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Influence of Climate Variability on The Dynamics of Land Use Land Cover in the Sub-Soudanian Sector: The Case of the Badenou Classified Forest, Northern Côte D'ivoire

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ABSTRACT: In a context of global change marked by climate evolution, tropical forest ecosystems are under increasing pressure that threatens their integrity and biodiversity. This study quantifies the impact of climatic parameters on the evolution of land use/cover in the Badenou Classified Forest (northern Côte d'Ivoire) between 1990 and 2022. By cross-referencing Landsat images and climatic data (temperatures, precipitation, PDSI, SPI) via Google Earth Engine, and applying statistical tests (Spearman correlations, PCA, regressions), significant relationships were highlighted. The results show a distinct vulnerability of natural ecosystems to climatic stresses. Dense dry forests and galleries regress with drought (PDSI: $\rho = -0.502$, $p = 0.003$). The low density shrub savannah declines sharply with rising temperatures (Tmax: $\rho = -0.613$, $p < 0.0001$). Water bodies decrease during dry periods (PDSI: $\rho = -0.545$, $p = 0.001$). Anthropogenic dynamics present contrasting responses. Fallow lands decrease with temperature (Tmax: $\rho = -0.413$, $p = 0.017$), while perennial crops expand their reach under these same conditions (Tmax: $\rho = +0.413$, $p = 0.017$). An increase in bare soils and built-up areas is correlated with humid conditions (SPI: $\rho = +0.362$, $p = 0.039$). This research demonstrates that climatic variables, particularly temperatures and drought indices, are major explanatory factors for landscape transformations. These quantified results provide an essential scientific basis for the development of adaptive management policies, reconciling biodiversity preservation and local development in a context of global change.

KEYWORDS: Badenou Classified Forest, Climate change, Land Use Land Cover change, Ivory Coast, Sub-Sudanese zone.

I. INTRODUCTION

In 1979, the international community, concerned by the threat of climate change linked to anthropogenic emissions, organised a World Climate Conference in Geneva **(IPCC, 2023)**. It was during this conference that the Intergovernmental Panel on Climate Change (IPCC) first defined the term 'climate change'. According to the **IPCC (2021)**, climate change is manifested by a perceptible increase in the intensity and frequency of extreme temperatures, notably heatwaves and heavy precipitation, as well as agricultural and ecological droughts in some regions. Most scientific analyses have shown that global warming is largely caused by anthropogenic activities, particularly the release of greenhouse gases into the atmosphere **(Ardoin *et al.*, 2003; Sighomnou, 2004)**. As a result, concerns have grown significantly in recent decades regarding the increase in this global surface temperature **(United Nations Environment Programme, 2022)**.

Because of this situation, countries and territories are vulnerable depending on their specific climatic conditions. Climate variability is a global phenomenon that significantly affects forest ecosystems by altering their structures and dynamics. This

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phenomenon is particularly acute in Africa, where the consequences are manifested through desertification **(Cornet, 2022; Yao et al., 2018)**. Côte d'Ivoire is not spared from these major current climatic upheavals, which cause floods and droughts in forested areas. Indeed, according to **Diawara *et al*., (2014)**, the major impacts on the country's ecosystems over the past three decades are due to changing temperatures, altered rainfall patterns, longer drought periods, and increased evapotranspiration. If no action is taken to mitigate these effects, the country will face the combined impact of rising temperatures (+2 degrees Celsius), varying rainfall (-9% in May and +9% in October), and rising sea levels (30 cm) by 2050 (**World Bank, 2018**).

In this context, various studies have been conducted in Côte d'Ivoire. These have focused on the combined effect of climate variability and anthropogenic activities on land **(Ogbuji and Adejuwon, 2006)**, on biodiversity and ecosystem services **(Achieng *et al*., 2016)**, and on ecosystems in Africa **(Al Hamndou & Requier-Desjardins, 2008; Omotoso et al., 2023).** Furthermore, this study was initiated to assess specifically the impact of climate variability on the spatio-temporal dynamics of the Badenou Classified Forest. Indeed, due to its location in northern Côte d'Ivoire, this classified forest is likely to be influenced by various climatic variables. Similarly, research in the sub-Sudanian sector has revealed changes in drought periods, which have become increasingly longer over recent decades. Based on this observation, it is necessary to conduct a study to understand the contribution of climate variability to land use dynamics in order to anticipate and plan current and future measures. To this end, remote sensing proves to be the ideal methodology, enabling a reliable classification and description of land use and land cover, to which climatic variables can be correlated. This study will rely on satellite data and field surveys to quantify variations in forest cover and to understand biodiversity dynamics in response to climate variability.

