	0.0134	0.3858	0	0	0.0137	0.1147
14	0	5.5327	0	0	8.3763	0.1095
15	2.8093	3.0017	0	0.3336	0.6965	0.0213
16	0	3.5855	1.5982	0	0.5774	0
17	0	0.7191	0.333	5.4918	1.9749	0.0881
18	1.727	0.2666	0.1154	0.0556	3.5443	0.7177
19	0	5.7227	0.5916	20.2768	2.4364	9.4658
20	0.1194	3.3371	0.8436	0	13.0872	12.5656
21	0.2137	9.7727	10.0605	12.4149	20.877	20.8585
22	15.5534	4.5855	8.3296	20.614	12.3631	26.9076
23	12.9674	11.2979	12.1165	31.4371	12.1528	6.2074
24	28.747	7.5588	11.934	27.3594	0.5879	10.5367
25	21.1834	6.4689	43.9974	23.5559	16.8223	0
26	28.9559	48.3251	4.9773	41.3107	22.9233	0.5584
27	8.4463	31.4026	6.4061	42.4398	8.8787	10.1548
28	28.7848	26.8666	51.6782	5.4764	4.2264	37.611
29	18.8454	19.7137	39.6977	2.249	9.7503	29.4105
30	21.4898	37.5643	64.4837	25.6175	34.3211	49.5132
31	53.752	24.1475	56.0921	40.9725	65.7809	49.5599
32	38.4617	12.1367	25.4472	35.5381	57.134	38.8899
33	39.3289	18.415	33.1285	40.0572	53.9762	52.4116
34	48.9234	28.7761	35.0001	21.5783	52.7022	32.4336
35	46.7245	34.3314	32.7034	63.197	50.3528	31.9234
36	37.5106	53.8895	13.0424	44.3712	26.0087	28.977
37	22.7415	66.2199	31.5605	57.4375	49.5613	28.2028
38	36.9873	39.209	57.8783	30.9638	48.8175	54.0879
39	47.1551	46.5511	43.3486	29.6242	29.5043	58.6937
40	69.1729	51.9787	46.9143	49.7414	52.8571	55.018
41	43.2975	66.7837	41.9705	43.4315	57.1935	28.1563
42	40.0193	34.7286	54.0725	62.0113	36.5404	62.5109
43	19.5422	40.1438	36.5804	31.0208	61.7905	56.1995
44	56.469	21.2327	75.2001	35.2901	30.2478	30.5358
45	68.7751	25.7781	64.6822	39.4925	52.3969	48.1753
46	58.1912	49.9064	83.0048	13.0434	36.3012	67.6712
47	67.3197	64.1361	86.6225	33.7696	61.5509	63.2551
48	30.5551	36.5018	68.361	61.1318	78.6925	62.568
49	56.8898	58.3892	52.2031	55.5889	62.8375	65.8111

50	85.6434	62.7087	58.205	35.0523	70.7418	77.6987
51	49.2401	44.521	96.3201	57.8792	49.6387	79.7013
52	63.0191	56.1274	51.1034	45.3505	58.4873	36.7923
53	47.2042	50.6911	48.2532	70.426	56.997	65.9093
54	41.7083	66.8138	35.451	40.8439	41.7621	61.5691
55	51.5257	50.2446	47.002	51.3672	30.4509	
56	62.2827	50.2281	23.5639	38.1447	23.348	
57	56.6059	34.8552	33.3742	31.4346	20.6893	
58	53.7946	22.5205	45.4777	15.8168	18.069	
59	28.9924	2.0614	2.7806	0	12.9954	
60	10.4831	8.5353	3.5862	0	0.7161	
61	0	0.0067	1.6697	0	4.563	
62	0	0.0767	0.6303	0	2.6608	
63	1.2201	3.7462	0	0	0.3987	
64	0.6221	0	0.0121	0	0	
65	0.305	0	0.3252	0	0	
66	0.6484	0	0	0	0	
67	0	1.8562	0	0.0027	0.2143	
68	0	0	0	0.737	0.002	
69	0	0	0.9171	1.3909	0.7838	
70	0.4654	0	1.0989	0.3913	0	
71	0	0	0.0222	2.1118	0.1232	
72	0	0.0723	0.808	0	0	
73	0	0	0	0	0	
74	0	0.0723	0.808	0	0	
75	0	0	0	0	0	

KANO PENTADE VALUE

pentade	1998	1999	2000	2001	2002	2003
1	0	0	0.4234	0.749	0	1.561
2	0.628	0	0.0423	2.0521	0	0
3	2.586	0	0	0	0	0.3137
4	0	0.1174	0	0	0	0.7148
5	0	0	0	0	0	0
6	0	1.1346	0	0	0	0.5763
7	3.3632	0	0	0.0899	0.0473	0
8	0	0	2.8229	0.0082	0	0
9	0	0	0	0	0.0725	0
10	0	0.3528	0	0.1736	0	1.3857
11	0	0	0	1.9156	0	0.002
12	0	0	0	1.4438	1.3297	0
13	0	0	0	0	0.5353	0.3053
14	0	0.0341	0	0.0081	4.2986	0.0467
15	0.0215	0.6949	0	2.5095	0.1273	0.1682
16	0	0.0512	1.2799	0	0	0.3426
17	0	0	0.0076	10.5787	2.329	0.0934
18	4.9183	0.1432	0	0.0807	1.4766	0
19	0.2306	0.3676	0	0.3139	0	11.0963
20	3.0568	0.7837	0	0.0124	3.0725	3.0339
21	0	0.1656	0.0171	1.3269	1.7473	9.7341
22	5.2334	0.0182	0.0114	1.2212	1.9797	9.2161
23	14.0022	1.1009	1.3064	14.0304	0.9089	0.0034
24	28.4897	1.1999	0	16.4886	1.3271	0.3095
25	2.6315	0	4.944	17.1025	0.2046	0
26	6.741	0.5454	0	6.2549	0.0819	0
27	0.1261	1.8134	0	26.6079	0.2354	0.05
28	4.873	0	0	0.1316	0.1509	11.5033
29	2.9653	24.1838	1.6529	0.4343	3.7684	9.9764
30	4.6745	10.668	27.0033	11.9266	4.4567	41.1054
31	40.9361	2.8933	14.4623	21.7483	34.9309	33.2215
32	31.8007	0.1923	21.3868	27.7916	22.7392	1.6707
33	29.2284	0.2316	10.5251	25.4046	20.6467	27.2441
34	38.4496	7.2637	26.5995	17.6358	25.2552	24.7382
35	30.4373	9.1736	9.5461	51.1059	12.7383	23.6973
36	19.2819	24.8635	10.525	25.7088	10.5573	14.8169
37	15.408	44.4456	15.0921	33.082	28.8251	34.1384
38	18.6447	36.0044	26.6958	23.7992	20.6212	57.3854
39	49.4774	37.7925	36.6971	29.4635	39.3153	25.7538
40	40.5621	44.0545	19.8901	28.2359	48.3106	40.0238
41	39.0064	60.9051	44.9968	54.4401	19.5689	15.993
42	27.431	32.4503	39.1153	44.6406	34.3645	46.8085
43	21.035	48.0503	35.8275	29.3272	29.1936	28.023
44	53.209	27.8725	31.3337	26.5661	31.2087	43.8544
45	51.0085	27.1301	42.4378	38.254	32.5602	44.5717
46	30.998	21.5441	54.9763	48.4151	30.3777	64.347
47	63.5265	48.3139	41.4074	40.961	34.9524	62.1315
48	31.6681	16.8807	42.7428	59.5921	36.7402	50.9456
49	28.8996	37.636	13.1155	39.2807	28.9908	59.7047

50	74.61	28.6486	25.707	34.108	47.2075	42.9986
51	5.919	18.1474	48.2685	20.0313	64.1297	37.4618
52	32.107	16.2921	31.2817	15.7743	14.3033	29.3389
53	37.7224	32.9591	6.701	20.3534	25.2743	29.324
54	6.9319	12.7563	10.3808	19.9704	27.3055	23.0494
55	0.8472	26.3893	5.3112	0.0609	24.5891	0.6483
56	0.6039	25.5351	18.6132	0.0826	31.1284	
57	24.0099	6.7715	20.7434	0.1789	2.9763	
58	19.3413	6.2691	1.0826	0	10.986	
59	0	0	0	0	2.1705	
60	0	0	0	0	0.5933	
61	0	0	1.6588	0	1.9529	
62	0.0172	0.1333	0.3297	0	1.0837	
63	0	0.0465	0	0	0.587	
64	2.0615	0	0	0	0	
65	1.3972	0	0.0347	0	0	
66	0.8046	0	0	0.5485	0	
67	0.1661	0.0404	0	0.2572	0.5419	
68	0	0	0.198	0.4375	0.0343	
69	0.0686	0	1.6766	0.0409	1.2242	
70	0.6356	0	0.1616	0.4087	0	
71	0.2378	0	0	1.536	0	
72	0	0	0.2444	0	0	
73	0	0	0	0	0	
74						
75						

