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Research Article

INVESTIGATING THE TIME TREND OF TRUE AGRICULTURAL SEASONS BASED ON THE RAINFALL AND EVAPOTRANSPIRATION DATA. CASE OF NGAOUNDERE AREAS IN ADAMAOUA REGION – CAMEROON - PERIOD FROM 1997 TO 2016

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Abstract

This study has shown frequent oscillations of the beginnings of true agricultural seasons in a large interval of time, from April till June, particularly in the second half period of investigation, 2007 – 2016. This indicates that the climate change is going on in this zone. This situation has caused a lot of disturbances in the calendar of agricultural activities leading to a lower food productivity level and hunger.

Keywords: True agricultural seasons, pluviometry, evapotranspiration, curves, points intercept, soil water reserve, beginnings and ends of true agricultural season, duration of the period, time trend.

INTRODUCTION

Position of the problem

The ongoing global climate change is one of the main problems of this century. International conferences have been organized on this item, recall for example Rio de Janeiro, Brazil, in 1992. Its impacts cover almost all the domains of activities and one could say that the further existence of the mankind depends on how this problem will be solved. Today, we are all living under permanent fear of natural catastrophes such as cyclones, droughts, hunger and floods which are the most encountered. These catastrophes always cause humans and animals deaths, material destructions estimated in billions of US dollars, between others. Thus, more attention should be paid to this problem. The situation in developing countries is more crucial with hunger which terrifies millions of inhabitants of these parts of the globe putting them under permanent international food assistance from developed world. The authors are confident that if these populations were able to well master their agricultural seasons, they could considerably reduce this dependence on aids from abroad. For already many years, farmers have a lot of difficulties with their calendar of agricultural activities as the beginnings of rainy seasons frequently fluctuate from a year to another. Thus, sometimes they plant earlier the beginning of the true agricultural rainy season, and inversely. Also its ends use to occur earlier than expected, and inversely. So, investigations must be done to determine the most accurate periods of the true agricultural season in all localities, whence the importance of this study which concerns Ngaoundere and surroundings in the Adamaoua Region of Cameroon. Pluviometry and evapotranspiration are the two main data to be used for determining the beginnings and ends of the true agricultural rainy seasons, their durations, soil water reserves, time during which the pluviometry is at least 200 mm for a well growth of plants in the fields and high level of productivity.

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Similar investigations have been done before for other localities; (Njipouakouyou *et al.,* 2017a, Njipouakouyou *et al.,* 2017b, Njipouakouyou *et al.,* 2020). This paper has five sections. The first and present one introduces the problem to be solved. The second concerns the data and methodology. The third exposes the results and analysis. The conclusion, recommendations, acknowledgement and the references are contained in the fourth and fifth sections.

DATA AND METHODOLOGY

Data

Monthly averages of pluviometry and evapotranspiration from the treatment of daily data from the airport of Ngaoundere are considered in this paper. The instruments of measure were a station pluviometer and a standard evapotranspiration vessel. It is important to know that this meteorological station is well equipped and well trained personnel works there. Therefore, the results issued from this study should be considered as acceptable.

Methodology

Absolute maximal values of the pluviometry, R_{max}, minimal ones of evapotranspiration, ET_{min}, and the months of their observation were determined and put in a tabular form. This has enabled us to highlight their time trends. Next, pluviometry and evapotranspiration were plotted in a same coordinate axis to determine their points intercept, the first one corresponding to the beginning, and the second - to the end of a true agricultural rainy season. It is clear that a normal time distribution of the two curves should lead to only two points intercept. The distance between these points corresponds to the duration of this season. In order to well appreciate how intensive were the agricultural activities inside a period, the maximal, WR_{max}, and minimal, WR_{min}, soil water reserve were estimated, representing the maximal and minimal distances between both curves inside the season. For more precise idea

on the evolution of these activities, the time during which the pluviometry was at least 200 mm inside each true agricultural season was determined and kept in a tabular form. This parameter has permitted us to judge the time stability of the true agricultural seasons in Ngaoundere and surroundings.

