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RESEARCH ARTICLE

Climate Change for Yangambi Forest Region, DR Congo

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Abstract

Global hit due to the average temperature increase of 0.6 °C has changed world environment. In Yangambi region, temperature being increased to 0.44 °C, climatic study on chronological annual regimes from 1931 to 2017 of climatic elements has been conducted using the serial tests of stationarity, trend and rupture to detect climate change. It has been revealed that during 88 last years, it rains in the bimodal regime with the annual rainfall means of 1811.7 ± 214.8 mm, number of rainy days (RDN) of 172.24, relative air humidity (RH) of 87.17 ± 6.97 %, potential evapotranspiration (PET) of 1132.16 ± 54.43 mm, sunshine of 2040 ± 98.17 hours and average temperature of 24.94 ± 0.30 °C. The decades hits of 1981-1990 and 2000-2017 have characterised the average temperatures positive trend ruptured in 1977 with the highly significant increasing change of 0.44 °C. Thermal increase has been related (r = -0.333) to decreasing RH annual trend with significant changing point in 1975. Decreasing trend change points were detected significantly for RDN in 1950, PET in 1984, and sunshine in 2000 ; and unsignificantly for rainfall in 1945 and 2000. Climatic elements excepte rainfall, have undergone changes which will impact on monthly or ten-daily seasonal regimes to be elucidated for more knowledge about climate change in Yangambi.

Keywords: Serial Temperature and Rainfall; Rupture Change point and Yangambi

Introduction

Because of the global warming the global average temperature has increased by 0.6 °C and led to climate change [1]. During 88 years of climatological observations at INERA-Yangambi research center, temperature and other climatic elements trends have not yet been studied for cheking climate change that would be caused by the hit under deforestation effect [2,3].

Actually, 60% of climatic variabilities come meanly from human activities pomping daily the green house gases in the atmosphere with great quantities of water vapor, CO_2, NO_2, NH_4, SO_2 and other gases coming from massive combustion of fossiles fuels by growing industrialisations, urbanisations, technologic modernisations and deforestation [1,4,5]. Whereas, 20% of CO2 emission is libereted by deforestation through burning agriculture and livestock which is the most useful practice by peasant farmer in the forest region of Yangambi [1].

Climatic disturbances due to hit increase have been characterised by decreased trends of rainfall and consequently decreasing relative air humidity, potential evapotranspiration and sunshine trends [6,7]. with impacts relevant on environment drought, soil and crop destructions, and detrimented health of beings by infectuous deseases [1,8,9]. The humidity diminution of denuded soils by deforestation, has shortened evaporated surfaces and consequently rains, in enhancing latent hit flux from soil to atmosphere [7,10].

In Yangambi region, the increasing population from 8500 in 1955 to 80 000 inhabitants in 2017 and the increasing agricultural needs, have been the cause of more than 15% of deforestation during the economic and political crises periods in DR Congo. Shift cultivation, wood carbonisation, clandestin diamond, gold and timber peasant exploitations and canoes construction have contributed to the deforestation [3,11].

The objective of the present study is to determine an eventual climate change in Yangambi in analysing the climatic elements registered from 1931 to 2017, to control forest management.

Materials and Methods

Localisation

The ecological region of Yangambi covers 440, 000 hectares on oxisoils in equatorial zone of central african pristine of DR Congo (Figure 1). The region is dominated by the ombrophile humid evergreen forest of *Brachystezia laurentii* and caducious of *Scorodophleus zenkeri* and *Pericopsis elata* and semi-caducious with *Gilbetiodendron dewevrei* [12-14]. With 80,000 inhabitants, the research center of INERA Yangambi is situated at 0°49'-0°54'N, 24°29-24°49'E and 435-485m of altitude distant from 100 km to the West of Kisangani city [15].