KATSINA PENTADE VALUE

pentade	1998	1999	2000	2001	2002	2003
1	0	0.303	2.1064	0.1397	0	0
2	0.4291	0	0.0327	3.417	1.5004	0
3	0.0526	0	0	0	0	0.0123
4	0	0.0202	0	0	0	0.0221
5	0	0	0.6112	0	0	0
6	0	0.8888	0	0	0	0
7	0.4867	0	0	0	0.0384	0
8	0.1156	0	4.4147	0	0	0
9	0.9612	0	0	0	0	0
10	0	0.9928	0	0	0	0.4403
11	0	0	0	0.5555	0.0162	0
12	0	0.2308	0	0.7535	0.0606	0
13	0	0	0	0	0	0.0727
14	0	0.3086	0	2.7081	2.5917	0.101
15	0.2797	0.73	0	0.5671	0	0.0161
16	0	0.0276	0.7705	0.0058	0.0182	1.006
17	0.0959	0	0	0.162	1.6564	0
18	0.8683	0.06	0	0	1.3796	0
19	0.1217	0.1333	0	0.0183	0.0525	3.1378
20	1.3723	1.3555	0.0444	0	0.2262	4.1934
21	0	0.0586	0	0.7841	5.351	3.3149
22	0.9432	0	0.0028	1.2151	2.9554	8.4698
23	0.639	0.2565	1.8905	8.4599	0.1253	0.0904
24	21.5671	0.3636	0	4.5187	0	0.206
25	4.8709	0	0	16.8584	0.334	0
26	5.3303	0.2677	0	4.8417	0.03	0
27	1.1985	10.3617	0	26.2774	2.7512	0
28	4.3557	0	0	0.0403	0	2.0485
29	0.014	15.6467	1.0276	0.3538	1.0847	2.315
30	2.5439	13.0488	6.9577	15.9313	1.1223	28.035
31	20.1533	2.362	8.7891	5.0302	14.7577	28.5103
32	15.4573	0.0541	25.3326	7.0315	22.399	0.3348
33	14.9659	0.0541	8.8955	18.2434	22.0334	21.0688
34	29.2574	2.5932	9.254	17.3661	8.7392	36.6258
35	22.526	11.9822	3.9192	33.0325	10.894	26.1623
36	8.5719	16.6618	13.4391	30.867	7.6319	20.2318
37	13.6558	36.9797	15.7398	30.2953	15.9352	29.2638
38	8.8317	24.7545	37.8388	34.5052	16.084	32.6801
39	64.7458	35.3184	42.4872	15.4001	25.6125	21.6418
40	26.4261	46.5769	27.7886	28.7688	31.406	38.6306
41	36.9655	34.7011	55.5866	72.0506	15.2397	25.2223
42	46.1422	50.9676	32.1211	27.5957	30.585	23.403
43	25.7742	31.9055	21.2356	32.6405	30.4135	25.8732
44	54.2898	36.7438	36.8937	24.4328	39.4745	44.5712
45	40.7132	29.3801	11.3577	42.5603	43.6224	30.4777
46	23.4535	28.8714	49.7115	46.2663	45.1266	46.1122
47	45.3503	70.8858	30.5968	31.3462	37.5904	37.6743
48	36.5197	11.4668	26.5648	39.2013	19.517	49.2358
49	21.0138	38.9381	17.7708	52.5402	12.4733	53.0611

50	41.8189	36.9375	8.6761	31.1254	35.0225	35.7787
51	25.3774	26.7723	30.9945	21.5631	36.899	28.5956
52	41.811	22.3258	19.5585	14.8285	11.4488	17.3991
53	25.3531	25.299	0.0898	13.0611	20.1095	20.9907
54	2.5581	19.2054	22.7597	8.8011	14.4496	24.2673
55	3.1243	13.8427	24.3702	9.0101	14.2208	
56	0.9493	15.6007	21.0068	0.1035	35.9134	
57	4.3337	0.1721	15.9045	0	7.6407	
58	9.3001	3.8643	0.243	0	5.6619	
59	0	0	2.1736	0	8.2187	
60	0	0	0	0	0.1334	
61	0	0	14.5321	0	0.4965	
62	0	0.2707	0.2821	0	0.0572	
63	0	0	0	0	0.1621	
64	0	0.0444	0	0	0	
65	0.0525	0	0.0036	0	0	
66	0.0081	0	0	0	0	
67	0.099	0.0424	0	0	0.1494	
68	0	0	0.0101	0.7232	0.0344	
69	0.1111	0	0.6303	0	0.8141	
70	0.6617	0	0.1959	0.0606	0	
71	0.0657	0	0.0061	0.0707	0	
72	0	0	0.1212	0	0	
73	0	0	0	0	0	
74	0	0	0.1212	0	0	
75	0	0	0	0	0	

MAIDUGURI PENTADE VALUE

pentade	1998	1999	2000	2001	2002	2003
1	0	0	0	19.0082	0	0
2	0.9009	0	0	0	1.4232	0
3	0	0	0	0	0	0.4444
4	0	0	0	1.6564	0	2.9088
5	0	0	0	0	0	0
6	0	0.197	0	0	0	0.3232
7	0	0	0	0.0545	1.0532	0
8	0	0.0202	2.7364	0	0.3075	0
9	0	0	0	2.325	0.9561	0
10	0	0.6666	0	0.0061	0	5.8552
11	1.2051	0	0	0.7817	0.0982	0
12	0	0	0	0.0519	2.734	0.7023
13	0	0	0	0.0135	1.5187	0.0203
14	0.1505	0	0	0.5662	0	0
15	1.3187	6.5022	0.0202	9.7477	0	0.1627
16	0.005	0	0	0	1.9936	0.4542
17	0	0	0	1.3078	1.7275	0.1085
18	0.005	0.0227	0.1616	0	2.051	0.3593
19	1.6947	1.4025	0	6.5989	0	2.9767
20	0.8705	0.2655	0.0206	0.2357	1.7654	0.014
21	0	3.013	0	3.3473	12.8041	6.5983
22	2.2371	0	0	7.6741	2.1401	2.1542
23	10.5214	0.0346	3.06	5.8292	1.3029	1.4533
24	15.6138	1.1111	0.814	16.3498	0.9544	0
25	7.1976	0	0.6693	16.7168	2.2557	0
26	0.5789	1.3856	0	8.2225	0.5867	0.5302
27	1.84	24.6687	0	20.7853	0.0956	0.8248
28	2.7101	0.8357	10.3664	3.832	0.6954	5.5526
29	4.6717	20.3068	4.7035	0.0737	0.3868	12.6074
30	14.4615	17.7557	24.3026	10.4722	7.9015	14.0459
31	9.0679	11.6145	8.8548	24.5309	30.9969	37.1576
32	27.3103	1.9577	20.3743	19.783	22.9805	8.5598
33	16.8591	5.4513	7.4497	11.1854	13.7525	10.351
34	14.8209	9.9863	27.3495	15.8692	14.9785	33.4326
35	12.9655	21.1461	31.9782	40.892	27.0818	60.3414
36	17.269	14.4292	16.502	43.1305	16.6134	22.9097
37	21.0877	24.8815	38.1554	35.5713	18.722	32.9593
38	26.3939	15.2258	21.9005	42.8145	24.521	64.0765
39	60.5874	36.6859	22.4269	12.2407	20.6611	17.0937
40	50.889	38.4396	59.3627	43.7507	39.1799	82.4124
41	49.0899	56.296	45.0391	60.3092	12.1419	32.537
42	15.8322	50.5781	48.8351	58.9188	41.1224	40.3719
43	34.991	54.4473	49.326	39.6978	53.1497	51.641
44	41.1784	79.1427	35.5053	47.5309	41.2758	85.0849
45	43.7643	27.7543	43.0138	35.7286	7.945	70.9633
46	60.0437	54.4154	80.2215	52.2912	38.9392	66.3482
47	51.1237	25.6704	30.0819	31.5716	49.9503	50.5894
48	30.1164	47.2137	64.2863	40.5932	22.518	76.7125
49	19.114	47.4267	19.3786	25.3755	29.7859	39.3539

50	79.3547	43.7799	23.3829	34.2864	43.7897	28.2048
51	18.1242	12.3582	23.168	39.5823	53.2006	25.2051
52	31.1644	15.7076	42.959	27.6954	24.4228	35.3277
53	36.7976	14.7498	16.3423	20.115	11.4855	20.5322
54	25.8832	36.3673	16.7421	33.7183	20.7619	5.6649
55	10.8779	31.24	24.9151	8.0447	38.8141	1.9899
56	19.6853	31.1109	25.396	0.0813	6.5144	
57	29.9789	10.4435	14.8413	2.6344	2.2724	
58	7.6331	30.1474	0.1847	1.0948	12.1321	
59	0.0268	0.2126	0	0.1069	0.2687	
60	0	0.0283	0	0.1368	0.0202	
61	0	0.0192	0.347	0.0043	1.7453	
62	0	0	0.0363	0	0.5195	
63	0.4186	0.4387	3.5156	0	0.0427	
64	3.3986	0	0	0	0	
65	0.1395	0	0.0545	0	0	
66	1.1663	0	0	2.5375	0	
67	0	0.3363	0.3873	0	4.17	
68	0	0	0.1676	0	0.002	
69	0	0	6.0095	0	0.2747	
70	0	0	0	0.4511	0.0808	
71	0	0	0.5838	0	0.0081	
72	0	0	0.1212	0	0.8524	
73	0	0.5	0	0	0	
74	0	0	0.1212	0	0.8524	
75	0	0.5	0	0	0	

MINNA PENTADE VALUE

pentade	1998	1999	2000	2001
1	0.0182	0	0	0
2	0.0747	0	0.0131	1.398
3	1.713	0	0	0
4	0	3.0785	0.5614	0.0142
5	0	0.579	0	0
6	0	0.1347	0	0
7	0	0.8713	0	0.2028
8	0	0	0	0
9	2.9946	3.8013	0	0
10	0	12.1496	0	0
11	0	0	0	2.2643
12	0	0.4645	0	0.0124
13	0.2735	1.8341	0	0
14	0	5.7672	0	0.0119
15	2.0548	5.1712	0	1.1105
16	0	3.4583	2.0324	0.0158
17	0	0.5333	1.7153	2.0985
18	1.0889	0.3773	4.4507	0.083
19	1.9909	9.2919	2.7625	14.945
20	0.1406	8.5522	6.278	0.0618
21	1.8244	12.7105	20.5731	10.929
22	14.6766	12.065	8.5009	27.5786
23	11.1499	12.734	13.1025	22.8537
24	25.3418	11.4124	7.7091	31.5693
25	28.9214	14.5436	37.8153	20.6822
26	28.6352	46.0748	12.5734	51.7783
27	8.036	31.8179	11.5718	38.1906
28	14.2469	36.4947	24.3689	15.5584
29	21.5395	19.7259	30.2618	4.1488
30	23.491	36.0195	39.2276	17.2024
31	38.824	24.4409	57.48	49.0809
32	38.1557	17.4477	29.2587	42.3776
33	36.7509	22.343	29.512	33.957
34	23.3534	30.1161	39.3221	17.6396
35	44.5465	31.5076	38.8634	34.9243
36	52.9086	56.5342	10.919	47.4264
37	25.2806	48.8695	33.6071	73.0226
38	39.0945	41.2781	35.7875	21.7435
39	28.4257	48.456	19.5283	29.2429
40	57.3368	33.0349	40.4895	45.735
41	30.6316	46.249	23.1379	32.6985
42	24.6244	25.0356	23.0747	34.3191
43	22.4928	36.2605	25.8475	20.4835
44	18.9176	14.6794	57.5892	27.4256
45	61.9344	20.0165	55.8079	34.7372
46	28.4171	52.2359	63.3384	13.5875
47	47.4243	57.3853	83.445	15.3102
48	12.2533	35.3706	78.4851	41.5632
49	41.9379	54.146	34.4236	34.4143

