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The Evolution of the Onset and the Cessation of the Rainy Season in Burkina Faso: A Comparative Study of Two Climatic Conditions

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Abstract

Rainfall is a key variable in agricultural production. In Burkina Faso, it contributes to cereal production, which in turn contributes to food security. Understanding these characteristics is essential for a successful cropping season. The main objective of the study is to analyze changes in the rainy season between 1991 and 2020. To achieve this, the methodology is based on the collection of monthly rainfall data between 1991 and 2020. The data collected was processed by calculating the onset and cessation of the rainy season, as well as the dry periods of the rainy season. The study shows that the onset of the rainy season varies greatly from one decade to the next (1991-2000, 2001-2010, 2011-2020). Conversely, cessation of the rainy season varies very little. In addition, the onset of the rainy season is accompanied by dry periods, which are both increasing and decreasing at the Boromo station. On the other hand, at the Gaoua station, the onset and cessation of the rainy season are followed by dry periods, which are decreasing. It is therefore important that political decision-makers take steps to support farmers in the Boucle du Mouhoun region with seeds that adapt to the new agricultural calendars.

Keywords: *onset of rainy season, cessation of the rainy Season, dry season, Burkina Faso*

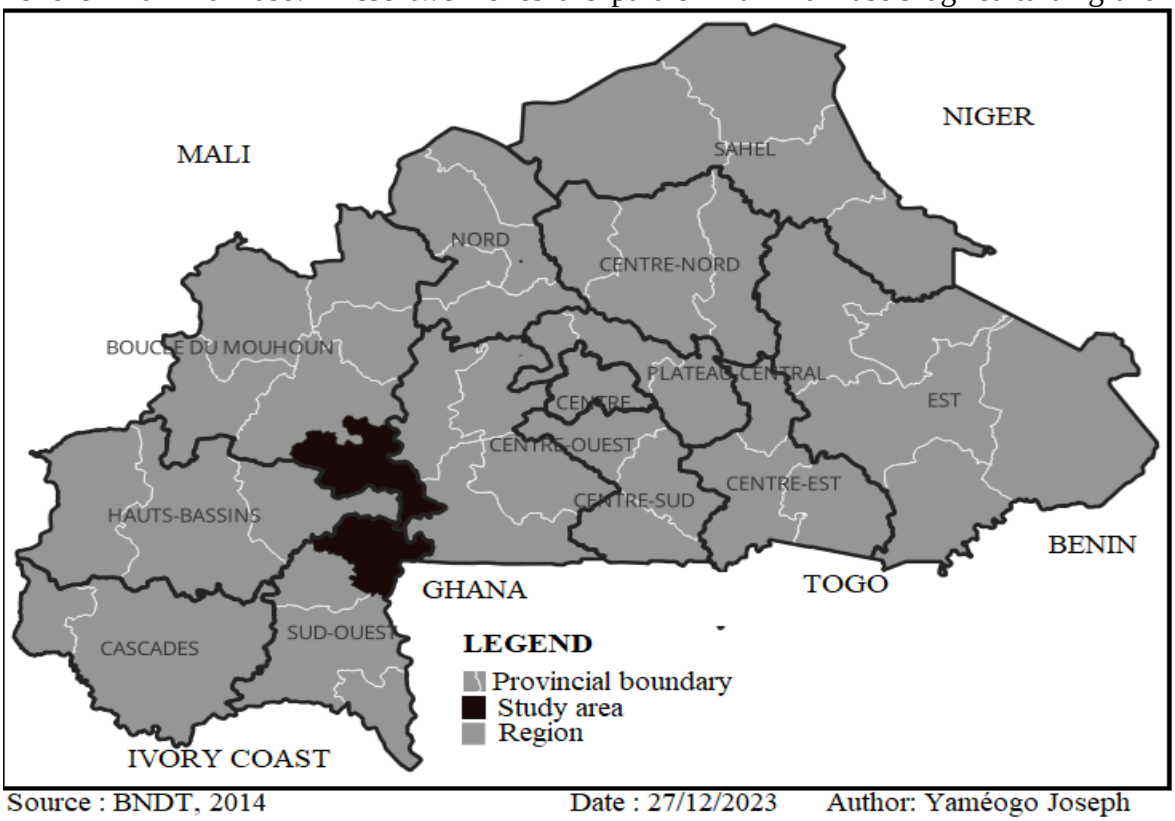
Introduction

Climate variability is a reality in West Africa (Sanogo et al., 2015; Nouaceur & Murarescu, 2020; Ibrahim et al., 2021). The impacts of climate change are expected to be particularly severe in sub-Saharan Africa (El Bilali, 2021). Burkina Faso is no exception (Roncoli et al., 2021). This situation attracts the attention of Burkinabè researchers because the agro-sylvo-pastoral activities of rural populations are intrinsically dependent on rainfall, which was subject to climatic pejorative in the 1970s and 1980s (Nielsen et al., 2019) and to climatic variability today (Yanogo & Yaméogo, 2023; Yaméogo & Yanogo,2023; Rouamba et al., 2023). In this context, numerous studies have focused on the