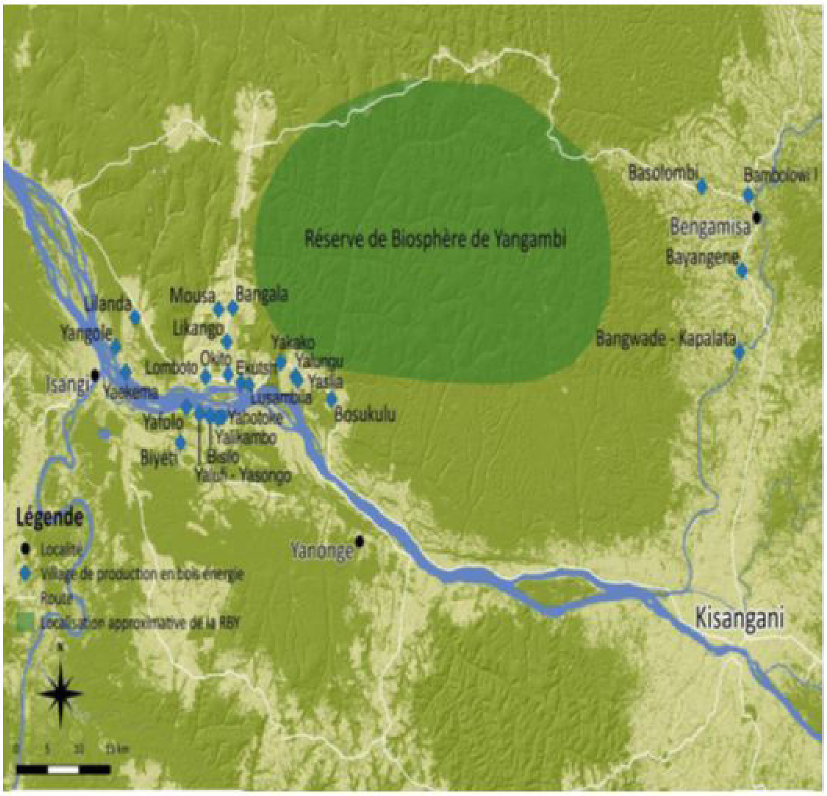

Figure 1: Yangambi biosphere reserve (in green) within ecological Yangambi region (in greenish) (Projet FORETS, 2017)

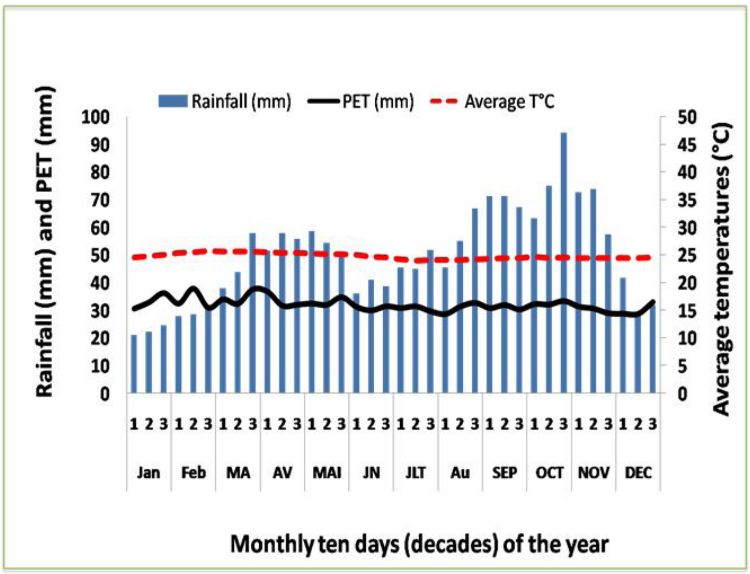

Figure 2: Ombrothermic diagram for Yangambi region, monthly decadal means of rainfall (mm), potential evapotranspiration (mm) and average temperature (°C) from 1931 to 2017

The warm and humid climate of Yangambi is characterised in figure 2 by the rainfall all the year with the annual means of 1820 mm following the double rain periodicity of two maxima to equinoxes of may with 154 mm and octobre with 234 mm, and two minima to solstices of june with 119 mm and january with 87 mm. The annual observations of PET is 1142 mm and average temperatures is 24.98 °C (Figure 2).

Methods

Rainfall and temperature are the determining climatic factors with the seasonal consequences on rainy days, PET, RH and sunshine for subtropical rainforest zone as that of Yangambi region. The daily observations of rainfall (mm), number of rainy days (RDN), relative air humidity (RH, %), potential evapotranspiration (PET, mm), sunshine (hours) and average, minima and maxima temperatures (°C) registered from 1931-2017 at the Km 5 climatological station of INERA Yangambi, have been traited in serial annual means values. The serial means for each climatic element were statistically and graphically analysed with logiciel R 3.4 to find the independance and non stationarity by the test of Wald Wolfowitz, the trends variations by the test of Mann Kendhall, the annual climatic change point at time K following the test of Pettitt and the statistic method U of Buishand [16-19].

The Wald Wolfowitz test is a non-parametric one where are set two different random samples from different populations with different continuous cumulative distribution functions. The null hypothesis (H0) in that is the no statistical significant difference between the two populations from the two samples, so that whose elements are independent and identically distributed. If the number of runs is significantly higher or lower than expected, the hypothesis of statistical independence of the elements is rejected [17,19,20].

The Kendall test is a non parametric test and has the low sensitivity to abrupt breaks due to inhomogeneous time series. If the p-value is less than the significance level α (alpha) = 0.05, H0 is rejected indicating that there is a significant trend in the time series. Statistics Z, S, tau are measures of significance used for Kendall test. The test statistic Z has measured the significance of trend, to test the null hypothesis, H0. If Z is greater than $Z\alpha/2$, where α represents the chosen significance level (5%, 1%, 0.1%) then the null hypothesis is not true and thus the trend is significant [16,17].

The Kendall's tau (the Kendall's rank correlation coefficient) has determined correlation measuring the strength of the relationship between the two variables. Kendall's tau take values between ± 1 and +1, with a positive correlation indicating that the ranks of both variables increase together, whereas the negative correlation indicates that as the rank of one variable increases, the other decreases. Kendall tau=S/D, where S=Kendall score and D = denominator, the maximum value of S [16-18].

