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Variation in Onset and Cessation of the Rainy Season in Ibadan, Nigeria

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Abstract
The need to understand changes in rainfall characteristics associated with climate variability and change in tropical Africa has become very important since the livelihoods of a majority of the population depend on climate-sensitive activities. The onset and cessation dates of rainfall is of utmost significance to agriculture in many West African countries because the sector is largely rain-fed. The paper examines annual variations and patterns in the onset and cessation dates; as well as the length of the rainy season in Ibadan for the period 1981-2010. A modification of the method employed by Jolliffe and Saria-Dodd was adopted for the determination of the onset of the wet season. The mean onset date of the rainy season for the study period is the 125th day in the year while the mean cessation date is the 306th day in the year. The determined mean onset date of the rainy season for the period of study is later than that estimated for earlier climatological period. A comparative analysis of the rainy season characteristics for two time slices within the study period, 1981-2000 and 2001-2010, show differences in mean onset and cessation dates for the rainy season and a corresponding reduction in the length of the rainy season during the latter period. The difference between the means of the length of the rainy season during the two periods was shown to be significant. The emerging pattern of the characteristics of the rainy season has important implications for agricultural practice in the region.

Key words: Length of Rainy Season, Onset and Cessation Dates, Rainfall, Rainy Season, Ibadan.

Introduction

Knowledge of changes in rainfall characteristics at the local level and in particular during the wet season is important for agricultural planning and sustainable food production in West Africa because of the strong dependence of agriculture in the region on rainfall [1]. The onset and cessation dates of the rainy season are important characteristics of annual rainfall distribution because these are more closely associated with precipitation effectiveness which is more important to the growing season than annual rainfall totals [2-4]. Huge losses in crop production by peasant farmers have been recorded in West Africa due to wrong interpretation of the true commence-ment of the growing season [5,6]. This has informed the study of the onset and cessation dates of the rainy season using different methods in West africa and different parts of the Nigeria [4, 7-11]. The determination of the onset and cessation dates and the length of the rainy season in Nigeria can however be challenging due to variations in the spatial and temporal pattern of rainfall over the country [9]. Observed changes in rainfall patterns since the later years of the twentieth century which has continued to the present neccessitates the analysis of rainy season characteristics for specific locations in the country.

The study location is Ibadan (Latitude 7° 23' North and Longitude 3° 53' East) located at the rainforest-grassland boundary of south-west Nigeria. Since the early years of its foundation, Ibadan had a large farming population engaged in large scale production of staple crops and cotton [12]. Agricultural activity in the town was enhanced by the favourable climate of a long rainy season which traditionally occurs between March and October when the region is under the influence of the moist south-west monsoon winds originating from the Atlantic Ocean [13]. Notwithstanding the rapid urban growth

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associated with the city, agriculture still remains an important livelihood activity within the city and the surrounding region. Contemporary perception of the rainfall climate by farmers in Ibadan, however, suggest late onset of the rainy season since the last decade of the twentieth century compared to earlier periods [5, 14]. A reliable determination of the true onset of the rainy season is therefore important for a successful agricultural year because of the risk involved in planting too early or too late [7, 15, 16]. Although, farmers have relied on their past experiences and traditional methods to determine the onset of the rainy season, there is need to confirm these perceptions empirically [5, 17]. In the light of the above, the specific objectives of this study are: (i) to examine the inter-annual variations in the onset and cessation dates of, and the length of the rainy season, (ii) determine the mean dates of these characteristics of the rainy season for the period 1981-2010, and (iii) examine any differences in mean onset and cessation dates and length of the rainy season for the period 1981-2000 and 2001-2010.

Determination of the Onset of the Rainy Season

Different methods have been employed to determine the onset and cessation of rainy season in different parts of West Africa [3, 1]. Five approaches have been recognised and employed by earlier investigators to determine onset and cessation dates of the rainy season in Nigeria [4]. These include the Intertropical Discontinuity– rainfall model [18], rainfall-evapotranspiration relation model [19], percentage cumulative mean rainfall model [20, 21], wind shear model [22, 23] and the theta – E technique [24]. The data requirement with respect to measured or estimated values of potential evapo-transpiration for the Benoit (1977) method [19] has been indicated as a major limitation in its widespread application in Nigeria [8]. The method also does not provide a way of knowing when the growing season has ended. Models based on rainfall data alone have been considered to be more efficient in determining the onset and cessation dates of the rainy season [7, 8, 25, 26, 29]. This is because rainfall totals exhibit the most direct relationship rather than some other related factors [1]. The merits and limitations of these models have been described in different studies [e.g 3, 8]. The method of Walter (1967) is considered to give early onset dates [7, 3] while the accumulated rainfall at the start of the growing season and onset according to Ilesanmi (1972) seems quite efficient for determining onset dates[20]; however, the method is cumbersome for handling large amount of data [9].