50	52.7576	57.343	45.9454	44.4863
51	47.2984	32.8284	60.8227	83.9638
52	43.8772	78.3661	42.144	38.1703
53	55.0816	52.1508	43.2761	41.9453
54	42.4997	32.3601	41.04	50.391
55	53.1711	38.7788	43.8166	
56	48.0007	49.8718	15.8564	
57	51.7724	66.7012	31.6232	
58	44.5894	41.7419	31.9961	
59	48.0929	19.1857	2.7693	
60	17.5089	22.3299	6.1811	
61	0.3269	1.4824	13.9987	
62	0.0061	0.2719	0	
63	0.1091	3.08	0	
64	0.1151	0	0.0343	
65	0.398	0	0.6525	
66	0.6808	0.0089	0	
67	0	0.8558	0	
68	0.054	0	0.0848	
69	0	0	1.0524	
70	0.6064	0	0.4989	
71	0.2409	0	0.0545	
72	0	0	0.6363	
73	0	0	0	
74				
75				

SOKOTO PENTADE VALUE

pentade	1998	1999	2000	2001	2002	2003
1	0	0.8838	0.7974	0.1415	0	0
2	0	0.0331	0.0109	0.3255	1.1674	0
3	0.035	0	0	0	0	0.0675
4	0	0.5854	0	0	0	0.1261
5	0	0	0	0.0778	0	0
6	0	0.6628	0	0	0	0
7	0.1838	0.9631	0	0	1.2216	0.0283
8	0.0404	0	2.2861	0	0.0061	0
9	0	0	0	0	0	0.0061
10	0	1.8548	0	0.0727	0	3.3107
11	0	0	0	0.105	0	0
12	0	0	0	0.198	0.5737	0.002
13	0	0	0	0	0	0
14	0	0.69	0	0.9082	0.2242	0.9473
15	0.4914	0.2887	0	0.9029	1.1635	0.608
16	0	0.1815	0.5153	0.0321	0	0.7939
17	0.3435	0	0	0	0.1697	0.0606
18	1.3217	0.2978	0	0.2618	1.3534	0
19	0	0.9837	0.3249	0.0222	2.7593	0.1854
20	0.2772	0.3636	1.7357	0	0.2828	7.0064
21	0	0.0243	0	0.6343	9.7243	7.7613
22	1.5178	0	0.0027	1.4584	0.8584	1.0515
23	0.0027	1.21	0	5.6722	0	1.4559
24	9.1116	0.2081	0	1.8624	0.6868	0.8358
25	0.8738	0	1.6254	12.8083	3.3346	0
26	5.1619	0.0106	0	8.2011	0.8292	0
27	5.5959	7.7768	0.0283	19.3726	6.4671	0.4014
28	7.0675	4.0152	0.1334	0	1.3733	11.0397
29	4.314	28.0324	0.3758	3.044	10.4379	3.5577
30	9.6341	23.2353	7.9609	18.2728	1.5883	25.592
31	18.9654	2.8053	14.7738	11.784	27.4682	15.709
32	19.7079	0	26.2343	5.8042	4.8214	11.2165
33	30.4118	1.9918	10.8629	7.0888	24.5365	10.2099
34	15.9038	6.0409	15.8968	35.0156	6.0811	24.1024
35	22.0585	12.1939	6.3105	18.3834	17.4875	22.4456
36	16.5692	16.0934	15.9989	33.861	16.3825	21.9078
37	26.3686	28.5858	16.4572	22.7523	18.9377	8.7575
38	10.8472	21.4708	52.8649	32.1832	12.9966	24.5357
39	38.8704	42.2868	36.646	11.7522	22.4157	29.4955
40	30.5816	48.8451	26.1115	37.3031	21.8328	26.3516
41	37.8393	49.0226	36.5543	74.7274	24.7604	20.8359
42	52.2603	40.6761	37.847	28.0662	40.9325	1.3349
43	35.4059	42.5305	21.8732	16.129	45.9095	24.5277
44	39.061	18.0878	24.1802	27.6633	24.1395	39.4708
45	41.845	41.9869	22.8216	42.6377	21.8928	17.4716
46	21.2976	34.3462	39.544	45.6715	37.4375	33.4419
47	42.3035	58.6347	33.5791	6.6103	32.1464	41.1666
48	26.7158	33.8099	12.1984	23.2093	27.5969	35.1222
49	6.0846	31.1797	12.7583	43.0294	16.9095	50.671

50	34.1877	50.8525	6.9583	27.9653	43.0996	24.3416
51	24.7209	35.4411	30.7553	21.4724	24.2655	26.0775
52	16.2978	24.5152	20.6762	17.3862	22.3057	3.4555
53	17.9296	16.7743	4.497	11.7107	24.0134	25.7868
54	4.328	26.4542	14.4768	9.1691	8.0488	12.2152
55	0.7053	8.1977	16.6089	10.0255	21.8066	0.0969
56	2.8014	14.4995	11.4339	1.574	23.0654	
57	5.3377	0.7807	15.4615	0.054	0.7139	
58	20.3744	17.4448	0.1149	0	15.8427	
59	0	0	13.1842	0	0.8213	
60	0	0	0.0203	0	0.023	
61	0	0	0.3041	0	0.0505	
62	0	0.1575	0.3495	0	0.0465	
63	0	0	0	0	0.0242	
64	0	0.307	0	0	0	
65	0.0747	0	0.1172	0	0	
66	0.2	0	0	0	0	
67	0.202	0	0.0727	0	0	
68	0.004	0	0.0404	0.7272	0.1596	
69	0.0363	0	1.4301	0	0.4363	
70	0.7434	0	2.62	0.3313	0	
71	0	0	0.0364	0.505	0	
72	0	0.0445	0.0606	0.0121	0	
73	0.2586	0	0	0	0	
74	0	0.0445	0.0606	0.0121	0	
75	0.2586	0	0	0	0	

BAUCHI CUMULATIVE PENTADE VALUES

pentade	1998	1999	2000	2001	2002	2003
1	0.1919	0	0	0.2248	0	0
2	0.1919	0	0.174	0.6404	0.0921	0
3	0.1919	0	2.6326	0.6404	0.0921	5.4069
4	0.1919	3.2201	2.7505	0.6404	0.0921	6.681
5	0.1919	5.7608	4.5804	0.6404	0.0921	6.6993
6	0.1969	5.7844	4.5804	0.6404	0.0921	11.6916
7	0.1969	8.4419	4.5804	3.5322	0.0921	11.6916
8	0.2418	8.7263	7.2765	3.5322	0.0921	11.6916
9	0.2418	8.7263	7.2765	3.7459	0.1971	11.6916
10	0.2418	10.3216	7.2765	4.0019	0.1971	14.2852
11	0.4264	10.4949	7.2765	4.9602	0.1971	15.0205
12	0.4264	10.4949	7.2765	6.9274	5.9907	16.9759
13	0.568	11.8416	7.2765	6.9274	6.8364	17.0636
14	3.7085	13.2839	7.2765	7.313	22.0516	17.1184
15	3.7085	22.1333	7.2765	8.5345	22.0516	17.2555
16	3.7403	23.1467	19.7436	9.7704	26.123	17.5981
17	3.7432	25.5735	20.9253	10.1091	30.1795	19.2508
18	4.1729	26.8276	20.931	13.5826	33.8916	19.4755
19	5.4815	38.6381	21.0121	40.1794	34.486	39.2488
20	5.5264	42.198	23.0496	43.0373	53.2542	54.655
21	20.0938	47.048	38.9901	50.9955	82.4014	87.2588
22	43.2727	60.2879	43.2238	75.6254	96.7216	104.0044
23	80.3809	74.5545	65.3086	101.2482	118.1936	120.4994
24	111.5452	89.4724	77.1989	121.1741	126.9123	126.6865
25	157.715	90.7463	101.5163	145.8215	143.4641	127.4133
26	175.9645	141.4802	118.0233	170.8462	154.8238	129.6455
27	198.0505	204.548	128.816	210.2366	163.4852	139.2192
28	235.316	233.5231	157.9545	216.5922	174.1729	185.1144
29	275.9459	253.154	178.6452	232.1021	186.3138	210.422
30	300.1939	287.637	212.5785	255.0912	201.1155	247.2456
31	328.7099	307.3406	244.0134	281.5402	219.3865	292.0553
32	359.9696	328.8868	287.7215	305.7558	246.2841	318.7594
33	378.2826	352.0737	310.695	321.4919	259.6331	362.8983
34	403.455	381.602	333.0966	342.8729	295.4634	388.7381
35	410.091	388.6731	346.3948	396.2848	315.2908	430.298
36	434.8437	425.9091	369.4914	421.7395	360.486	443.2215
37	467.5216	454.5524	392.7288	450.7288	390.9957	465.3078
38	489.1948	482.3319	419.5074	473.8822	417.7418	496.3034
39	509.1174	508.2324	446.34	484.0955	438.5658	511.0965
40	542.0831	538.8112	482.6884	528.2847	448.5669	548.912
41	565.6659	578.4627	520.4348	551.4146	468.1836	582.6555
42	589.3813	614.8232	561.2243	586.6018	508.0528	606.1407
43	625.381	666.1156	609.9584	625.1628	556.3613	627.9135
44	676.5225	713.2652	630.5159	645.6625	580.0781	677.2584
45	711.3201	746.5529	664.2125	675.1029	596.4608	704.698
46	767.4691	786.6239	710.1944	711.6519	613.2264	727.0093
47	793.645	833.6181	744.0543	738.848	668.3851	741.5409
48	830.0208	876.4009	788.9285	799.9732	722.7196	772.2117
49	884.454	934.6126	802.7395	834.6756	736.3912	817.7704