The statistic S denotes the trend slope. If the data value from a later time period is lower than a data value sampled earlier, S is decremented by 1. The net result of all such increments and decrements produces the final value of S. The positive or negative value of S indicates an upward or downward trend. Variance of S is symbolized by var S [16,17].

The Pettitt test determines the change-point of the series located at time K (Kt), defining that the statistic is significant at p-value ≤ 0.05 or highly significant at p-value ≤ 0.001 [16,17,19]. The test symbols U of Buishand represents the standardized coefficient of separation means of fhe rupture subseries to determine the significance of climate change [18,19].

Results

Annual Regimes of Climatic Elements in Yangambi

The interannual and decennal hydric regimes (rainfall, RDN, RH and PET) and thermic regimes (temperatures and sunshine) observed from 1931 to 2018 in Yangambi are presented on the Figures 3 and 4. The annual coefficients of variation of the climatic elements have been less than 13 %. The annual decenal regimes on the Figure 4, show clairly the similar decrease of rainfall, PET, RH and sunshine because of thier depressions in decennies 1981-1990 et 2000-2018, against the positive increase of temperatures and rain days (Figure 4).

Rainfall

The rains of Yangambi region shown on figure 3, fall each year and all the year in the annual means of 1822.19 ± 214.80 mm superior to the normal of 1784.4 mm. Its CV of 11.86 % expresses the homogeneous quantities of rains falling annually in the region. It rained annually the least in 1949 and 1950 with 1439.10 mm and the most in 1966 with 2432 mm. Rain quantities superior to 2000 mm have been observed ten times with occurrence in 1943, 1944, 1954, 1956, 1966, 1974, 1975, 1988, 1999 and 2003 at means lengh of deviations of years of 6.6 ± 4.24 years. The most importants deviations were registred between 1944 and 1954 : 10 years, 1975 and 1988 : 13 years and 1988 and 1999 : 11 years by only one (1) fall of rains superior to 2000 mm. Meanwhile, rainfall quatities inférior to 1600 mm were registered 13 times in 1949, 1950, 1959, 1968, 1069, 1970, 1977, 1978, 1979, 1983, 1984, 2000 and 2004.

Decennial rainfalls have been characterised by the rupture valleyed from 1971 to 2010, to say decennies 1971-1980 : 1794.5 mm, 1981-1990 : 1760.1 mm and the depression 1991-2000 : 1724.5 mm (Figure 4).

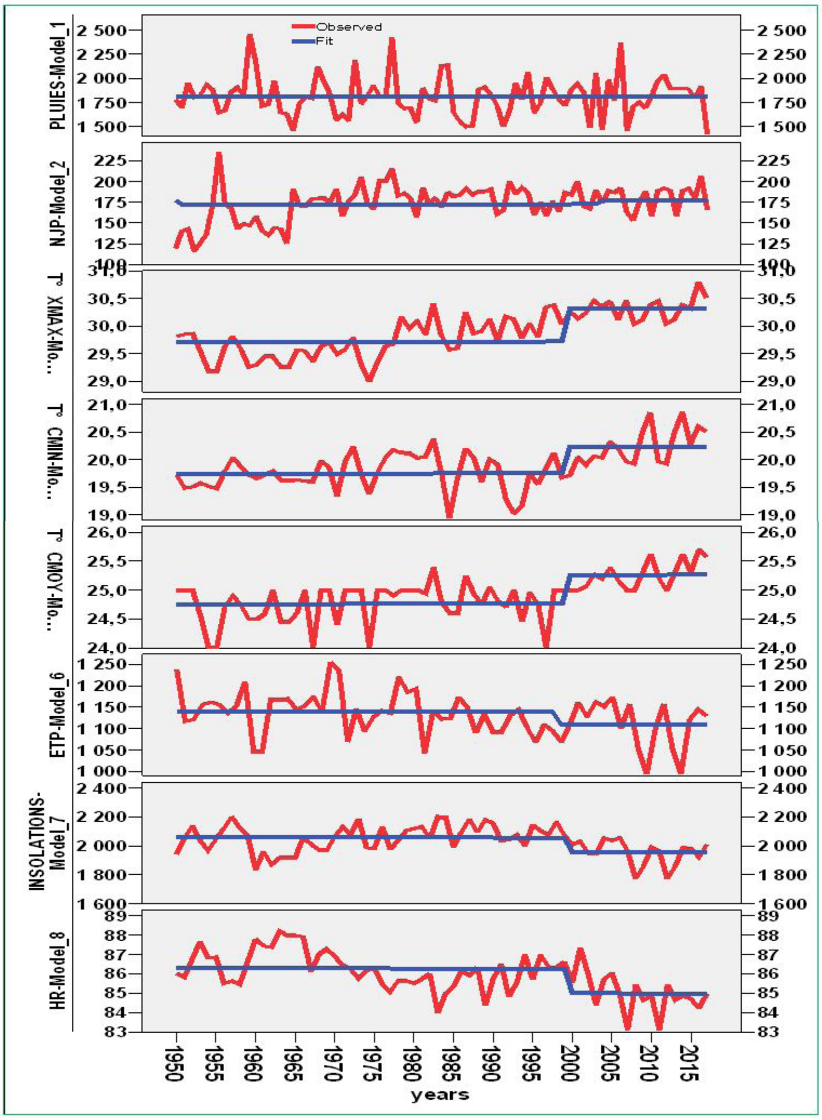

Figure 3: Annual means of rainfall (mm), PET (mm), NJP (number of rain days), relative air humidity (RH, %), sunshine (hours), temperatures maxima (T °C max), minima (T °C Min) and average (T °C Moy) from 1931-2018 in Yangambi