Data and Methods

A simplified rainfall model derived from Jolliffe and Saria-Dodd's technique for determining the start of the rainy season in tropical climates [25] is adopted for the study. This derived model addresses the limitations of earlier models while taking advantage of the merits of Jolliffe and Saria-Dodd's technique. The annual onset date of the rainy season for Ibadan was determined using daily rainfall records for Ibadan obtained from the archives of the Nigerian Meteorological Agency, Ibadan for the 30 year period (1981-2010). We incorporate the Food and Agricultural Organisation (FAO) threshold of at least 25 mm of rainfall [27] in five consecutive days and 0.25 mm threshold for a rainy day [28]. The use of rainy days yields rainfall onset and retreat dates that are more realistic than those obtained using rainfall amount [29]. The FAO Water Requirement Satisfaction Index (WRSI) considers the rainy season to have been established when a threshold amount of at least 25mm of rainfall is received in the first 10 days (first dekad) followed by a total of at least 20 mm in the next two consecutive dekads.

However, in humid environments the use of five consecutive days (pentad) is considered more acceptable in determining the onset of rains [8, 21, 25, 26, 29, 30]. Jolliffe and Saria-Dodd (1994), [25] outlined the criteria for identifying the onset of the rainy season as a period of five consecutive days (pentad) with the start day and at least

two other wet days producing not less than 25 mm of rainfall. In addition the onset/start date should not be followed by a dry period of seven (7) or more consecutive days in the following 30 days. This criteria reduces the chance of a false start of rain characterised by early rainfall followed by long dry spells. The method also allows for flexibility regarding the definition of the start of rains for different locations [16]. The onset date of the rainy season for individual years is therefore determined using the following criteria:

(i) Observation of a period of five (5) consecutive days with at least 25 mm of rainfall.
(ii) The start day and at least two other days in the period of five days receive rainfall not less than 0.25 mm.
(iii) No dry period of seven days or more occurs in the following 30 days.

The converse of the above defines the date of cessation of the rainy season, i.e.

(i) Observation of a period of five (5) consecutive days with less than 25 mm of rainfall
(ii) Three (3) days of this period are dry i.e. receive rainfall less than 0.25 mm and
(iii) This period is followed by a dry period of at least seven (7) days.

Results and Discussion

Variation in Rainy Season Characteristics (1981-2010)

Changes in the rainy season over Ibadan for the study is observed from results of descriptive statistics of three characteristics of the rainy season – onset and cessation dates, and length of the rainy season (Table 1).

Onset of the Rainy Season

The annual variation of onset of the rainy season derived from the study method is described in Figure 1. The mean date for the onset of the rainy season in Ibadan during the period 1981-2010 is the 125th day of the year (i.e.May 5) with a standard deviation value of 21.73. This date is much later than the mean onset date of the rainy season for the climatological period 1961-2000 estimated at 31st March [30].

The mean onset date for the rainy season for the period 1981-2000 is the 120th day of the year (i.e. April 30) while that for the period 2001-2010 is the 132nd day (May 12). The difference in the mean onset dates for the two periods is however not significant ($P = 0.53$, $P > 0.05$, 2-tail test).

Table 1: Characteristics of Onset and Cessation dates, and Length of Rainy Season in Ibadan (1981-2010)

Period	Onset Date			Cessation Date			Length of rainy season (Days)		
	Mean (Day)	Stdev	CV (%)	Mean (Day)	Stdev	CV (%)	Mean (Day)	Std dev	CV (%)
1981-2010	125	21.73	17.35	306	6.3	2.06	180	20.82	11.54
1981-2000	120	16.60	13.86	305	6.0	1.97	186	21.58	11.61
2001-2010	132	21.70	16.44	307	6.9	2.25	173	13.9	8.06