50	902.6206	969.3626	840.0352	856.8516	772.5365	832.1889
51	964.8466	994.7861	882.4528	913.9371	812.661	863.7104
52	1023.736	1010.243	903.7905	946.2199	834.5297	904.2888
53	1085.214	1027.675	917.3235	954.9653	856.7314	934.8153
54	1097.016	1064.32	942.6541	1002.521	890.8372	961.0447
55	1130.431	1095.787	969.4274	1025.481	934.3031	987.5827
56	1136.465	1111.25	989.8309	1034.519	939.3356	
57	1166.253	1148.075	1032.398	1055.714	957.6481	
58	1199.349	1180.569	1049.282	1081.432	972.5336	
59	1199.873	1182.453	1051.041	1082.737	974.9917	
60	1200.659	1199.326	1053.358	1084.514	981.613	
61	1200.736	1201.848	1057.765	1084.514	985.1274	
62	1201.316	1202.004	1058.742	1085.157	992.7394	
63	1205.089	1203.796	1059.51	1085.157	993.2193	
64	1205.089	1203.796	1060.342	1085.157	993.2193	
65	1205.335	1203.796	1060.518	1085.157	993.2193	
66	1205.335	1203.796	1060.518	1085.238	994.3836	
67	1205.335	1203.796	1060.686	1085.288	994.442	
68	1205.335	1203.796	1060.686	1085.288	994.442	
69	1205.382	1203.796	1069.137	1085.288	995.8156	
70	1205.382	1203.796	1069.535	1086.113	995.8156	
71	1205.382	1203.796	1069.535	1086.191	995.8338	
72	1205.382	1204.128	1069.564	1086.198	995.858	
73		1204.553	1069.564	1086.198	995.858	

JALINGO

CUMULATIVE PENTADE VALUES

pentade	1998	1999	2000	2001	2002	2003
1	0	0.1567	0.1564	0.4242	0	0
2	0.4707	0.1567	0.1668	0.4444	0.0108	0
3	0.4707	0.1567	0.1824	0.4444	0.0108	2.9196
4	0.4707	0.6482	0.9278	0.4444	0.0108	4.5623
5	0.4707	3.1406	1.4777	0.4444	0.0108	4.5623
6	0.4707	5.6188	1.4777	0.4444	0.0108	4.5623
7	0.4707	5.9091	1.4777	1.6322	1.8469	4.5623
8	0.4707	7.7857	1.8583	1.6322	2.4111	4.5623
9	1.1245	7.9049	1.8583	1.9413	3.1977	4.5623
10	1.1245	20.2371	1.8583	2.1352	3.1977	5.0431
11	1.1245	20.2371	1.8583	2.6563	3.1977	5.2633
12	1.3055	20.2527	3.2284	4.3726	4.2225	5.3239
13	1.5628	20.9123	3.2284	4.3887	5.3331	6.0888
14	1.5769	23.2589	3.2284	4.3887	6.2742	6.6564
15	2.3701	38.2772	4.3945	5.0203	6.3188	7.1572
16	2.92	40.2128	13.8576	5.0203	17.2955	7.6368
17	3.759	40.8927	14.1256	6.3237	18.4642	9.1879
18	4.101	43.4119	14.1658	6.6415	21.3991	12.6847
19	9.7452	59.3206	18.1285	30.9193	24.0512	26.8756
20	11.1133	68.916	32.4859	30.9193	54.3432	61.2314
21	11.4213	78.5018	63.792	59.3281	79.2686	96.9081
22	19.748	90.8742	84.8765	99.7579	100.9001	130.5985
23	43.4388	109.2251	113.1566	125.1842	124.1176	167.823
24	83.6218	127.2865	137.2249	138.3762	133.7752	177.3362
25	108.5154	134.5032	172.2437	166.7705	167.9131	177.4301
26	125.0512	177.0008	191.9567	198.3047	196.7987	178.4634
27	151.315	263.3643	203.445	232.7669	209.9225	195.6922
28	180.2548	309.5468	243.8357	246.7713	234.6247	244.175
29	203.8853	344.9118	275.3438	274.3224	256.0962	286.3792
30	222.5276	359.6052	309.201	299.6107	280.2663	317.3267
31	252.805	391.9148	349.5123	328.4196	314.7055	384.5491
32	280.9639	403.3389	391.5583	355.5211	356.0535	416.1819
33	303.1015	444.8873	415.4705	382.3065	389.3504	450.485
34	334.5752	484.5626	461.5901	418.1388	429.5375	492.8546
35	359.8886	497.73	497.153	484.4067	457.0977	549.4447
36	388.9979	533.925	537.1318	517.2522	490.3187	567.775
37	398.1915	560.372	591.3694	573.3696	538.451	624.5081
38	427.1751	597.7019	632.7686	604.8295	571.0468	669.9992
39	463.0854	641.3882	670.3879	613.4883	612.0793	719.5624
40	505.4834	673.5812	695.3368	667.291	640.0121	779.9955
41	550.1575	696.8611	726.8496	701.9595	690.4825	818.6159
42	573.1848	723.0905	767.2529	740.9364	741.5359	835.237
43	594.112	751.2202	843.7076	768.4511	778.3516	870.6999
44	610.4895	761.0302	882.7923	781.9776	835.3592	920.748
45	676.7735	787.1331	942.8858	811.4354	849.342	975.9493
46	751.4177	854.2689	988.8934	835.6294	870.5338	999.9276
47	806.2381	896.6571	1044.668	855.131	931.1236	1024.074
48	844.1306	960.0208	1106.396	919.3183	983.4801	1072.13
49	879.5861	1011.809	1144.05	939.5426	1038.41	1117.255

50	939.3103	1096.557	1173.776	969.1309	1080.234	1162.469
51	973.611	1144.872	1218.023	1010.39	1157.57	1212.846
52	1035.412	1192.603	1266.471	1051.334	1194.263	1270.384
53	1102.099	1219.187	1297.182	1079.557	1257.632	1313.616
54	1147.639	1282.039	1341.579	1169.217	1289.932	1365.998
55	1187.355	1326.831	1381.185	1195.429	1328.038	1400.518
56	1224.657	1377.852	1420.868	1218.799	1348.892	
57	1259.385	1434.257	1474.041	1268.558	1379.312	
58	1302.568	1474.477	1494.567	1326.266	1405.408	
59	1364.108	1501.533	1506.956	1335.602	1428.947	
60	1367.38	1527.316	1521.823	1340.28	1433.834	
61	1367.501	1550.668	1523.271	1340.28	1439.448	
62	1367.776	1551.173	1523.295	1340.28	1455.836	
63	1368.021	1551.991	1529.056	1340.28	1456.074	
64	1375.856	1551.991	1532.231	1340.28	1457.484	
65	1377.545	1551.991	1532.231	1340.768	1457.484	
66	1379.071	1552.153	1532.231	1341.04	1457.484	
67	1379.279	1552.153	1532.456	1341.04	1458.207	
68	1379.288	1552.153	1532.469	1341.04	1458.305	
69	1379.288	1552.153	1534.597	1341.04	1458.388	
70	1380.963	1552.153	1535.026	1341.04	1458.457	
71	1380.963	1552.153	1535.658	1341.42	1458.772	
72	1380.966	1552.445	1535.658	1341.42	1458.916	
73	1380.966	1552.445	1535.658	1341.42	1458.916	

KANO

CUMULATIVE PENTADE VALUES

pentade	1998	1999	2000	2001	2002	2003
1	0	0	0	0	0	1.561
2	0.628	0	0.0423	2.0521	0	1.561
3	3.214	0	0.0423	2.0521	0	1.8747
4	3.214	0.1174	0.0423	2.0521	0	2.5895
5	3.214	0.1174	0.0423	2.0521	0	2.5895
6	3.214	1.252	0.0423	2.0521	0	3.1658
7	6.5772	1.252	0.0423	2.142	0.0473	3.1658
8	6.5772	1.252	2.8652	2.1502	0.0473	3.1658
9	6.5772	1.252	2.8652	2.1502	0.1198	3.1658
10	6.5772	1.6048	2.8652	2.3238	0.1198	4.5515
11	6.5772	1.6048	2.8652	4.2394	0.1198	4.5535
12	6.5772	1.6048	2.8652	5.6832	1.4495	4.5535
13	6.5772	1.6048	2.8652	5.6832	1.9848	4.8588
14	6.5772	1.6389	2.8652	5.6913	6.2834	4.9055
15	6.5987	2.3338	2.8652	8.2008	6.4107	5.0737
16	6.5987	2.385	4.1451	8.2008	6.4107	5.4163
17	6.5987	2.385	4.1527	18.7795	8.7397	5.5097
18	11.517	2.5282	4.1527	18.8602	10.2163	5.5097
19	11.7476	2.8958	4.1527	19.1741	10.2163	16.606
20	14.8044	3.6795	4.1527	19.1865	13.2888	19.6399
21	14.8044	3.8451	4.1698	20.5134	15.0361	29.374
22	20.0378	3.8633	4.1812	21.7346	17.0158	38.5901
23	34.04	4.9642	5.4876	35.765	17.9247	38.5935
24	62.5297	6.1641	5.4876	52.2536	19.2518	38.903
25	65.1612	6.1641	10.4316	69.3561	19.4564	38.903
26	71.9022	6.7095	10.4316	75.611	19.5383	38.903
27	72.0283	8.5229	10.4316	102.2189	19.7737	38.953
28	76.9013	8.5229	10.4316	102.3505	19.9246	50.4563
29	79.8666	32.7067	12.0845	102.7848	23.693	60.4327
30	84.5411	43.3747	39.0878	114.7114	28.1497	101.5381
31	125.4772	46.268	53.5501	136.4597	63.0806	134.7596
32	157.2779	46.4603	74.9369	164.2513	85.8198	136.4303
33	186.5063	46.6919	85.462	189.6559	106.4665	163.6744
34	224.9559	53.9556	112.0615	207.2917	131.7217	188.4126
35	255.3932	63.1292	121.6076	258.3976	144.46	212.1099
36	274.6751	87.9927	132.1326	284.1064	155.0173	226.9268
37	290.0831	132.4383	147.2247	317.1884	183.8424	261.0652
38	308.7278	168.4427	173.9205	340.9876	204.4636	318.4506
39	358.2052	206.2352	210.6176	370.4511	243.7789	344.2044
40	398.7673	250.2897	230.5077	398.687	292.0895	384.2282
41	437.7737	311.1948	275.5045	453.1271	311.6584	400.2212
42	465.2047	343.6451	314.6198	497.7677	346.0229	447.0297
43	486.2397	391.6954	350.4473	527.0949	375.2165	475.0527
44	539.4487	419.5679	381.781	553.661	406.4252	518.9071
45	590.4572	446.698	424.2188	591.915	438.9854	563.4788
46	621.4552	468.2421	479.1951	640.3301	469.3631	627.8258
47	684.9817	516.556	520.6025	681.2911	504.3155	689.9573
48	716.6498	533.4367	563.3453	740.8832	541.0557	740.9029
49	745.5494	571.0727	576.4608	780.1639	570.0465	800.6076