RESULTS AND ANALYSIS

The absolute maximal values of the pluviometry, R_{max}, and minimal ones of the evapotranspiration, ET_{min}, are presented in Table 1. It indicates that during the first half period, 1997-2006, $R_{max} \geq 300$ mm. The highest value of 350 mm was registered in 1998 and 2005, and the lowest, 300 mm – in 1997, and 2004. During the second half period, 2007-2016, this interval of variation has become larger, from 250 mm in 2013 to 375 mm in 2011. Moreover, the values registered during four years over ten were less than 300 mm precisely in 2007 with 255 mm, 2013 with 250 mm, 2014 with 290 mm and 2015 with 260 mm.

Table 1 Absolutes maximal pluviometry (R_{max}) and minimal evapotranspiration, (ET_{min}) in Ngaoundere during the period from 1997 to 2016

Years	R_{max}(mm)	Periods	ET_{min} (mm)	Periods
1997	300	April	110	June
1998	350	August	100	July
1999	310	July	110	July
2000	320	August	125	July
2001	320	August	105	June
2002	310	September	100	August
2003	325	August	75	September
2004	300	July, Sept	100	June
2005	350	August	100	August
2006	325	May	80	August
2007	255	May	100	July
2008	310	August	100	August
2009	350	August	105	August
2010	300	September	-	-
2011	375	August	100	September
2012	300	June	100	July
2013	250	September	90	August
2014	290	September	90	August
2015	260	July	100	July
2016	300	June	100	July

These values were usually registered from July to September, rarely in April (only one observation in 1997), in May (two observations in 2006 and 2007) and June (two observations in 2012 and 2016). This time distribution of rainfall is qualitatively comparable to obtained in Bissau, (Njipouakouyou, 2019). Table 1 also shows that the minimal values of the evapotranspiration, ET_{min}, were included in the interval [80, 125] and were registered mostly between July–August. The highest and lowest values in the first half period were 125 and 80 mm registered respectively in 2001 and 2006. In the second half period, all the values of ET_{min} were around 100 mm.

Thus, from the analysis of Table 1 it comes that maximal rainfalls were decreasing during the second half period confirming the thesis of the degradation of the rainfall regime due to the climate change. To analyze the beginnings, ends and durations of true agricultural seasons, consider Table 2 issued from the determination of the points intercept of the graphs of pluviometry and evapotranspiration. For example by end April, we should understand that the point intercept could occur either by the end of the indicating month or the beginning of the next one, by early (and mid) April we should understand that it surely occurs in April. Table 2 shows that during the first half period, first points intercept were usually observed from the end of April to mid May, and the second points intercept – from the end of September to mid October for the duration of the true agricultural seasons from 4 to $6\frac{1}{2}$ months. The shortest durationn, 4 months, was registered in 2000 and the longest, $6\frac{1}{2}$ months – in 1997. During this half period, the maximal soil water reserve varied from 175 mm in 1997 and 2002 to 250 mm in 1998 and 2005. They used to occur in July-August and very few in September (2002) and May (2006). Its minimal values varied from 40 in 2005 to 80 mm in 2004 and were registered mostly in June. During the second half period, 2007-2016, the first points intercept used to occur early May (and even early June like in 2011), the second points intercept were observed mostly in October for the duration of the true agricultural seasons from $4\frac{1}{2}$ in 2007 and 2011 to 7 months in 2009. The maximal values of the soil water reserve varied from 150 mm in 2007, 2013 and 2015 to 275 mm in 2011 and its minimal values - from 50 to 100 mm. Thus, when the beginnings of the true agricultural seasons occurred mostly in April – May in the first half period, they were scattered in the period from April to June in the second half, indicating the degradation of the rainfall regime in the concerned areas. For the second points intercept, there was no significant difference between both halves periods The maximal and minimal soil water reserve were respectively of the same range and used to occur almost at the same periods in both halves. The frequent oscillations of the firsts points intercept particularly during the second half period is the main problem of the farmers and their impacts on the yields are very important. During the whole period of study, these points intercept were sprayed over at least two months laps of time making difficult the prediction of the beginning of the true agricultural season.