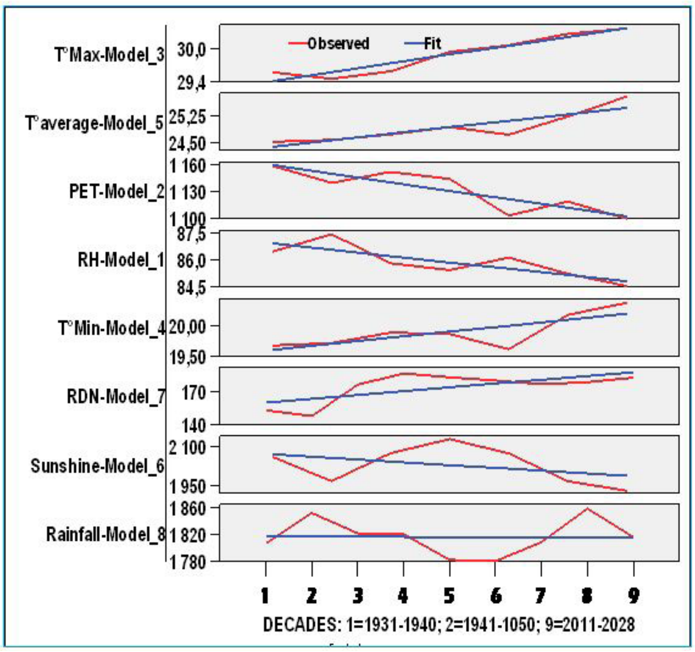

Figure 4: Decennial means of rainfall (mm), PET (mm), RDN (number of rain days), relative air humidity (RH, %), sunshine (hours), temperatures maxima (T °C max), minima (T °C MIN) and average (T °C Average) from 1931-2018 in Yangambi

Temperatures

From figure 3, the annual average temperature has indicated 24.98 ± 0.30 °C, superior to the normal 24.58 °C and to the temperature before 1980 of 24.5 °C. Annual maxima and minima temperatures means have increased to 29.83 ± 0.39 °C and 19.83 ± 0.32 °C, respectively. On the figure 4, in the two last decades 2001-2010 and 2011-2018, the average temperatures have increased to 25.23 and 25.78, respectively. Only maxima temperatures observed and fitted have increasingly macthed straighly as compared to average and minima temperatures downing in decade 1991-2000 while the fitted line is straight.

Rainy Days Number (RDN)

From figure 3, the RDN CV of 12.72 % has reflected the homogeneous annual rainy days with the annual means of 172.24 ± 21.90 RDN inferior to the normal 179.63 RDN. The lowest RDN registered before 1980 notably 119 days in 1931 (frequency of 16.3 mm/day) and 116 days in 1934 (frequency of 15.5 mm/day) produced respective great quantities of rains of 1934.6 mm and 1804 mm significantly superior to 1662 mm of rains obtained from 200 days registered in 1985 (frequency of 16.6 mm/day). Values inferior to negative standard deviation of 151 RDN is found between 1931 and 1947 and values superior to positive standard deviation of 194 were observed in 1961 with 205, 1964 with 201, 1966 with 216, 1985 with 200 and 1996 with 200 RDN, corresponding to the faible decennial depression of 175.6 RDN. In the figure 4, the first two decades of 1931-1940 with 152.9 RDN and 1941-1950 with 148.4 RDN have presented RDN values significantly inferior to those of other decades from 1951 to 2018.

Relative Air Humidity

Relative air humidity from 1950 to 2017 has denoted the annual means of 83.17 ± 6.98 % superior to the normal of 85.81 %, of CV of 8.39 % between the maximum of 88.21 % in 1963 and the minimum of 83.98 % in 1983 (Figure 3). The RH superior to positive standard deviation of 87% has been registered in 1963 with 88.21%, 1964 with 87.99, 1966 with 87.92, 1968 with 87.01, 1969 with 87.28 and 2001 with 87.36 %. The RH inferior to negative standard deviation of 84,40% acomptes for in 1983 with 83.98% and in 1992 with 84.83 %. In the figure 4, the decennial RH has been constantly decreasing to the lowest in the last decades 2001-2010 and 2011-2018.