50	820.1594	599.7213	602.1678	814.2719	617.254	843.6062
51	826.0784	617.8687	650.4363	834.3032	681.3837	881.068
52	858.1854	634.1608	681.718	850.0775	695.687	910.4069
53	895.9078	667.1199	688.419	870.4309	720.9613	939.7309
54	902.8397	679.8762	698.7998	890.4013	748.2668	962.7803
55	903.6869	706.2655	704.111	890.4622	772.8559	963.4286
56	904.2908	731.8006	722.7242	890.5448	803.9843	
57	928.3007	738.5721	743.4676	890.7237	806.9606	
58	947.642	744.8412	744.5502	890.7237	817.9466	
59	947.642	744.8412	744.5502	890.7237	820.1171	
60	947.642	744.8412	744.5502	890.7237	820.7104	
61	947.642	744.8412	746.209	890.7237	822.6633	
62	947.6592	744.9745	746.5387	890.7237	823.747	
63	947.6592	745.021	746.5387	890.7237	824.334	
64	949.7207	745.021	746.5387	890.7237	824.334	
65	951.1179	745.021	746.5734	890.7237	824.334	
66	951.9225	745.021	746.5734	891.2722	824.334	
67	952.0886	745.0614	746.5734	891.5294	824.8759	
68	952.0886	745.0614	746.7714	891.9669	824.9102	
69	952.1572	745.0614	748.448	892.0078	826.1344	
70	952.7928	745.0614	748.6096	892.4165	826.1344	
71	953.0306	745.0614	748.6096	893.9525	826.1344	
72	953.0306	745.0614	748.854	893.9525	826.1344	
73	953.0306	745.0614	748.854	893.9525	826.1344	

KADUNA

CUMULATIVE PENTADE VALUES

pentade	1998	1999	2000	2001	2002	2003
1	0	0.0239	0	0.6685	0	0.4694
2	0.163	0.0239	0.1865	0.7395	0	0.4694
3	3.0174	0.0239	0.1865	0.7395	0	1.5033
4	3.0174	0.2684	0.6586	0.7395	0	2.2341
5	3.0174	0.5608	0.6586	0.7395	0	2.8461
6	3.0174	0.6352	0.6586	0.7395	0.0202	3.5175
7	3.0771	0.939	0.6586	0.768	0.1414	3.5175
8	3.0771	0.939	0.6586	0.7807	0.1414	3.5175
9	3.1205	1.1273	0.6586	0.7807	0.8663	3.5175
10	3.1205	3.6303	0.6586	0.7807	0.8663	7.2061
11	3.1205	3.6303	0.6586	2.3291	0.8663	7.598
12	3.1205	3.6364	0.6586	2.4589	6.8172	7.6
13	3.1339	4.0222	0.6586	2.4589	6.8309	7.7147
14	3.1339	9.5549	0.6586	2.4589	15.2072	7.8242
15	5.9432	12.5566	0.6586	2.7925	15.9037	7.8455
16	5.9432	16.1421	2.2568	2.7925	16.4811	7.8455
17	5.9432	16.8612	2.5898	8.2843	18.456	7.9336
18	7.6702	17.1278	2.7052	8.3399	22.0003	8.6513
19	7.6702	22.8505	3.2968	28.6167	24.4367	18.1171
20	7.7896	26.1876	4.1404	28.6167	37.5239	30.6827
21	8.0033	35.9603	14.2009	41.0316	58.4009	51.5412
22	23.5567	40.5458	22.5305	61.6456	70.764	78.4488
23	36.5241	51.8437	34.647	93.0827	82.9168	84.6562
24	65.2711	59.4025	46.581	120.4421	83.5047	95.1929
25	86.4545	65.8714	90.5784	143.998	100.327	95.1929
26	115.4104	114.1965	95.5557	185.3087	123.2503	95.7513
27	123.8567	145.5991	101.9618	227.7485	132.129	105.9061
28	152.6415	172.4657	153.64	233.2249	136.3554	143.5171
29	171.4869	192.1794	193.3377	235.4739	146.1057	172.9276
30	192.9767	229.7437	257.8214	261.0914	180.4268	222.4408
31	246.7287	253.8912	313.9135	302.0639	246.2077	272.0007
32	285.1904	266.0279	339.3607	337.602	303.3417	310.8906
33	324.5193	284.4429	372.4892	377.6592	357.3179	363.3022
34	373.4427	313.219	407.4893	399.2375	410.0201	395.7358
35	420.1672	347.5504	440.1927	462.4345	460.3729	427.6592
36	457.6778	401.4399	453.2351	506.8057	486.3816	456.6362
37	480.4193	467.6598	484.7956	564.2432	535.9429	484.839
38	517.4066	506.8688	542.6739	595.207	584.7604	538.9269
39	564.5617	553.4199	586.0225	624.8312	614.2647	597.6206
40	633.7346	605.3986	632.9368	674.5726	667.1218	652.6386
41	677.0321	672.1823	674.9073	718.0041	724.3153	680.7949
42	717.0514	706.9109	728.9798	780.0154	760.8557	743.3058
43	736.5936	747.0547	765.5602	811.0362	822.6462	799.5053
44	793.0626	768.2874	840.7603	846.3263	852.894	830.0411
45	861.8377	794.0655	905.4425	885.8188	905.2909	878.2164
46	920.0239	843.9719	988.4473	898.8622	941.5921	945.8876
47	987.3486	908.108	1075.07	932.6318	1003.143	1009.143
48	1017.904	944.6098	1143.431	993.7636	1081.836	1071.711
49	1074.794	1002.999	1195.634	1049.353	1144.673	1137.522

50	1160.437	1065.708	1253.839	1084.405	1215.415	1215.221
51	1209.677	1110.229	1350.159	1142.284	1265.054	1294.922
52	1272.696	1166.356	1401.262	1187.635	1323.541	1331.714
53	1319.9	1217.047	1449.516	1258.061	1380.538	1397.623
54	1361.609	1283.861	1484.967	1298.904	1422.3	1459.193
55	1413.134	1334.106	1531.969	1350.272	1452.751	
56	1475.417	1384.334	1555.533	1388.416	1476.099	
57	1532.023	1419.189	1588.907	1419.851	1496.788	
58	1585.818	1441.709	1634.384	1435.668	1514.857	
59	1614.81	1443.771	1637.165	1435.668	1527.853	
60	1625.293	1452.306	1640.751	1435.668	1528.569	
61	1625.293	1452.313	1642.421	1435.668	1533.132	
62	1625.293	1452.39	1643.051	1435.668	1535.792	
63	1626.513	1456.136	1643.051	1435.668	1536.191	
64	1627.135	1456.136	1643.063	1435.668	1536.191	
65	1627.44	1456.136	1643.389	1435.668	1536.191	
66	1628.089	1456.136	1643.389	1435.668	1536.191	
67	1628.089	1457.992	1643.389	1435.67	1536.405	
68	1628.089	1457.992	1643.389	1436.407	1536.407	
69	1628.089	1457.992	1644.306	1437.798	1537.191	
70	1628.554	1457.992	1645.405	1438.19	1537.191	
71	1628.554	1457.992	1645.427	1440.301	1537.314	
72	1628.554	1458.064	1646.235	1440.301	1537.314	
73	1628.554	1458.064	1646.235	1440.301	1537.314	