The objective of this study is to analyse the influences of climate variability on the spatio-temporal dynamics of the Badenou Classified Forest over a period of more than three decades. (1) We will examine how the Badenou Classified Forest adapts to climate change; this can provide valuable information for long-term conservation management and adaptation strategies in the face of future climate scenarios. (2) To understand the ecosystem dynamics of the Badenou Classified Forest, which can contribute to guiding sustainable development policies by integrating ecological considerations into regional and national planning.

II. MATERIALS AND METHODS

A. Study Area

The Badenou Classified Forest is located 30 km from Korhogo and covers 26,980 hectares. The forest stands like a verdant oasis in the heart of the Ivorian savannah. The GPS coordinates are 9° 41' 63" to 9° 51' 63" North latitude and 5° 32' 06" West longitude **(Figure 1)**. It was established by Decree N°3499/SE/5 on 29 November 1937, and its management is entrusted to SODEFOR. The forest lies within a Sudano-Guinean climate, characterised by two distinct seasons, which is typical of the sub-Sudanian phytogeographical zone **(Guillaumet and Adjanohoun, 1971)**. The mean annual temperatures range between 26.07°C and 28.60°C, with peak heat in February-March (reaching up to 29°C) and cooler periods in August (dropping to 24°C). Precipitation, on the other hand, mean 1178 mm per year, shaping a landscape where lush vegetation thrives. Under the influence of this generous climate, the Badenou Classified Forest is home to a fascinating mosaic of vegetation landscapes. Gallery forests, dry dense forests, open forests, wooded savannahs, tree savannahs and shrub savannahs coexist, creating a rich and valuable biodiversity. This diversity of habitats attracts abundant and varied fauna. Numerous mammals, birds, reptiles and amphibians inhabit the forest, contributing to the fragile balance of this unique ecosystem. Furthermore, it contains several rivers, including the Vaka, Badenou, Kodjalogo, Loua, Nafounloho and the Bandaman. It derives its name from the Badenou River which flows through its central part. The Badenou Classified Forest, with its natural beauty and ecological richness, constitutes an invaluable treasure for Côte d'Ivoire. Its protection and sustainable management are essential to preserve this unique natural heritage for future generations.

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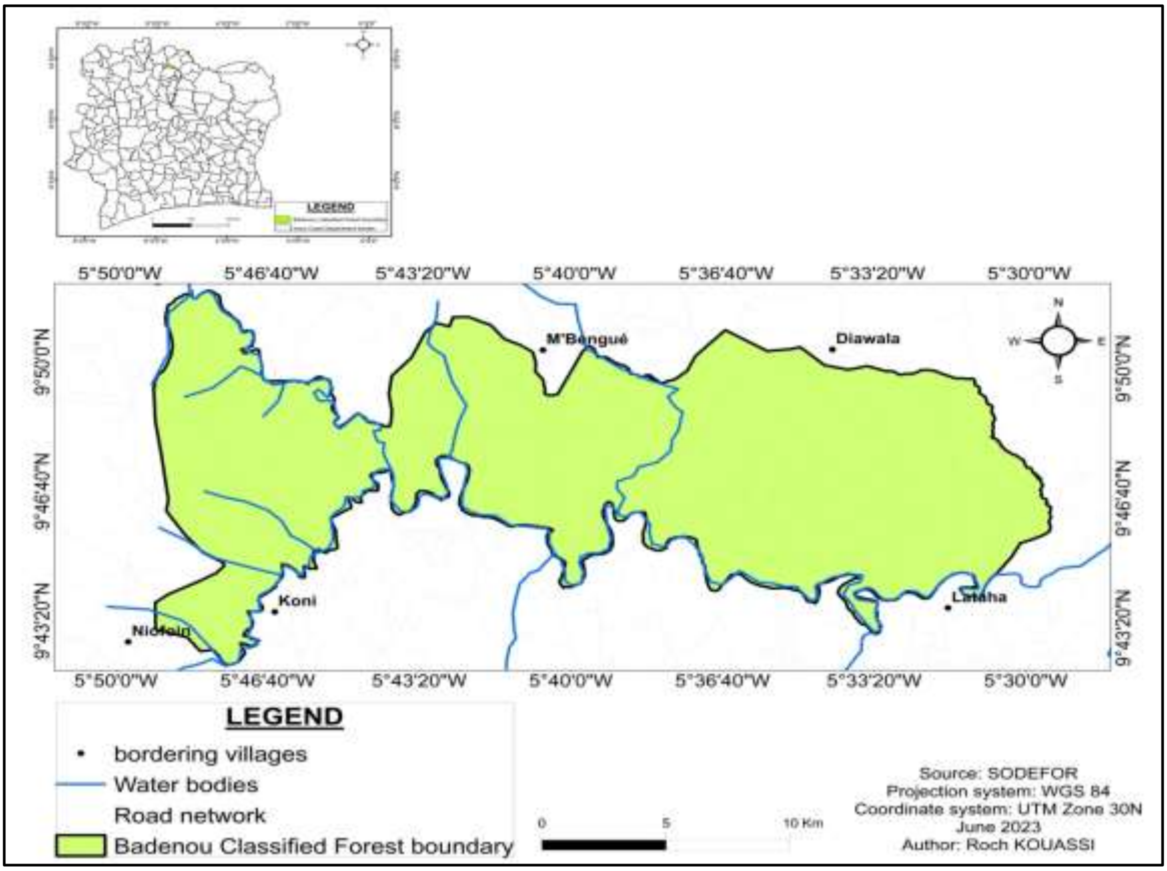