Potential Evapotranspiration (PET)

From the Figure 3, PET has shown the annual means of 1132.16 ± 160.66 mm between 994 mm obtained in 2010 and 1255 mm in 1973, superorir to the normal 1127.67 mm, with the CV of 4.81 %. From 1955 to 2012, the PET values superior to the positive standard deviaton of 1200 mm have been registered in 1955, 1963, 1973, 1974, and 1981 before the globalisation hit peak period during which PET has the most diminished to 994 mm. PET inferior to the negative standard deviation of 1080 was obtained in 1964, 1975, 1984, 1997, 2000 and 2004 (Figure 3). The decade 1951-1960 has been the most evapotranspirated with 1158.5 mm having produced the corresponding great rainfall quatities of 1831.2 mm. The lowest PET were registered in the last decades 2001-2010 and 2011-2018 (Figure 4).

Sunshine

In the figure 3, the annual sunshine means of 2039.26 ± 98.17 hours has been inferior to the normal 2074.4 hours with the CV of 4.82 % between the maximum of 2200 hours in 1958 and 1983 and the minimum of 1772 hours in 2008. Sunshine superior to the positive standard deviation of 2140 hours has been observed in 1958, 1973, 1983, 1984, 1987, 1989, 1990 and 1995, against that of negative standard deviation inferior to 1942 hours in 1951, 1961, 1963, 1965 and 2008. In the figure 4, since 1970 the sunshine has been decreasing to the lowest in the last decade 2011-2018.

Stationarity and Trend

The tests of Wald-Wolfowitz and Mann Kendhall were applied on serial climatic elements means to find respectively the non stationarity and the linear trend estimates presented on Table 1.

Climatic Elements	Years of observation	Sationarity		Trends			
		P-Value	Standardised Coefficient Z	P-Value	Statistic S	Statistic tau	Standardised Coefficient Z
(*C) Average Temparature	64	4.203e-06*	4.6011	1.153e-10*	1691	0.49289	6.4453
Rainfall (mm)	87	0.9888ns	0.014067	-0.7665	-82.00	-0.02194	-0.29697
Rainy Days	87	2.52e-06*	4.7065	5.373e-05*	-1121	-0.29513	4.0388
Relative air Humidity (%)	64	9.34e-06*	4.4319	2.077e-06*	-820	-0.40776	-4.7458
Potential Evapotranspiration (PET, mm)	63	0.03916*	2.0625	0.00318*	-496	-0.25482	-2.9366
Sunshine (hours)	70	3.815e-06*	4.6212	0.1308*	-299	-0.12412	-1.511

***Very highly significant, **highly significant, * Significant at probability level 0.05, N.s : non significant

Table 1: Stationarity and linear trend significancies of climatic elements from 1931 to 2018 for Yangambi region

The null hypothesis is rejected for the alternative hypothesis shows in Table 1 that the series of temperature of 67 years, RDN of 87 years, RH of 64 years, PET of 63 years and sunshine of 70 years are significantly different from independence and stationarity. So, the Mann-Kendall trend test has defined the alternative hypothesis such as the true S is not equal to 0, with the sample estimates respectivement for the temperature highly significant (p-value <0.001) increasing positive linear trend of S= 1691.00 and varS = 68751.67, for the RDN highly significant (p-value <0.001) decreasing negative linear trend of S = -1121.00 and var S = 76902.33, for the PET significant (p-value <0.05) negative linear trend of S= -496.00 and var S = 28413.33, for the RH highly significant (p-value <0.001) negative trend of S = -820.00 and var S = 29781.33, and for the sunshine (p-value = 0.1308) negative trend of S = -299.00 and var S = 38895.67.

The trend correlation coefficients between the chronology and the climatic elements have shown that the temperature had the highest with tau= 0.49289, followed by RH with tau = -0.40776, RDN with tau= -0.29513, PET with tau= -0.25482 and sunshine with tau= -0.12412

On the other hand, the null hypothesis has been accepted for the annual rainfall series during 87 years with stationarity at p-value = 0.9888 and the standardised coefficient z = 0.014067. The test indicates a non significant (p-value = 0.7665 > 0.05) decreasing negative linear trend with S= -82.00, var S= 74397.33 and the weaker correlation coefficient of tau = -0.02194.

Rupture Change Points

Températures Segmentation Change

From Figure 5, the rupture of the series detected probably at 26 years in 1977 over 68 years of observations, has been highly significant with p-value = 3.976e-06 < 0.001 and the high standardised coefficient U = 1166. The change-point of average temperatures series would be attributed to the begining of economical crises and demographic pressure in DR Congo deforesting Yangambi reserve manifested by the highest hit decades of 1981-1990 and 2000-2017 observed in the increase of maxima and minima temperatures.