characterisation of rainfall trends (Ibrahim et al., 2012; Borona et al., 2016; Ibrahim et al., 2022), as well as on the evolution of climatic parameters and their impact on rainfed crops (Bambara et al., 2013; D'haen et al., 2014; Bougma et al., 2016; Borona et al., 2021; Sanou et al., 2023). However, very little research has been carried out in Burkina Faso on the onset and cessation of the rainy season and on dry periods. However, the work of Vischel et al. 2015 in West Africa shows that the onset and cessation of the rainy season

are disrupted in Sudano-Sahelian West Africa. Given the importance of the onset and cessation of the rainy season for farmers in Burkina Faso in terms of successful agricultural production, it is therefore imperative to study this issue in order to inform both policymakers and farmers in Burkina Faso. The main objective of the study is to analyze the evolution of the rainy season through the onset and cessation of the rainy season, as well as periods of drought over the period 1990 to 2020.

Presentation of the study area

The study areas are located in the Boucle du Mouhoun and South-West regions of Burkina Faso (Figure 1). These areas have different climatic zones. Indeed, the Boucle du Mouhoun region is located in the Sudano-Sahelian zone, and the South-West region is located in the Sudanian zone of Burkina Faso. These two zones are part of Burkina Faso's agricultural granaries.



Source : BNDT, 2014 Date : 27/12/2023 Author: Yaméogo Joseph

Figure 1: study area

Data and methods

Climate Data

The data come from Burkina Faso's national meteorological agency. They concern monthly rainfall data. The stations considered are the Boromo synoptic station (in the Mouhoun loop) and the Gaoua synoptic station (in the south-west region) (Figure 2). The Boromo synoptic station is located in the Sudano-Sahelian zone, and the Gaoua synoptic station is located in the Sudanian zone (figure 2).

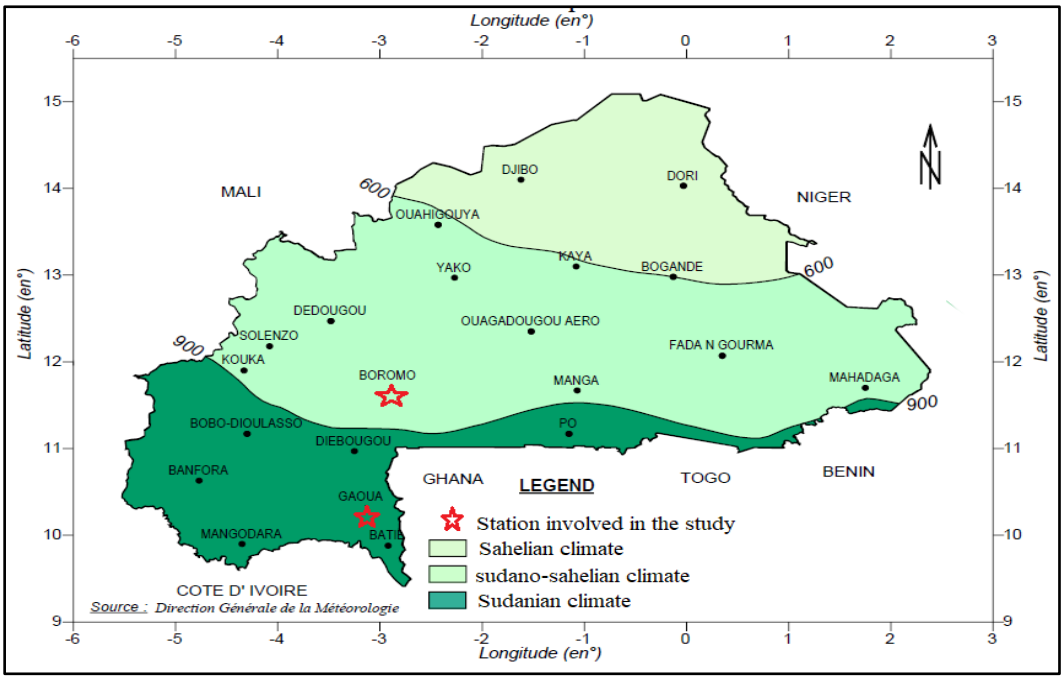


Figure 2: Location of the synoptic stations considered in the study

Methods

It consists of determining the dates of the onset and cessation of the rainy seasons, and the onset and cessation of the dry spells, following a procedure put in place by Burkina Faso's national meteorological agency. The procedure is as follows:

- Calculation of rainy season onset dates

It is calculated from the date after 15 March of the year, from which a cumulative rainfall of at least 20 mm is recorded for 01 to 03 consecutive days and without a dry spell exceeding 20 days during the following 30 days.

- Calculating the dates of the cessation of the rainy season

This is done from the date after 1st September, when a soil capable of holding 70 mm of available water is completely exhausted by a daily evapotranspiration loss of 5 mm.

- Calculation of maximum dry sequence durations

This involves calculating the unconditional dry sequence, which gives the maximum duration of the dry sequence (number of consecutive days without rain (P <= 0.85 mm) based on a given datum and for a given duration.

- Dry sequences at the onset of the season

This involves calculating the longest number of consecutive dry days during the 50 days after the onset of the season.

- Dry sequences at the cessation of the season

The calculation of the longest dry sequences towards the end of the season, i.e. over the period taking into account the critical heading-flowering and crop ripening phases, can be done, for example, from the 50th day after the calculated onset date of the season to the cessation date. To do this, we calculate:
- the length of the season for all years (LS),

- the average length of the rainy season at the station (LS_Av),

- subtract 50 days from the average length of the season (LS_Av-50),

- calculate the dry sequences over the remaining period of the average length of the season (LS_Av-50), from the onset date of the season +50 days (Relative to SDS+50).

The results of the calculations, representing the maximum number of consecutive dry days during the period indicated.

The various calculations of the onset and cessation of the rainy seasons, and the onset and cessation of the dry sequences, were carried out using INSTAT+ software, and then exported to an Excel spreadsheet to produce the graphs and tables.

Results

The onset of the rainy season: strong variability between 1990 and 2020

The onset of the rainy season in the Sudano-Sahelian and Sudanese zones is variable over the period 1990-2020. First, in the decade 1991-2000, the rainy season starts in April, May and June for the Boromo station and in April, March and May for the Gaoua station. Then, in the decade from 2001 to 2010, May and June are more likely to be the onset of the rainy season for the Boromo station, and April and May for the Gaoua station. Finally, in the decade 2011-2020, it is May, June and July that are affected by the rainy season, and March and April for the Gaoua station. Table 2 below summarises the onset of the rainy season for the period 1991-2020.

Table 2: High variability in the onset of rainy seasons between 1991 and 2020

	Years	Month	Colour	Years	Month	Colour	Years	Month	Colour
		The decade 1991-2000			The decade 2001-2010			The decade 2011-2021	
Station of Boromo	1991	16 april	April	2001	16 may	May	2011	12 june	June
	1992	18 may	May	2002	4 june	june	2012	4 july	July
	1993	22 june	June	2003	26 may	May	2013	26 may	May
	1994	27 june	june	2004	13 may	May	2014	23 may	May
	1995	12 may	May	2005	21 may	May	2015	9 june	June
	1996	18 may	May	2006	29 june	June	2016	7 may	May
	1997	30 may	May	2007	22 june	June	2017	1 may	May
	1998	18 april	April	2008	28 june	June	2018	22 june	June
	1999	30 june	June	2009	22 may	May	2019	23 june	June
	2000	21 may	May	2010	23 may	May	2020	5 june	June
	Years	Month	Color	Years	Month	Colour	Years	Month	Colour
		The decade 1991-2000			The decade 2001-2010			The decade 2011-2021	
Stat.	1991	13 april	**April**	2001	23 may	**May**	2011	29 april	April
	1992	25 may	**May**	2002	7 april	**April**	2012	1 may	May

	1993	25 april	**April**	2003	15 may	**May**	2013	25 april	April
	1994	19 april	**April**	2004	19 may	**May**	2014	4 june	June
	1995	25 april	**April**	2005	21 april	**April**	2015	2 may	May
	1996	28 april	**April**	2006	19 may	**May**	2016	27 april	April
	1997	29 march	**March**	2007	1 april	**April**	2017	20 april	April
	1998	22 april	**April**	2008	11 june	**June**	2018	15 june	June
	1999	28 april	**April**	2009	4 may	**May**	2019	25 march	March
	2000	4 april	**April**	2010	30 april	**April**	2020	10 may	May
							2021	30 may	May

Source: Burkina Faso's national meteorological agency, 1991-2020

This table shows that the onset of the rainy season (March-April-May) in the Sudanian zone is earlier than that (April-May-June) in the Sudano-Sahelian zone. Moreover, in the months at the onset of the rainy season, May and June are the most frequent at the Boromo station (table 3. At the Gaoua station, April and May are the months with the highest rainfall frequency.