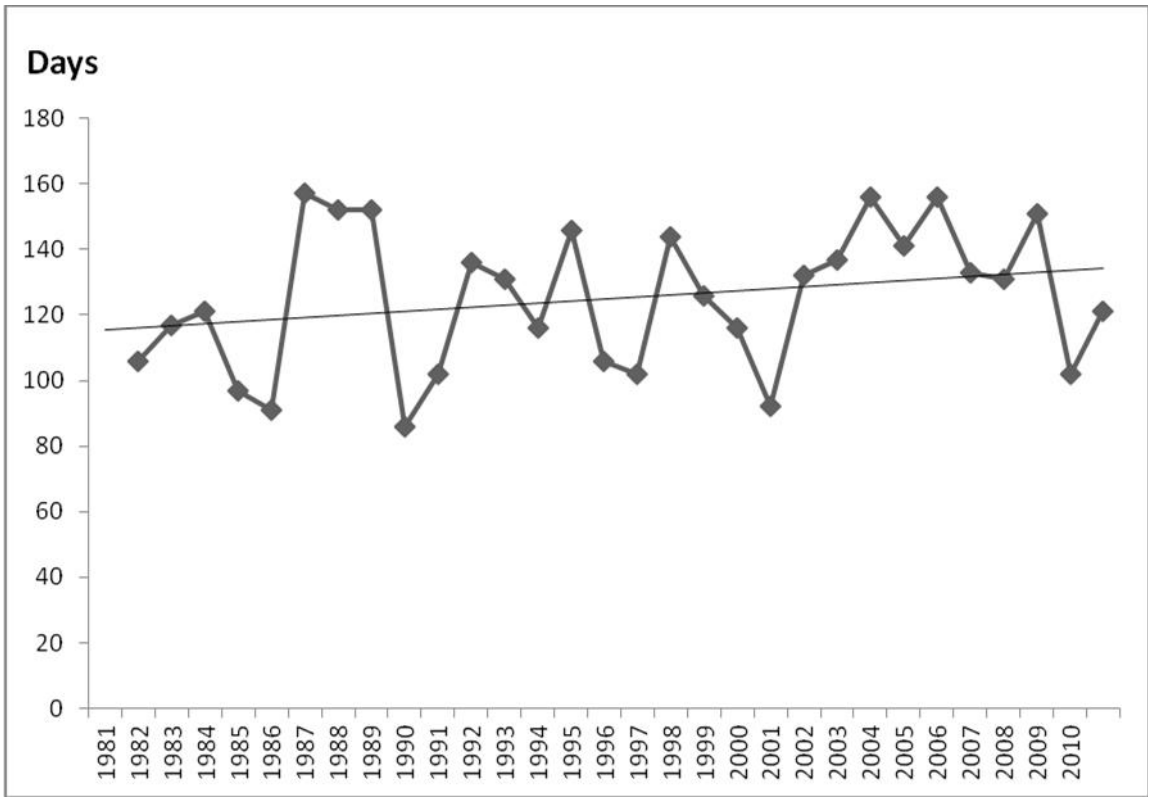

Fig. 1: Annual variation in onset dates of the rainy season in Ibadan (1981-2010).

Cessation of the Rainy Season

The annual variation in the date of cessation of rains during the 1981-2010 period is described in Figure 2. The trend pattern shows that the date of cessation of the rainy season occured later in the year during the latter years compared to the earlier years of the period. The mean date for cessation of the rains (1981-2010) is the 306th day in the year i. e. November 2, (standard deviation is 6.3). This means that the mean cessation date for the rainy season (1981-2010) is later than the mean cessation date estimated at 12th October for the climatological period 1961-2000 [30]. The difference in the mean cessation dates for the earlier years, 1981-2000 (November 1) and the later years, 2001-2010 (November 3) is not significant ($P = 0.33$, $P > 0.05$).