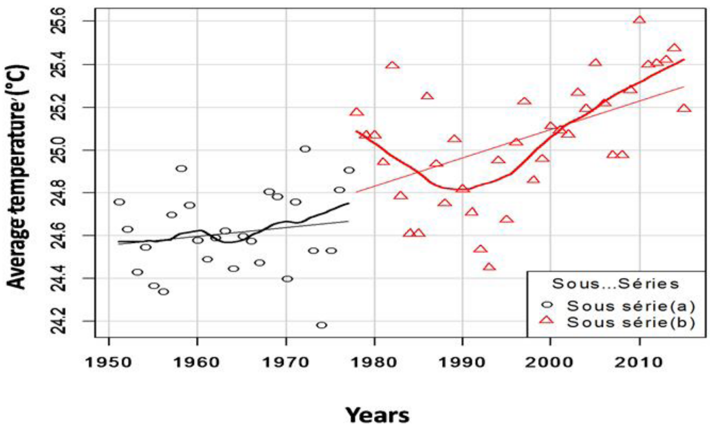

Figure 5: Rupture point of average temperatures (°C) linear trend in sub series A ascending 1951-1977 and sub series B more ascending 1978-2017 from the chronological temperatures of 1951 - 2017 in Yangambi

Rainfall Segmentation Change

The ruptures of the series detected at 14 years in 1945 and at 70 years in 2000, have not been significant with p-value =1.052 and the standardised coefficient U = 267 (figure not shown for unsignificance).

Rain-days Segmentation Change

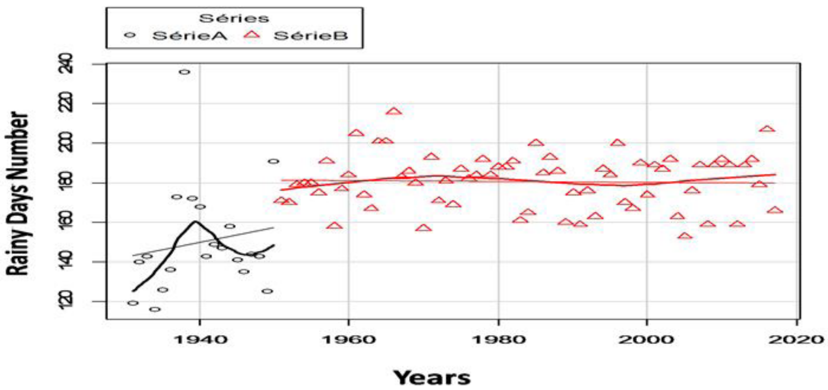

Figure 6: Rupture point in sub series A of 1931-1950 and sub series B of 1951-2017 of the chronological rainy days number from 1931 to 2017 in Yangambi

From Figure 6, the rupture of the series detected at 19 years in 1950, has been highly significant with p-value = 0.0001049 and the standardised coefficient U = 1064.

The Figure 6 has shown that the Welch test (t) presents the highly significant (p<0.001 < 9.799e-05) increase of 30.50 DRN decreasing, difference between the first subseries A ascending from 1931 to 1950 with the annual means of 150.25 RDN and the second subseries B lighly negative from 1951 to 2017 with the annual means of 180.75 RDN with t = -4.7536 and df = 21.8

Relative Air Humidity Segmentation Change

On the Figure 7, the rupture of the series detected at 25 years in 1975, has been highly significant (p<0.001) with p-value = 1.582e-05 and the standardised coefficient U = 722.

The decade 1961-1970 was the most humid with 87.37 %, but the ruptured made in 1975 has favored the significant RH decrease of -1.35% between the two subseries A and B. From decades 1971-1980 and 2010-2017, the RH has been downing respectively to 85.84 % and 84.89 %. This confirmes the phenomenum of continuing global warming which could dry atmospheric air.

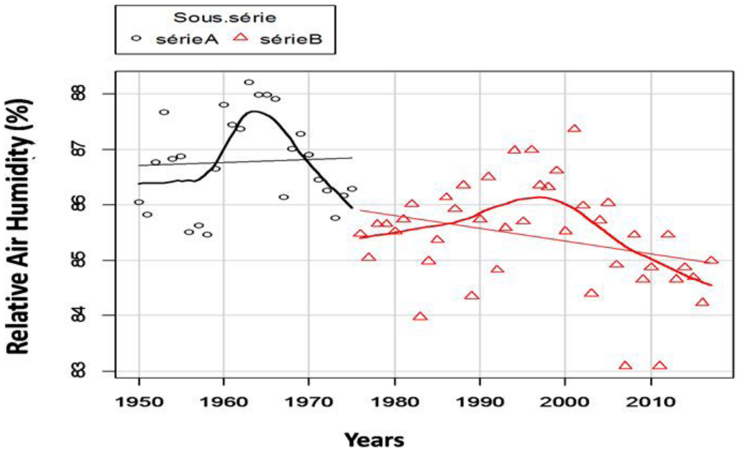

Figure 7: Rupture Point in sub series A of 1950-1975 and sub series B of 1976-2017 of the chronological relative air humidity (%) from 1950 to 2017 in Yangambi

Potential Evapotranspiration Segmentation Change

From Figure 8, the rupture of the series detected at 29 years in 1984, has been significant with p-value = 0.005581 and the standardized coefficient U = 499.