Table 3: Dominance and occurrence of the onset of the rainy season 1991-2020

	Decade	Dominant months	Occurrence frequency
Station of Boromo	1991-2000	May	50%
	2001-2010	May	60%
		June	40%
	2011-2020	May	50%
		June	50%
	decade	Dominant months	Occurrence frequency
Station of Gaoua	1991-2000	April	80%
	2001-2010	May	50%
		April	40%
	2011-2020	May	40%
		April	40%

Source: Burkina Faso's national meteorological agency, 1991-2020

This table shows that the month of May is the period in the Sudano-Sahelian zone when the rainy season begins during the period from 1991 to 2020.

Cessation of rainy season: low variability 1991 to 2020

The cessation of the wet season in the two climate zones varies only slightly between 1991 and 2020 (Table 4).

Table 4: Little change in the timing of the cessation of the rainy season between 1991 and 2020

	Years	Month	Colour	Years	Month	Colour	Years	Month	Colour
		The decade 1991-2000			The decade 2001-2010			The decade 2011-2021	
Station	1991	17 october	October	2001	2 October	October	2011	2 october	October
	1992	11 october	October	2002	11 august	August	2012	10 october	October
	1993	18 october	October	2003	10 October	October	2013	5 october	October

	1994	16 october	October	2004	28 September	September	2014	15 october	October
	1995	18 september	September	2005	18 October	October	2015	16 october	October
	1996	30 october	October	2006	25 October	October	2016	11 october	October
	1997	28 september	September	2007	1 October	October	2017	4 october	October
	1998	14 october	October	2008	14 October	October	2018	17 october	October
	1999	11 october	October	2009	8 October	October	2019	2 november	November
	2000	11 september	September	2010	28 October	October	2020	25 september	September
	Years	Month	Colour	Years	Month	Colour	Years	Month	Colour
		The decade 1991-2000			The decade 2001-2010			The decade 2011-2021	
Station Gaoua	1991	28 october	October	2001	19 october	October	2011	5 october	October
	1992	9 august	August	2002	28 october	October	2012	19 october	October
	1993	13 october	October	2003	23 october	October	2013	20 october	October
	1994	9 november	November	2004	6 october	October	2014	25 october	October
	1995	30 september	September	2005	14 october	October	2015	23 october	October
	1996	24 october	October	2006	25 october	October	2016	11 october	October
	1997	18 september	September	2007	9 october	October	2017	6 august	August
	1998	16 october	October	2008	4 october	October	2018	30 october	October
	1999	5 november	November	2009	26 october	October	2019	7 november	November
	2000	21 October	October	2010	20 october	October	2020	25 october	October

Source: Burkina Faso's national meteorological agency, 1991-2020

The table shows that October is the cessation of the rainy season at both Boromo and Gaoua stations. The frequency of occurrence confirms this situation. In the Sudano-Sahelian zone, October is the cessation of the rainy season, with 70% of occurrences in the 1991-2000 decade, 80% in the 2001-2010 decade, and 80% in the 2011-2020 decade (Table 5). The same situation is repeated in the Sudanian zone. In the 1991-2000 decade, the cessation of the rainy season occurs during in the month of October (50%), in the 2001-2010 decade, the month of October corresponds to the cessation of the rainy season, and in the 2011-2020 decade, the month of October corresponds to the end of the rainy season (80%). Table 5 below summarizes this situation.