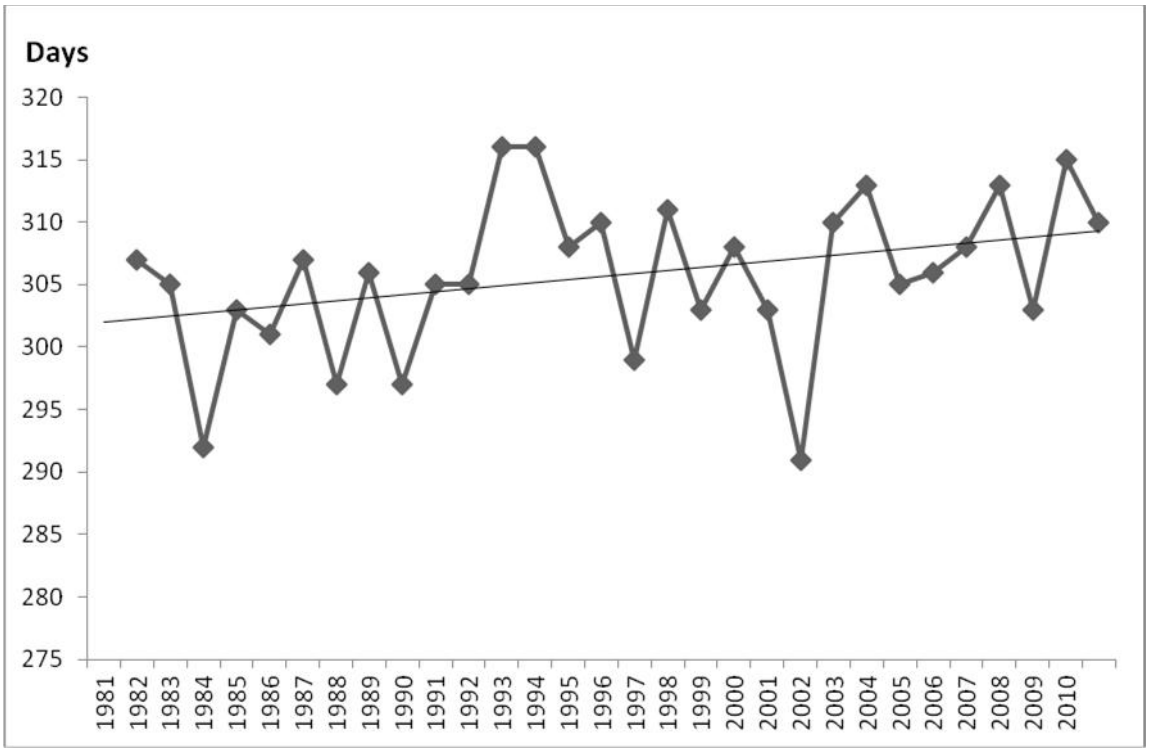

Fig. 2: Annual variation in cessation dates of the rainy season in Ibadan (1981-2010).

Length of the Rainy Season

The length of the rainy season in any given area is influenced by the onset and cessation dates. Variations in the length of the rainy season during the period of study corresponding with annual variations in the onset and cessation dates of the rains is shown in Figure 3. The mean length of rainy season for the 30-year period is 180days (standard deviation 20.8). The overall trend as depicted by the five-year moving average shows a reduction in the length of the rainy season during the 30-year period (Fig. 4). During this period the length of the rainy season ranged between 212 days in 1989 and 146 days in 1987, a difference of 66 days. The mean length of the rainy season for the period 1981-2000 is however 186 days (standard deviation 21.6) while that for 2000-2010 is 173 days (standard deviation 13.9). Although there is a decline in the length of the rainy season between the two periods 1981-2000 and 2001-2010, using the student t-test, the difference is statistically not significant (calculated $t = 1.99 <$ tabulated $t = 2.05$). The correlation coefficient between the length of rainy season and time shows a weak relationship between length of rainy season and time ($r = 0.26$). The overall trend observed in the length of rainy season is also not significant ($p = 0.174$, $p > 0.05$). Annual deviations of the length of the rainy season from the 30-year mean shows that while the earlier time slice (1981-2000) recorded only seven years when the length of the rainy season was below normal, seven of the ten years in the period 2001-2010 recorded length of the rainy season below normal (Fig. 5).