Figure 1. Geographical location of the Badenou Classified Forest

B. Cartographic and Climatic Data

The cartographic data consist of the digital contour of the study area, which is the Badenou Classified Forest, and various other layers of vectors (road network, localities, hydrographic network, and administrative division) extracted from the BNETD database. Regarding the satellite images, they were downloaded from the United States Geological Survey (USGS) website (http://earthexplorer.usgs.gov/). The satellite images used date from the 1990s, 2002, 2012, and 2022. An average interval of 10 years was chosen between the dates, as this is the minimum duration for perceiving changes in vegetation. They are derived from scene 197-53 for Badenou, and from sensors (Landsat TM for the year 1990, Landsat ETM+ for the years 2002 and 2012, and Landsat OLI for the year 2022 **(Table 1)**. These images date from the period of the major dry season, when the cloud cover and cloudiness rates are the lowest (**Chatelain, 1996**). Furthermore, they were acquired during the same period to reduce issues related to solar angles, phenological changes in vegetation, and differences in soil moisture.

Moreover, data relating to climatic parameters such as rainfall (monthly and annual) and maximum, minimum and mean temperatures (Tmax, Tmin, Tmean) were collected at the Korhogo weather station for those that were available. Missing data were collected from the Climate Engine website (ClimateEngine.org). Evaluation of the dynamics of climatic variables from 1990 to 2022 in the different study areas. The climatic variables considered in this study are precipitation (monthly and annual), maximum, minimum, and mean temperatures (Tmax, Tmin, Tmean) and drought indices such as the Standardized Precipitation Index (SPI) and the Palmer Drought Severity Index (PDSI). These parameters are generally considered as components of the climate and environment that most influence the behaviour of forest fires and the dynamics of vegetation (**Guiguindibaye *et al*., 2013; Ago, 2016; Vissin, 2007**). Indeed, temperature is considered one of the main factors influencing the rate of plant development. Higher temperatures predicted by climate change and the risk of more extreme thermal events will impact plant productivity. According to **Hatfield and Prueger (2015)**, the latter dries them out and weakens them in the face of water stress.

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Table 1. Landsat image data from 1990 to 2022 used for the Land use/cover (LULC) dynamics of Badenou Classified Forest (BCF)

YEARS	1990	2002	2012	2022
Categories	Landsat 4 TM	Landsat 7 ETM+	Landsat 7 ETM+	Landsat 9 OLI/TIR
Acquisition date	29/12/1990	22/12/2002	16/01/2012	13/12/2022
Path/Row	197/53	197/53	197/53	197/53

C. Methods

Assessment of Climatic Variables dynamics from 1990 to 2022

To assess the potential climatic drivers of land use and land cover change in the Badenou Classified Forest, a temporal analysis of key meteorological variables was conducted for the period 1990–2022. This analysis focused on temperature regimes, precipitation patterns, and derived drought indices to characterise the climatic stresses acting on the forest ecosystem.

Temperature and precipitation regimes

Time-series data for maximum, minimum, and mean monthly temperatures, alongside total monthly precipitation, were acquired for the study area. A descriptive statistical analysis was performed to quantify interannual variability and identify significant long-term trends. For temperature, linear regression models were applied to the annual time series to determine the rate of warming over the 33 years. Precipitation data were aggregated annually and seasonally to evaluate fluctuations in total rainfall and its intra-annual distribution.