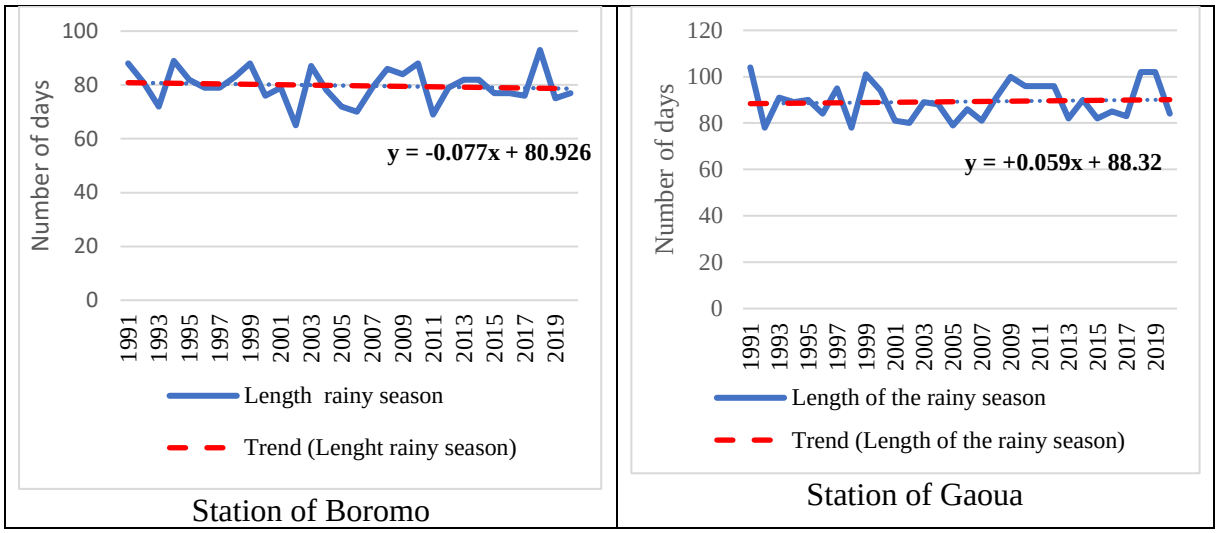
Table 5: Dominance and occurrence of the cessation of the rainy season 1991-2020

	Decade	Dominant months	Occurrence frequency
Station of Boromo	1991-2000	October	70%
	2001-2010	October	80%
	2011-2020	October	80%
	decade	Dominant months	Occurrence frequency
Station of Gaoua	1991-2000	October	50%
	2001-2010	October	100%
	2011-2020	October	80%

Source: Burkina Faso's national meteorological agency, 1991-2020

However, the variability in the onset and cessation of the rainy season has an impact on the length of the rainy season over the period 1991-2021 (Figure 3).

Figure 3: High variability in the length of the rainy season between 1991 and 2020



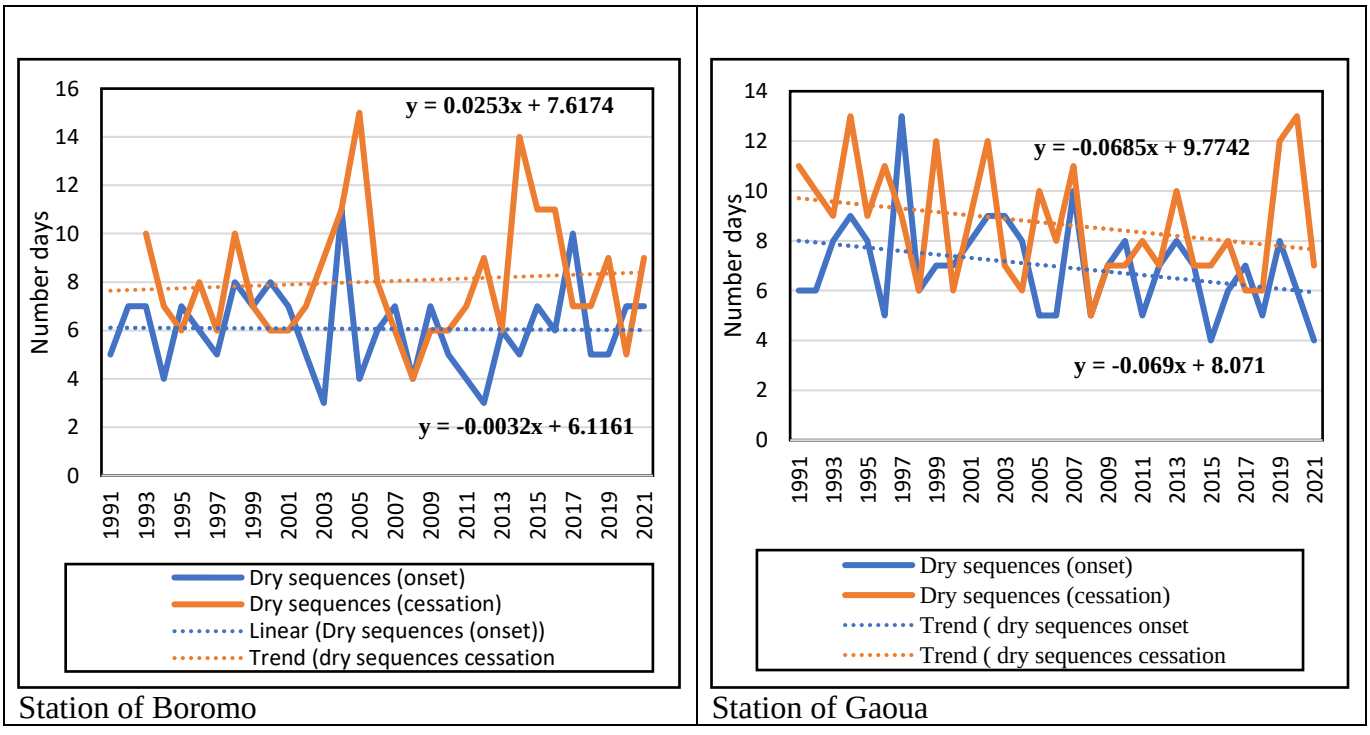
Source: Burkina Faso's national meteorological agency, 1991-2020