Table 2 also indicates that the true agricultural seasons in Ngaoundere were decreasing with time and surely should lead to the reduction of the food production. The duration of periods with at least 200 mm soil water reserve inside true agricultural seasons was investigated. The results are presented in Table 3. According to Table 3, the first half period was dominated by long laps of time during which the soil water reserve was at least 200 mm. This duration varied from 2 in 2001 to 6 months in 1999, precisely 3 months in 2004 and 2005, 4 in 1998, 2000, 2003 and 2006 and 5 in 1997. During the second half period, this interval of variation was slightly reduced from 2 in 2008 and 2015 to 5 months in 2009, 2014 and 2016. Other durations were $2\frac{1}{2}$ months in 2010, 3 months in 2007 and 2013, $3\frac{1}{2}$ months in 2011 and 4 months in 2012. This clearly indicates the diminution of the rainfall regime in the considered areas. This situation should generate catastrophic consequences as agricultural activities are concerned. The causes of this degradation are surely many. Between others, the following ones are the most encountered: the drastically intensive deforestation in the zones surrounding Ngaoundere for international wood trade, the fast growth of the populations which obliges inhabitants to destroy large green spaces for new settlements and the abusive use of river water mostly for irrigation of new created fields. It is evident that when the green coverage of land by trees and grasses is sufficient, enough additional humidity will be provided to the atmosphere and will contribute to a quick formation of high quantities of rain and earlier beginning of rainy seasons.

Table 2. Beginnings and ends of the true agricultural seasons in Ngaoundere for the period from 1997 to 2016

Years	Beginning	End	Duration (Months)	R_{max}	Period	R_{min}	Period
1997	Early April	Mid October	$6\frac{1}{2}$	175	Mid July	50	Mid June
1998	Early May	Early September	6	250	Mid August	-	-
1999	End April	End October	6	200	Mid July	75	Mid June
2000	End May	Early October	4	200	Mid August	-	-
2001	Mid May	Mid October	$4\frac{1}{2}$	200	Mid August	50	Mid June
2002	End April	Mid October	$5\frac{1}{2}$	175	Mid September	-	-
2003	Mid April	Mid October	6	225	Mid August	-	-
2004	Mid April	Mid September	5	200	Mid July	80	Mid June
2005	Early May	Mid October	$5\frac{1}{2}$	250	Mid August	60	Mid July
2006	Early May	Mid September	5	200	Mid May	40	Mid June
2007	Mid April	Early August	$4\frac{1}{2}$	150	Mid May	-	-
2008	End April	Early October	6	200	Mid August	-	-
2009	Early April	End October	7	250	Mid August	50	Mid May
2010	Early May	End October	6	225	Mid September	-	-
2011	Early June	Mid October	$4\frac{1}{2}$	275	Mid Augustr	-	-
2012	Mid May	Mid October	5	175	Mid June	75	Mid July
2013	Mid May	Mid October	5	150	Mid August	75	Mid June
2014	End April	End September	5	200	Mid September	50	Mid June
2015	Early May	Mid October	$5\frac{1}{2}$	150	Mid July	-	-
2016	Mid April	Mid October	6	175	Mid June	100	Mid August

Table 3. Duration of the periods with at least 200 mm soil water reserve inside true agricultural seasons

Years	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Duration	5	4	6	4	2	$4\frac{1}{2}$	4	3	3	$4\frac{1}{2}$

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
3	2	5	$2\frac{1}{2}$	$3\frac{1}{2}$	4	3	5	2	5

Conclusion

In general, the climate change due to human activities is a real problem in Ngaoundere and has led to the degradation of the rainfall regime with the diminution of true agricultural seasons with many consequences, between others the reduction of food production. Thus, it is obvious that the populations are exposed to hunger, a terrible quiet killer. The rulers of this region must call the populations to a better and rational exploitation of the natural resources and well management of water by farmers as it is already done in Israel. The authors extend their sincere thanks to all those who have helped them to realize this study.

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