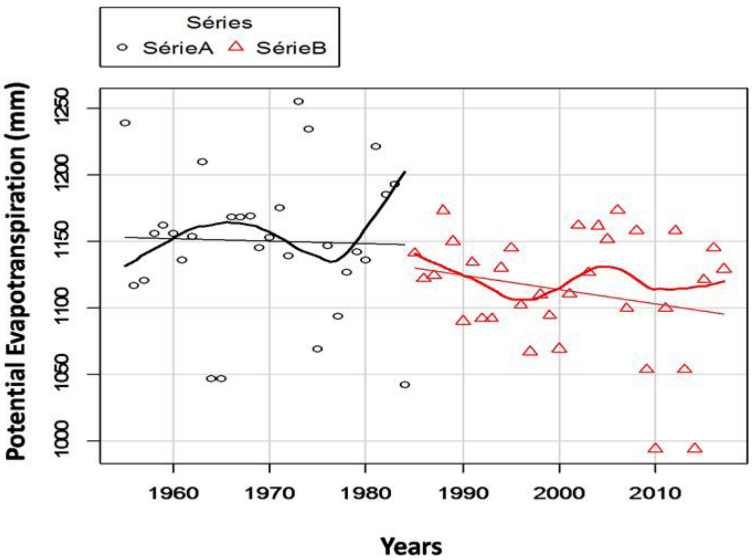

Figure 8: Rupture point in sub series A of 1955-1984 and sub series B of 1985-2017 for the chrological potential evapotranspiration (mm) of 1955 to 2017 in Yangambi

From the figure 8, the test t of Welch shows the significant (p-value = 0.004542 < 0.05 with t = 2.9557 and df = 56.584) PET decrease -37.31 mm, différence between the first sub series A constant of 1955-1984 of the annual means of 1150.233 mm and the second sub series B descending of 1985-2017 of the annual means of 1112.924 mm. The negative trend has been marked by the PET depression in the decade 1991-2000 with 1103.55 mm and the decade 2010-2018 with 1100.06 mm, influenced by the lowest PET of 1002 mm in 1993, 994 mm in 2014 and by the decreasing PET from june to december (Figure 4).

Sunshine Segmentation Change

From Figure 9, the rupture of the series detected at 50 years in 2000, has been significant with p-value = 0.007227 and the standardised coefficient U = 571.

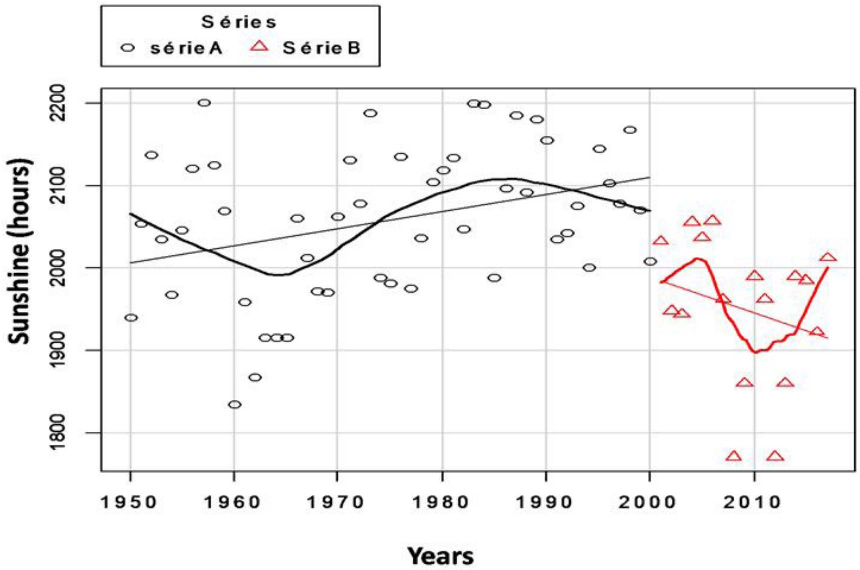

Figure 9: Rupture point in sub series A ascending 1950-2000 and sub series B descending 2001-2017 of the chronological sunshine (hours) of 1950 - 2017 in Yangambi

From the Figure 9, the test t of Welch shows highly significant (p<0.001> p-value = 0.0001965 with t = 4.2868 and df = 27.778) difference between the first sub series A ascending of 1950-2000 with the annual means of 2057.686 hours and the second sub series B descending of 2001-2017 with the annual means of 1950.529 hours. Sunshine out of global hit (before year 2000) was lower with 1962.2 hours in decade 1961-1970, for it was the most obstructed by clouds of heavy rains about 1824.1 mm fallen during 186.1 days with water particules saturated in the air at 87.37 % of RH accompagnied of higher PET of 1124.8 mm.

On the other hand, the lowest sunshine due to global hit in the last decade 2010-2017 with 1928.43 hours, has been obstructed by the permanent cloudy cover of small rain particules (less heavy) revealed at 1815.73 mm with the low PET of 1100.06 mm as opposed to the highest sunshine of 2128 hours observed in decade 1981-1990.

Discussion

Influence of Temperatures on Climatic Elements

Although rainfall and temperature are the principal climatic factors of tropical humid forest zone, annual relations between climatic elements are presented in Table 2.