KATSINA

CUMULATIVE PENTADE VALUES

pentade	1998	1999	2000	2001	2002	2003
1	0	0.303	2.1064	0.1397	0	0
2	0.4291	0.303	2.1391	3.5567	1.5004	0
3	0.4817	0.303	2.1391	3.5567	1.5004	0.0123
4	0.4817	0.3232	2.1391	3.5567	1.5004	0.0344
5	0.4817	0.3232	2.7503	3.5567	1.5004	0.0344
6	0.4817	1.212	2.7503	3.5567	1.5004	0.0344
7	0.9684	1.212	2.7503	3.5567	1.5388	0.0344
8	1.084	1.212	7.165	3.5567	1.5388	0.0344
9	2.0452	1.212	7.165	3.5567	1.5388	0.0344
10	2.0452	2.2048	7.165	3.5567	1.5388	0.4747
11	2.0452	2.2048	7.165	4.1122	1.555	0.4747
12	2.0452	2.4356	7.165	4.8657	1.6156	0.4747
13	2.0452	2.4356	7.165	4.8657	1.6156	0.5474
14	2.0452	2.7442	7.165	7.5738	4.2073	0.6484
15	2.3249	3.4742	7.165	8.1409	4.2073	0.6645
16	2.3249	3.5018	7.9355	8.1467	4.2255	1.6705
17	2.4208	3.5018	7.9355	8.3087	5.8819	1.6705
18	3.2891	3.5618	7.9355	8.3087	7.2615	1.6705
19	3.4108	3.6951	7.9355	8.327	7.314	4.8083
20	4.7831	5.0506	7.9799	8.327	7.5402	9.0017
21	4.7831	5.1092	7.9799	9.1111	12.8912	12.3166
22	5.7263	5.1092	7.9827	10.3262	15.8466	20.7864
23	6.3653	5.3657	9.8732	18.7861	15.9719	20.8768
24	27.9324	5.7293	9.8732	23.3048	15.9719	21.0828
25	32.8033	5.7293	9.8732	40.1632	16.3059	21.0828
26	38.1336	5.997	9.8732	45.0049	16.3359	21.0828
27	39.3321	16.3587	9.8732	71.2823	19.0871	21.0828
28	43.6878	16.3587	9.8732	71.3226	19.0871	23.1313
29	43.7018	32.0054	10.9008	71.6764	20.1718	25.4463
30	46.2457	45.0542	17.8585	87.6077	21.2941	53.4813
31	66.399	47.4162	26.6476	92.6379	36.0518	81.9916
32	81.8563	47.4703	51.9802	99.6694	58.4508	82.3264
33	96.8222	47.5244	60.8757	117.9128	80.4842	103.3952
34	126.0796	50.1176	70.1297	135.2789	89.2234	140.021
35	148.6056	62.0998	74.0489	168.3114	100.1174	166.1833
36	157.1775	78.7616	87.488	199.1784	107.7493	186.4151
37	170.8333	115.7413	103.2278	229.4737	123.6845	215.6789
38	179.665	140.4958	141.0666	263.9789	139.7685	248.359
39	244.4108	175.8142	183.5538	279.379	165.381	270.0008
40	270.8369	222.3911	211.3424	308.1478	196.787	308.6314
41	307.8024	257.0922	266.929	380.1984	212.0267	333.8537
42	353.9446	308.0598	299.0501	407.7941	242.6117	357.2567
43	379.7188	339.9653	320.2857	440.4346	273.0252	383.1299
44	434.0086	376.7091	357.1794	464.8674	312.4997	427.7011
45	474.7218	406.0892	368.5371	507.4277	356.1221	458.1788
46	498.1753	434.9606	418.2486	553.694	401.2487	504.291
47	543.5256	505.8464	448.8454	585.0402	438.8391	541.9653
48	580.0453	517.3132	475.4102	624.2415	458.3561	591.2011
49	601.0591	556.2513	493.181	676.7817	470.8294	644.2622

50	642.878	593.1888	501.8571	707.9071	505.8519	680.0409
51	668.2554	619.9611	532.8516	729.4702	542.7509	708.6365
52	710.0664	642.2869	552.4101	741.2987	554.1997	726.0356
53	735.4195	667.5859	552.4999	757.3598	574.3092	747.0263
54	737.9776	686.7913	575.2596	766.1609	588.7588	771.2936
55	741.1019	700.634	599.6298	775.171	602.9796	
56	742.0512	716.2347	620.6360	775.2745	638.893	
57	746.3849	716.4068	636.5411	775.2745	646.5337	
58	755.685	720.2711	636.7841	775.2745	652.1956	
59	755.685	720.2711	638.9577	775.2745	660.4143	
60	755.685	720.2711	638.9577	775.2745	660.5477	
61	755.685	720.2711	653.4898	775.2745	661.0442	
62	755.685	720.5418	653.7719	775.2745	661.1014	
63	755.685	720.5418	653.7719	775.2745	661.2635	
64	755.685	720.5862	653.7719	775.2745	661.2635	
65	755.7375	720.5862	653.7755	775.2745	661.2635	
66	755.7456	720.5862	653.7755	775.2745	661.2635	
67	755.8446	720.6286	653.7755	775.2745	661.4129	
68	755.8446	720.6286	653.7856	775.9977	661.4473	
69	755.9557	720.6286	654.4159	775.9977	662.2614	
70	756.6174	720.6286	654.6118	776.0583	662.2614	
71	756.6831	720.6286	654.6179	776.129	662.2614	
72	756.6831	720.6286	654.7391	776.129	662.2614	
73	756.6831	720.6286	654.7391	776.129	662.2614	

MAIDUGURI *CUMULATIVE PENTADE VALUES*

pentade	1998	1999	2000	2001	2002	2003
1	0	0	0	19.0082	0	0
2	0.9009	0	0	19.0082	1.4232	0
3	0.9009	0	0	19.0082	1.4232	0.4444
4	0.9009	0	0	20.6646	1.4232	3.3532
5	0.9009	0	0	20.6646	1.4232	3.3532
6	0.9009	0.197	0	20.6646	1.4232	3.6764
7	0.9009	0.197	0	20.7191	2.4764	3.6764
8	0.9009	0.2172	2.7364	20.7191	2.7839	3.6764
9	0.9009	0.2172	2.7364	23.0441	3.74	3.6764
10	0.9009	0.8838	2.7364	23.0502	3.74	9.5316
11	2.106	0.8838	2.7364	23.8319	3.8382	9.5316
12	2.106	0.8838	2.7364	23.8838	6.5722	10.2339
13	2.106	0.8838	2.7364	23.8973	8.0909	10.2542
14	2.2565	0.8838	2.7364	24.4635	8.0909	10.2542
15	3.5752	7.386	2.7566	34.2112	8.0909	10.4169
16	3.5802	7.386	2.7566	34.2112	10.0845	10.8711
17	3.5802	7.386	2.7566	35.519	11.812	10.9796
18	3.5852	7.4087	2.9182	35.519	13.863	11.3389
19	5.2799	8.8112	2.9182	42.1179	13.863	14.3156
20	6.1504	9.0767	2.9388	42.3536	15.6284	14.3296
21	6.1504	12.0897	2.9388	45.7009	28.4325	20.9279
22	8.3875	12.0897	2.9388	53.375	30.5726	23.0821
23	18.9089	12.1243	5.9988	59.2042	31.8755	24.5354
24	34.5227	13.2354	6.8128	75.554	32.8299	24.5354
25	41.7203	13.2354	7.4821	92.2708	35.0856	24.5354
26	42.2992	14.621	7.4821	100.4933	35.6723	25.0656
27	44.1392	39.2897	7.4821	121.2786	35.7679	25.8904
28	46.8493	40.1254	17.8485	125.1106	36.4633	31.443
29	51.521	60.4322	22.552	125.1843	36.8501	44.0504
30	65.9825	78.1879	46.8546	135.6565	44.7516	58.0963
31	75.0504	89.8024	55.7094	160.1874	75.7485	95.2539
32	102.3607	91.7601	76.0837	179.9704	98.729	103.8137
33	119.2198	97.2114	83.5334	191.1558	112.4815	114.1647
34	134.0407	107.1977	110.8829	207.025	127.46	147.5973
35	147.0062	128.3438	142.8611	247.917	154.5418	207.9387
36	164.2752	142.773	159.3631	291.0475	171.1552	230.8484
37	185.3629	167.6545	197.5185	326.6188	189.8772	263.8077
38	211.7568	182.8803	219.419	369.4333	214.3982	327.8842
39	272.3442	219.5662	241.8459	381.674	235.0593	344.9779
40	323.2332	258.0058	301.2086	425.4247	274.2392	427.3903
41	372.3231	314.3018	346.2477	485.7339	286.3811	459.9273
42	388.1553	364.8799	395.0828	544.6527	327.5035	500.2992
43	423.1463	419.3272	444.4088	584.3505	380.6532	551.9402
44	464.3247	498.4699	479.9141	631.8814	421.929	637.0251
45	508.089	526.2242	522.9279	667.61	429.874	707.9884
46	568.1327	580.6396	603.1494	719.9012	468.8132	774.3366
47	619.2564	606.31	633.2313	751.4728	518.7635	824.926
48	649.3728	653.5237	697.5176	792.066	541.2815	901.6385
49	668.4868	700.9504	716.8962	817.4415	571.0674	940.9924

50	747.8415	744.7303	740.2791	851.7279	614.8571	969.1972
51	765.9657	757.0885	763.4471	891.3102	668.0577	994.4023
52	797.1301	772.7961	806.4061	919.0056	692.4805	1029.73
53	833.9277	787.5459	822.7484	939.1206	703.966	1050.262
54	859.8109	823.9132	839.4905	972.8389	724.7279	1055.927
55	870.6888	855.1532	864.4056	980.8836	763.542	1057.917
56	890.3741	886.2641	889.8016	980.9649	770.0564	
57	920.353	896.7076	904.6429	983.5993	772.3288	
58	927.9861	926.855	904.8276	984.6941	784.4609	
59	928.0129	927.0676	904.8276	984.801	784.7296	
60	928.0129	927.0959	904.8276	984.9378	784.7498	
61	928.0129	927.1151	905.1746	984.9421	786.4951	
62	928.0129	927.1151	905.2109	984.9421	787.0146	
63	928.4315	927.5538	908.7265	984.9421	787.0573	
64	931.8301	927.5538	908.7265	984.9421	787.0573	
65	931.9696	927.5538	908.781	984.9421	787.0573	
66	933.1359	927.5538	908.781	987.4796	787.0573	
67	933.1359	927.8901	909.1683	987.4796	791.2273	
68	933.1359	927.8901	909.3359	987.4796	791.2293	
69	933.1359	927.8901	915.3454	987.4796	791.504	
70	933.1359	927.8901	915.3454	987.9307	791.5848	
71	933.1359	927.8901	915.9292	987.9307	791.5929	
72	933.1359	927.8901	916.0504	987.9307	792.4453	
73	933.1359	928.3901	916.0504	987.9307	792.4453	