Figure 3 shows that the length of the rainy season is decreasing at the Boromo station. However, it is increasing (y=+0.059x+88.32) for the Gaoua station.

Change in rainy season dry sequences between 1991 and 2021

Fluctuations in the onset, cessation and duration of the seasons are accompanied by dry sequences, which are on the increase at the Boromo station and on the decline at the Gaoua station (Figure 3).

Figure 3: Changes in dry sequences between 1991 and 2021



Source: Burkina Faso's national meteorological agency, 1991-2020

This figure shows that in the Sudano-Sahelian zone, the trajectory is upward for dry sequences (onset), and downward for dry sequences (cessation). On the other hand, in the Sudanian zone, the trajectories of the dry sequences (onset) and dry sequences (cessation) are ten decreases.

Discussions

The study of the rainy season showed a high decadal variability of the beginning of the rainy season and a low variability of the end of the rainy season. Our results are consistent with those of other authors in the West African region. For example, in Burkina Faso, Ouédraogo (2013) shows interannual variability at the start and end of the rainy season in Ouahigouya from 1960 to 2012. This observation is shared by Kaboré et al (2015) who note that in the basin of the Massali in the Center region, the variability of the beginning and end of the rainy season has been observed over the last 50 years from 1960 to 2012. Paturel et al (2002) add that a disturbance in monthly precipitation and daily was also observed in Burkina Faso between 1950 and 1999. Ouali (2021), Kabore et al. (2019) also reports an increase in the average duration of dry spells in Burkina Faso. Furthermore, based on regional models, Ibrahim et al. (2013) also predict an increase in the duration of dry periods by around 20% and a delay in the start of the rainy season by an average of one week in the coming years. The reasons for the disruption of the onset and end of the rainy season in Burkina Faso may lie in the amount of water that falls (Lodum et al. (2013). In addition, a shortening of the rainy season due to increasingly dry and hot conditions has been observed in the Sahel region of Africa (Gnanglè et al., 2011). For this reason, Salack et al. (2016) note that the false start of the early end of the rainy season has become, among other things, an indicator of new precipitation patterns in the Sahel.

In Ibadan, Nigeria, a comparison of the periods 1981-2000 and 2001-2010 reveals differences in the average onset and cessation dates of the rainy season and a reduction in the length of the rainy season over the last decade (Adelekan & Adegebo, 2014). In northern Ghana, the work of Atiah et al. (2021), and Mensah et al. (2016) confirms the growing impact of climate change on the onset and cessation of the rainy season. They report that the disruption of the onset and cessation of the rainy season results in a significant delay and early onset of rains observed in northern Ghana. Amekudzi et al. (2015) find that Ghana as a whole also experiences variability in the onset, termination and cessation of rains, although with much earlier cessation dates in the savannah zone than in the north, which has a unimodal regime compared to other regimes in Ghana.

Conclusion

The study of the evolution of the rainy season shows strong variability at the onset of the rainy season and very little variability at the cessation of the rainy season. In addition, this variability is accompanied by droughts, which are increasing in the Sudano-Sahelian zone and decreasing in the Sudanese zone. This would mean that the Sudano-Sahelian zone would face problems of agricultural production because of the high variability of dry sequences from one year to the next.

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