Climatic Elements	Rains	PET	Temp. Max	Temp. Min	Rain Days	Sunshine
PET	0, 037					
Temp. Max	-0, 176	-0, 195				
Temp. Min	-0,158	0, 101	0, 547**			
Rain Days	-0, 158	-0, 203	-0, 184	-0, 079		
Sunshine	0, 093	-0, 063	0, 104	0, 026	-0, 042	
Relative Air Humidity	0, 044	-0, 049	-0, 333*	-0, 390**	0, 074	-0, 366**

* : significant at probability 0.05, ** : significant at probability 0.01

Table 2 : Coefficients of simple correlation between climatic elements for annual observations from 1931 to 2017 in Yangambi

The negative highly significant coefficients of correlation (r) have been identified on the diminution of relative air humidity (RH) face to three thermic climatic elements responsable directly and positively of the increase of global hit notably maximum temperature with r= -0.333, minimum temperature with r= -0.390 and sunshine with r= -0.366. Diurnal as well as nocturnal hits increase has diminished air saturation rate, by RH from 87.8 % downed after 1975 to 84.5 %.

Whereas, the increase of maximum temperature from 29 to 30.89°C has enhanced the increase of minimum temperature from 19 to 21.32 °C presenting the highest significant positive coefficient of corrélation with r = +0.547. The annual influence of temperatures on rains, rainy-days and PET , has not been significant.

Rainfall Stationary

Annual rains have stayed stationary, homogenously equilibrated, by the increasing number of rain days from 150.25 days of heavy rains before to 180.75 days of light rains after the rupture changing point in 1950. The reduction of frequencies of heavy rains superior to 2000 mm corresponding to the increase of the number of rainy days seemed coincide with the period of economic and political crises added to the demographic pressure in the country (DRC) since 1980 having led to deforestation and hit island effect in Yangambi reserve. The effect of hit island caused by urbanisation expansion, has been observed in minimum temperature hit increase relative to maximum temperature [4].

The rainfall stationarity is also explained from figure 4 that, the great rain depression of 1760.10 mm in decade 1991-2000 thus weakening PET at 1094.5 mm ; was compensated by the positive rainfall increase inflexion of 1840.5 mm in following decade 2001-2010 which would be due to the rainfall increase of 2400 mm in 2003 and to the positive rainfall trends in months of june, august, september and november, having obstructed solar rays and shortened sunshine [6].

But, although the serial annual rainfall was stationary, the ruptures of decreasing serial trends of PET, RH and sunshine were highly significants and would lead to climatic seasonal disturbance or change instead of climate change because the annual results obtained are still included in the warm and humid equatorial climate criteria of Köppen [20,21] (Figures 7 and 8).

Agricultural Issues

With the favorable monthly rainfall distribution from august to november over PET and average temperature in figure 3, the unchanged (unsignificant) annual rainfall trend with the means of 1822 mm and its normal of 1785 mm superior to the PET of 1134 mm despite the temperature increase, satisfy the water needs of tropical annual and perenial crops, silviculture, rapid fallowing and reforestation in Yangambi [6,22,23].

However, cultural calendar could be reviewed, because the studied interannual regimes being influenced by global equilibrium of climatic oscillations between north atlantique and south atlantique [9], masque climatic intra-variabilities which would determine monthly seasonal climatic change [6,17,21]. In Yangambi, the seasonal disturbances could have enhanced flowerings and fructifications without seasons during all the year on coffea canephora, Persia americana, Dacriode edulis and millettia laurentii trees. The disturbances could also disturbe cultural density and yields of peanut and may affect bioecosystems and vulnerable human population [24].

The decreasing PET ruptured during the decennal hit of 1981-1990 would signify that the biomasses of crops and herbaceous fallows setteled in detriment of devastated forest have manifested a global transpiration inferior to the previous state before 1980. The deforestation would have altered, in dry period as in humid period, the parameters of denuded soil notably infiltration rate, drainage and rain-off, affecting the lowering evaporated surface [7].

The global green house effect would be attenuated not only by the action of CO_2 on transpiration et respiration of plantes, but also by the tampon effect of aquifers on superficial soil dryness and by the existing hydrographic richness contributive to global evaporation in favor of rainfall in Yangambi region, potential candidate for carbon credit.

Conclusion

The climatic change study on hydric and thermic climatic elements annual regimes registered from 1931 to 2017 in Yangambi, has shown faible fluctuations of CV inferior to 12 %. Changes have resulted to positive trend with highly significant average temperature increasing from 24.5°C before and 24.98°C after the year 1978. Although, the rainfall trend has not changed, the rainy days have significantly increased of 35.31 days since 1950.

The warm and humid climate, following Kôppen classification has persisted instead of climate change, but with significant change decreasing trends on relative air humidity of 1.35% since 1975 before temperature change, and PET of 37.31 mm since 1984 and sunshine of 107.157 hours since 2000 after temperature change, which would have climatic change impacts on intra-annual seasonal variations still favorable to agriculture and livestock in Yangambi [21,25]. Monthly and daily climatic movements study will determine more.

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