MINNA

CUMULATIVE PENTADE VALUES

pentade	1998	1999	2000	2001
1	0.0182	0	0	0
2	0.0929	0	0.0131	1.398
3	1.8059	0	0.0131	1.398
4	1.8059	3.0785	0.5745	1.4122
5	1.8059	3.6575	0.5745	1.4122
6	1.8059	3.7922	0.5745	1.4122
7	1.8059	4.6635	0.5745	1.615
8	1.8059	4.6635	0.5745	1.615
9	4.8005	8.4648	0.5745	1.615
10	4.8005	20.6144	0.5745	1.615
11	4.8005	20.6144	0.5745	3.8793
12	4.8005	21.0789	0.5745	3.8917
13	5.074	22.913	0.5745	3.8917
14	5.074	28.6802	0.5745	3.9036
15	7.1288	33.8514	0.5745	5.0141
16	7.1288	37.3097	2.6069	5.0299
17	7.1288	37.843	4.3222	7.1284
18	8.2177	38.2203	8.7729	7.2114
19	10.2086	47.5122	11.5354	22.1564
20	10.3492	56.0644	17.8134	22.2182
21	12.1736	68.7749	38.3865	33.1472
22	26.8502	80.8399	46.8874	60.7258
23	38.0001	93.5739	59.9899	83.5795
24	63.3419	104.9863	67.699	115.1488
25	92.2633	119.5299	105.5143	135.831
26	120.8985	165.6047	118.0877	187.6093
27	128.9345	197.4226	129.6595	225.7999
28	143.1814	233.9173	154.0284	241.3583
29	164.7209	253.6432	184.2902	245.5071
30	188.2119	289.6627	223.5178	262.7095
31	227.0359	314.1036	280.9978	311.7904
32	265.1916	331.5513	310.2565	354.168
33	301.9425	353.8943	339.7685	388.125
34	325.2959	384.0104	379.0906	405.7646
35	369.8424	415.518	417.954	440.6889
36	422.751	472.0522	428.873	488.1153
37	448.0316	520.9217	462.4801	561.1379
38	487.1261	562.1998	498.2676	582.8814
39	515.5518	610.6558	517.7959	612.1243
40	572.8886	643.6907	558.2854	657.8593
41	603.5202	689.9397	581.4233	690.5578
42	628.1446	714.9753	604.498	724.8769
43	650.6374	751.2358	630.3455	745.3604
44	669.555	765.9152	687.9347	772.786
45	731.4894	785.9317	743.7426	807.5232
46	759.9065	838.1676	807.081	821.1107
47	807.3308	895.5529	890.526	836.4209
48	819.5841	930.9235	969.0111	877.9841
49	861.522	985.0695	1003.435	912.3984

50	914.2796	1042.413	1049.38	956.8847
51	961.578	1075.241	1110.203	1040.849
52	1005.455	1153.607	1152.347	1079.019
53	1060.537	1205.758	1195.623	1120.964
54	1103.037	1238.118	1236.663	1171.355
55	1156.208	1276.897	1280.48	
56	1204.208	1326.769	1296.336	
57	1255.981	1393.47	1327.959	
58	1300.57	1435.212	1359.955	
59	1348.663	1454.397	1362.725	
60	1366.172	1476.727	1368.906	
61	1366.499	1478.21	1382.904	
62	1366.505	1478.482	1382.904	
63	1366.614	1481.562	1382.904	
64	1366.729	1481.562	1382.939	
65	1367.127	1481.562	1383.591	
66	1367.808	1481.57	1383.591	
67	1367.808	1482.426	1383.591	
68	1367.862	1482.426	1383.676	
69	1367.862	1482.426	1384.728	
70	1368.468	1482.426	1385.227	
71	1368.709	1482.426	1385.282	
72	1368.709	1482.426	1385.918	
73	1368.709	1482.426	1385.918	

SOKOTO

CUMULATIVE PENTADE VALUES

pentade	1998	1999	2000	2001	2002	2003
1	0	0.8838	0.7974	0.1415	0	0
2	0	0.9169	0.8083	0.467	1.1674	0
3	0.035	0.9169	0.8083	0.467	1.1674	0.0675
4	0.035	1.5023	0.8083	0.467	1.1674	0.1936
5	0.035	1.5023	0.8083	0.5448	1.1674	0.1936
6	0.035	2.1651	0.8083	0.5448	1.1674	0.1936
7	0.2188	3.1282	0.8083	0.5448	2.389	0.2219
8	0.2592	3.1282	3.0944	0.5448	2.3951	0.2219
9	0.2592	3.1282	3.0944	0.5448	2.3951	0.228
10	0.2592	4.983	3.0944	0.6175	2.3951	3.5387
11	0.2592	4.983	3.0944	0.7225	2.3951	3.5387
12	0.2592	4.983	3.0944	0.9205	2.9688	3.5407
13	0.2592	4.983	3.0944	0.9205	2.9688	3.5407
14	0.2592	5.673	3.0944	1.8287	3.193	4.488
15	0.7506	5.9617	3.0944	2.7316	4.3565	5.096
16	0.7506	6.1432	3.6097	2.7637	4.3565	5.8899
17	1.0941	6.1432	3.6097	2.7637	4.5262	5.9505
18	2.4158	6.441	3.6097	3.0255	5.8796	5.9505
19	2.4158	7.4247	3.9346	3.0477	8.6389	6.1359
20	2.693	7.7883	5.6703	3.0477	8.9217	13.1423
21	2.693	7.8126	5.6703	3.682	18.646	20.9036
22	4.2108	7.8126	5.673	5.1404	19.5044	21.9551
23	4.2135	9.0226	5.673	10.8126	19.5044	23.411
24	13.3251	9.2307	5.673	12.675	20.1912	24.2468
25	14.1989	9.2307	7.2984	25.4833	23.5258	24.2468
26	19.3608	9.2413	7.2984	33.6844	24.355	24.2468
27	24.9567	17.0181	7.3267	53.057	30.8221	24.6482
28	32.0242	21.0333	7.4601	53.057	32.1954	35.6879
29	36.3382	49.0657	7.8359	56.101	42.6333	39.2456
30	45.9723	72.301	15.7968	74.3738	44.2216	64.8376
31	64.9377	75.1063	30.5706	86.1578	71.6898	80.5466
32	84.6456	75.1063	56.8049	91.962	76.5112	91.7631
33	115.0574	77.0981	67.6678	99.0508	101.0477	101.973
34	130.9612	83.139	83.5646	134.0664	107.1288	126.0754
35	153.0197	95.3329	89.8751	152.4498	124.6163	148.521
36	169.5889	111.4263	105.874	186.3108	140.9988	170.4288
37	195.9575	140.0121	122.3312	209.0631	159.9365	179.1863
38	206.8047	161.4829	175.1961	241.2463	172.9331	203.722
39	245.6751	203.7697	211.8421	252.9985	195.3488	233.2175
40	276.2567	252.6148	237.9536	290.3016	217.1816	259.5691
41	314.096	301.6374	274.5079	365.029	241.942	280.405
42	366.3563	342.3135	312.3549	393.0952	282.8745	281.7399
43	401.7622	384.844	334.2281	409.2242	328.784	306.2676
44	440.8232	402.9318	358.4083	436.8875	352.9235	345.7384
45	482.6682	444.9187	381.2299	479.5252	374.8163	363.21
46	503.9658	479.2649	420.7739	525.1967	412.2538	396.6519
47	546.2693	537.8996	454.353	531.807	444.4002	437.8185
48	572.9851	571.7095	466.5514	555.0163	471.9971	472.9407
49	579.0697	602.8892	479.3097	598.0457	488.9066	523.6117

50	613.2574	653.7417	486.268	626.011	532.0062	547.9533
51	637.9783	689.1828	517.0233	647.4834	556.2717	574.0308
52	654.2761	713.698	537.6995	664.8696	578.5774	577.4863
53	672.2057	730.4723	542.1965	676.5803	602.5908	603.2731
54	676.5337	756.9265	556.6733	685.7494	610.6396	615.4883
55	677.239	765.1242	573.2822	695.7749	632.4462	615.5852
56	680.0404	779.6237	584.7161	697.3489	655.5116	
57	685.3781	780.4044	600.1776	697.4029	656.2255	
58	705.7525	797.8492	600.2925	697.4029	672.0682	
59	705.7525	797.8492	613.4767	697.4029	672.8895	
60	705.7525	797.8492	613.497	697.4029	672.9125	
61	705.7525	797.8492	613.8011	697.4029	672.963	
62	705.7525	798.0067	614.1506	697.4029	673.0095	
63	705.7525	798.0067	614.1506	697.4029	673.0337	
64	705.7525	798.3137	614.1506	697.4029	673.0337	
65	705.8272	798.3137	614.2678	697.4029	673.0337	
66	706.0272	798.3137	614.2678	697.4029	673.0337	
67	706.2292	798.3137	614.3405	697.4029	673.0337	
68	706.2332	798.3137	614.3809	698.1301	673.1933	
69	706.2695	798.3137	615.811	698.1301	673.6296	
70	707.0129	798.3137	618.431	698.4614	673.6296	
71	707.0129	798.3137	618.4674	698.9664	673.6296	
72	707.0129	798.3582	618.528	698.9785	673.6296	
73	707.2715	798.3582	618.528	698.9785	673.6296	

APPENDIX C

ANNUAL RAINFALL TOTALS

BAUCHI

1998	1169
1999	1175
2000	1040
2001	1065
2002	1086
2003	996

JALINGO

1998	1419
1999	1561
2000	1534
2001	1343
2002	1457
2003	1379

KADUNA

1998	1599
1999	1460
2000	1648
2001	1442
2002	1540
2003	1489

MINNA

1998	1338
1999	1480
2000	1413
2001	1027
2002	-
2003	-

KATSINA

1998	757
1999	720
2000	657
2001	768
2002	663
2003	765

MAIDUGURI

1998	926
1999	913
2000	901
2001	971
2002	793
2003	1055

SOKOTO

1998	704
1999	798
2000	620
2001	686
2002	674
2003	618

KANO

1998	957
1999	744
2000	750
2001	892
2002	826
2003	964

APPENDIX D

BAUCHI

PENTADE	1998	1999	2000	2001	2002	2003
18	-1	-0.997	-1	-0.985	-0.985	-1
19	-1	-0.967	-1	-0.838	-0.983	-0.936
20	-0.997	-0.948	-0.995	-0.815	-0.877	-0.797
21	-0.995	-0.917	-0.951	-0.722	-0.568	-0.546
22	-0.959	-0.803	-0.926	-0.26	-0.293	-0.299
23	-0.843	-0.622	-0.789	0.455	0.245	0.0004
24	-0.619	-0.357	-0.668			0.126
25	-0.24	-0.335	-0.366			
26	0.255	-0.383	-0.079			
27		0.201	0.126			