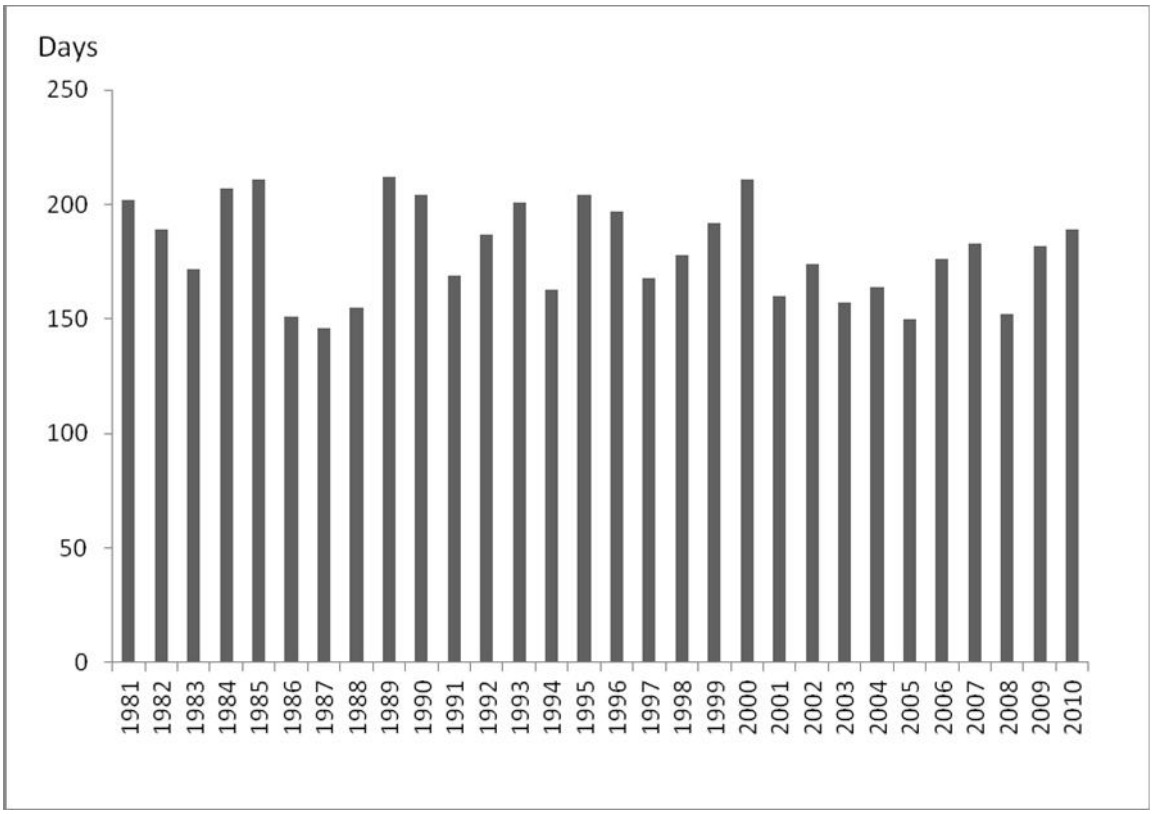

Fig. 3: Annual variation in length of rainy season in Ibadan (1981- 2010).

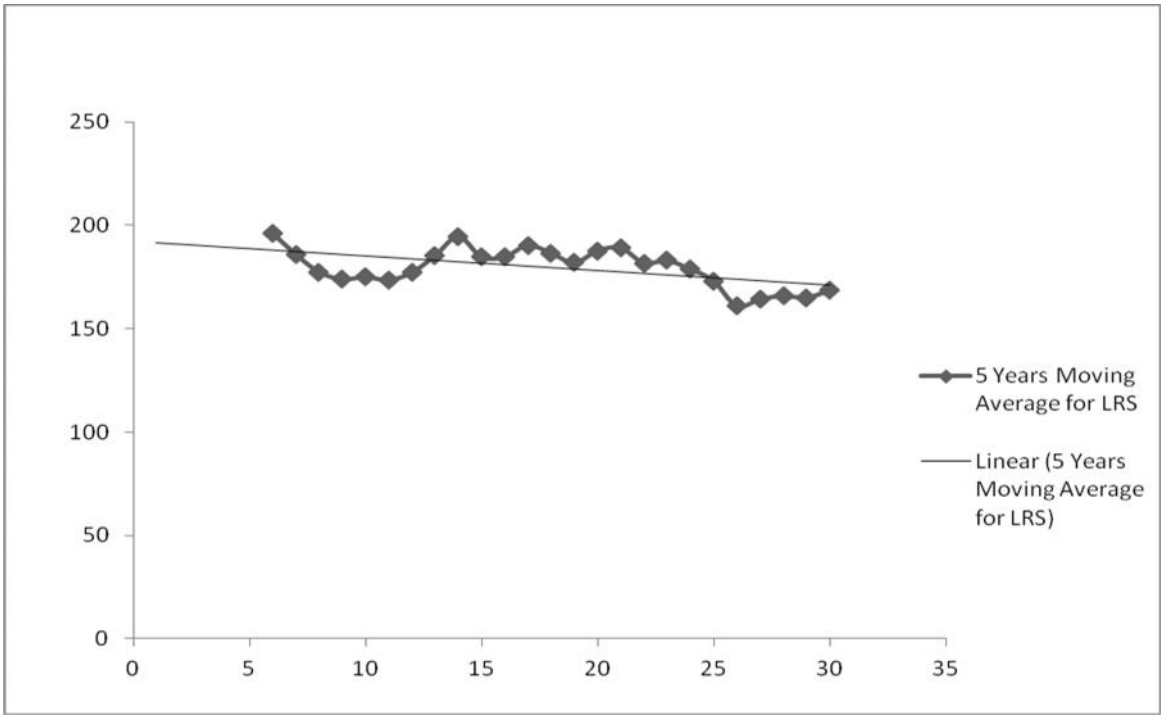

Fig. 4: 5 year moving average for the length of rainy season, LRS (days).