JALINGO

PENTADE	1998	1999	2000	2001	2002	2003
18	-1	-0.98	-1	-1	-0.99	-0.99
19	-0.983	-0.9036	-0.985	-0.88	-0.96	-0.931
20	-0.976	-0.808	-0.896	-0.88	-0.807	-0.745
21	-0.97	-0.637	-0.628	-0.517	-0.439	-0.295
22	-0.918	-0.325	-0.232	0.058	0.04	0.348
23	-0.801	0.102	0.517			
24	-0.505					
25	-0.149					
26	0.14					

KADUNA

PENTADE	1998	1999	2000	2001	2002	2003
18	-0.997	-0.999	-1	-1	-0.992	-1
19	-0.997	-0.983	-1	-0.933	-0.979	-0.955
20	-0.987	-0.957	-1	-0.933	-0.937	-0.816
21	-0.967	-0.892	-0.975	-0.829	-0.819	-0.579
22	-0.957	-0.836	-0.919	-0.549	-0.687	-0.136
23	-0.869	-0.689	-0.812	-0.259	-0.519	0.024
24	-0.72	-0.539	-0.649	0.3	-0.517	
25	-0.47	-0.399	-0.589		-0.239	
26	-0.015	-0.386	-0.549		0.136	
27	0.14	0.067	-0.486			
28			0.03			

MINNA

PENTADE	1998	1999	2000	2001
18	-0.997	-0.998	-0.98	-0.999
19	-0.99	-0.91	-0.955	-0.953
20	-0.98	-0.678	-0.88	-0.95
21	-0.977	-0.299	-0.744	-0.862
22	-0.948	0.4	-0.6	-0.678
23	-0.86		-0.297	-0.342
24	-0.719		-0.1	0.163
25	-0.414		0.271	
26	0.06			

MONSOON MONITORING INDEX

KATSINA

PENTADE	1998	1999	2000	2001	2002	2003
25	-0.993	-1	-1	-0.946	-1	-1
26	-0.973	-1	-1	-0.916	-1	-1
27	-0.966	-0.985	-1	-0.728	-0.996	-0.996
28	-0.934	-0.98	-1	-0.72	-0.996	-0.986
29	-0.93	-0.94	-0.998	-0.7	-0.992	-0.939
30	-0.914	-0.862	-0.986	-0.522	-0.986	-0.785
31	-0.892	-0.847	-0.953	-0.441	-0.961	-0.785
32	-0.783	-0.84	-0.893	-0.316	-0.878	-0.609
33	-0.647	-0.838	-0.846	0.06	-0.708	-0.336
34	-0.492	-0.832	-0.783		-0.628	-0.053
35	-0.226	-0.732	-0.76		-0.515	0.23
36	-0.116	-0.574	-0.644		-0.426	
37	0.078	-0.562	-0.483		-0.211	
38		-0.339	-0.296		0.054	
39		0.067	0.106			

MAIDUGURI

PENTADE	1998	1999	2000	2001	2002	2003
25	-0.982	-1	-1	-0.92	-0.996	-1
26	-0.98	-0.997	-1	-0.82	-0.994	-1
27	-0.977	-0.934	-1	-0.516	-0.992	-1
28	-0.964	-0.93	-0.975	-0.447	-0.99	-0.987
29	-0.93	-0.789	-0.951	-0.447	-0.988	-0.939
30	-0.86	-0.599	-0.849	-0.187	-0.919	-0.828
31	-0.755	-0.444	-0.779	0.366	-0.898	-0.036
32	-0.62	-0.429	-0.546		-0.751	-0.609
33	-0.407	-0.349	-0.444		-0.634	-0.5
34	-0.181	-0.193	-0.074		-0.483	-0.043
35	0.04	0.237	0.383		-0.118	0.335
36					0.144	

SOKOTO

PENTADE	1998	1999	2000	2001	2002	2003
25	-1	-1	-0.998	-0.94	-0.994	-1
26	-0.987	-0.998	-0.996	-0.83	-0.994	-1
27	-0.95	-0.986	-0.996	-0.59	-0.973	-1
28	-0.896	-0.97	-0.996	-0.59	-0.9666	-0.827
29	-0.842	-0.9057	-0.996	-0.535	-0.92	-0.72
30	-0.75	-0.7634	-0.984	-0.0526	-0.911	-0.913
31	-0.68	-0.7419	-0.942	0.326	-0.829	-0.833
32	-0.409	-0.7419	-0.852		-0.799	-0.758
33	-0.215	-0.7261	-0.784		-0.572	-0.678
34	0.045	-0.6752	-0.658		-0.501	-0.439
35		-0.559	-0.599		-0.274	-0.163
36		-0.379	-0.433		-0.02	0.152
37		-0.27	-0.224		0.31	
38		0.3515	-0.158			
39			0.256			

MONSOON MONITORING INDEX

KANO

PENTADE	1998	1999	2000	2001	2002	2003
25	-0.995	-1	-0.99	-0.943	-1	-1
26	-0.973	-1	-0.99	-0.896	-1	-1
27	-0.973	-0.998	-0.99	-0.692	-1	-1
28	-0.94	-0.998	-0.99	-0.692	-1	-0.978
29	-0.918	-0.956	-0.984	-0.692	-0.995	-0.927
30	-0.865	-0.914	-0.905	-0.538	-0.979	-0.818
31	-0.789	-0.904	-0.804	-0.158	-0.917	-0.568
32	-0.504	-0.904	-0.584	0.44	-0.805	-0.559
33	-0.129	-0.904	-0.451		-0.662	-0.273
34	0.521	-0.865	-0.017		-0.428	0.039
35		-0.804	0.161		-0.294	
36		-0.588			-0.171	
37		-0.445			0.223	
38		-0.066				
39		0.425				

MONSOON MONITORING INDEX

APPENDIX E

ONSET DATES FOR ALL STATIONS

BAUCHI

	MMI	CPT
1998	26	22
1999	27	26
2000	27	21
2001	23	19
2002	23	20
2003	23	19

JALINGO

	MMI	CPT
1998	26	22
1999	23	20
2000	23	20
2001	22	20
2002	22	20
2003	22	19

KADUNA

	MMI	CPT
1998	27	22
1999	27	21
2000	28	25
2001	24	21
2002	26	20
2003	23	21

MINNA

	MMI	CPT
1998	26	22
1999	22	19
2000	26	19
2001	25	21

KATSINA

	MMI	CPT
1998	37	24
1999	39	27
2000	39	30
2001	33	23
2002	38	31
2003	36	30

MAIDUGURI

	MMI	CPT
1998	35	28
1999	35	27
2000	35	29
2001	31	23
2002	36	30
2003	35	28

SOKOTO

	MMI	CPT
1998	34	25
1999	38	28
2000	39	30
2001	31	23
2002	37	30
2003	36	28

KANO

	MMI	CPT
1998	34	32
1999	39	36
2000	35	33
2001	32	31
2002	37	31
2003	34	29

ONSET DATES FOR ALL STATIONS

BAUCHI

	MMI	CPT
1998	26	22
1999	27	26
2000	27	21
2001	23	19
2002	23	20
2003	23	27

JALINGO

	MMI	CPT
1998	26	22
1999	23	20
2000	23	20
2001	22	20
2002	22	20
2003	22	27

KADUNA

	MMI	CPT
1998	27	22
1999	27	21
2000	28	25
2001	24	21
2002	26	20
2003	23	27

MINNA

	MMI	CPT
1998	26	22
1999	22	19
2000	26	19
2001	25	21

KATSINA

	MMI	CPT
1998	37	24
1999	39	27
2000	39	30
2001	33	23
2002	38	31
2003	36	30

MAIDUGURI

	MMI	CPT
1998	35	28
1999	35	27
2000	35	29
2001	31	23
2002	36	30
2003	35	28

SOKOTO

	MMI	CPT
1998	34	25
1999	38	28
2000	39	30
2001	31	23
2002	37	30
2003	36	28

KANO

	MMI	CPT
1998	34	32
1999	39	36
2000	35	33
2001	32	31
2002	37	31
2003	34	29

APPENDIX F

MONSOON QUALITY INDEX

EAR	BAUCHI	JALINGO	KADUNA	MINNA	KATSINA	MAIDUGU	SOKOTO	KANO
1998	0.000845	0.000397	0.00053	0.00062	0.0023	0.00125	0.00164	0.0016
1999	0.00075	0.00013	0.00047	0.000139	0.00314	0.00137	0.00214	0.00325
2000	0.00082	0.000286	0.0006	0.000361	0.00289	0.00148	0.00316	0.00176
2001	0.000372	0.000273	0.00043	0.000824	0.001	0.000517	0.000866	0.000916
2002	0.000359	0.00028	0.00056	-	0.0029	0.00173	0.00204	0.00183
2003	0.00064	0.000514	0.00035	-	0.0019	0.00143	0.00346	0.00158

APPENDIX G

Differences between MMI and CPTD onset dates.

Year	Bauchi	Jalingo	Kaduna	Minna	Katsina	Maiduguri	Sokoto	Kano
1998	4	4	5	4	13	7	9	8
1999	1	3	6	3	12	8	10	7
2000	6	3	3	7	9	6	9	9
2001	4	2	3	4	10	8	8	7
2002	3	2	6	-	7	6	7	8
2003	3	3	3	-	6	7	8	6