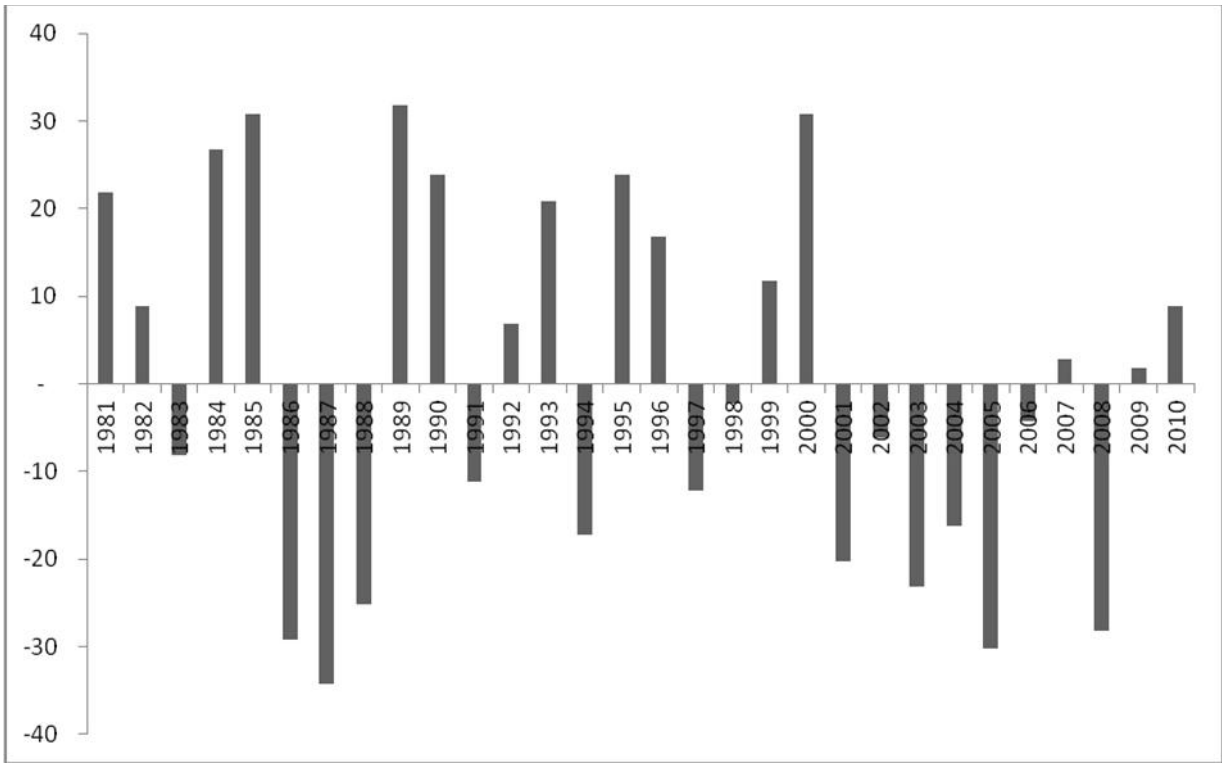

Fig. 5: Annual deviation of length of rainy season from 30-year mean (1981-2010).

Conclusion

The annual variation in onset and cessation dates of the rainy season in Ibadan have been examined using a modification of the method employed by Jollife and Saria-Dodd [25]. Results of analysis show that the onset and cessation dates of the rainy season have extended from 31st March and 12th October for the period 1961-2000 [30] to 5th May and 2nd November respectively during the climatological period 1981-2010. The change in characteristics of the rainy season therefore provides an indication of larger scale processes. The observed changes in the onset and cessation dates of the rainy season and as a consequence shortening of the length of the rainy season during the 30-year period have important implications for the agricultural calendar in the south-west region of the country. There is therefore need to factor these changes into agricultural planning.

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