Drought Indices Calculation

To move beyond raw precipitation and capture periods of hydrological deficit critical to vegetation health, two established drought indices were computed:

Standardised Precipitation Index (SPI)

The SPI was calculated to characterise meteorological drought. This index quantifies precipitation anomalies at multiple timescales **(McKee *et al.*, 1993)**. This allows for the classification of conditions into discrete categories of wetness and dryness **(Bergaoui and Alouini, 2001)**. The SPI's utility lies in its ability to directly link precipitation deficits a primary driver of vegetation stress to potential changes in forest cover dynamics **(McKee *et al.*, 1993)**. The interpretation of the SPI calculation results was made based on the SPI classes and their degree of drought or humidity **(Table 2)**. Negative SPI values correspond to a dry year, while positive values indicate wet years. The SPI was evaluated using the following equation:

$$\mathrm{SPI} = \frac{Pi - P_{mean}}{\sigma}$$

SPI = Rainfall Index for year *i*; *Pi* = the total rainfall for year *i*; *Pmean* = average annual rainfall observed over the entire series; σ = Standard deviation of the annual rainfall observed for a given series.

Table 2. Classification of drought according to SPI values (Mckee, Doesken and Kleist, 1993).

SPI Classes	SPI>2	1.5<SPI<1.99	1.0<SPI<1.49	-0.99 <SPI<0.99	-1<SPI<-1.49	-1.5<SPI<-1.99	SPI<-1.99
Level of drought or humidity	Extreme humidity (IL)	High humidity (WH)	Moderate humidity (WM)	Near to the normal	Moderate drought (DM)	High drought (DH)	Extreme drought (DE)

Palmer Drought Severity Index (PDSI)

To provide a more comprehensive assessment of soil moisture availability, the Palmer Drought Severity Index was also calculated. Unlike the SPI, which is based solely on precipitation, the PDSI incorporates a simplified water balance model that accounts for temperature-influenced evapotranspiration and soil water recharge. Thus, it is classified as a meteorological drought index and quantifies the departure of water from the soil surface **(Svoboda and Fuchs, 2016)**.

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This makes it particularly relevant for assessing ecological and agricultural drought, as it more directly reflects the moisture stress experienced by vegetation. The standardised measure of the **PDSI (Table 3)**, ranges from −4 (dry) to +4 (wet), with values below −3 representing severe to extreme drought **(Palmer, 1965)**. Descriptive and trend analyses were evaluated in the same manner monthly over the period (1990-2022) through time series data. The PDSI can be formulated according to the following equation:

$$X_{(i)} = \frac{Z(i)}{\alpha} + \beta X_{(i-1)}$$

X(i) is the PDSI result for the i-th month, *z(i)* is the moisture anomaly index for the i-th month, *X(i-1)* is the PDSI amount for the previous month, α and β are the climatic coefficients of the PDSI.

Table 3. PDSI categorisation of drought severity (Palmer, 1965)

PDSI Values	Drought Categories
4.00 ou more	Extremely wet
3.00 to 3.99	Very wet
2.00 to 2.99	Moderately wet
1.00 to 1.99	Slightly wet
0.50 to 0.99	Beginning of a wet period
0.49 to -0.49	Close to normal
-0.50 to -0.99	Beginning of drought
-1.00 to -1.99	Slightly drought
-2.00 to -2.99	Moderate drought

D. Analysis of the spatiotemporal dynamics of Land Use/Cover

Pre-processing through radiometric and atmospheric correction made it possible to correct certain data errors caused by the time lag during image acquisition and extraction of the study area. These corrections provided clear images for calculating indices such as NDVI, Tasseled cap and PCA, and for applying colour compositions **(Table 4)**. The colour composition allows the establishment of the 327 training plots. These plots were carried out through the identification of the different land use/cover classes. Each plot was assigned a label corresponding to the class to which it belongs **(Aka *et al*., 2022)**. The classes of land use types in Badenou Classified Forest are Gallery Forest, Dense dry forest, Open Forest/Wooded savanna, Tree savanna/Shrub savanna, Low dense shrub savanna, Fallow land, Perennial crop, Bare soil/Rock outcrop/Agricultural development and water body. Among the classification algorithms, maximum likelihood has been used. This method consists of searching for objects similar to reference objects **(Journaux, 2006)**. The classifications were first carried out based on the training points that guided the choice of regions of interest (ROIs) for the land cover classes produced on the most recent Landsat 9 OLI/TIRS images from 2022. Then the Assessment of the mapping result was possible using the confusion matrix. The classifications obtained in raster format were exported to ArcGIS 10.8 software for conversion to vector format. This stage was followed by the production of statistics and cartographic editing. The statistical analyses focused on calculating the area of Land Use/Cover of each classes.

Table 4. Bands used for the colour compositions in the Badenou Classified Forest

Years	1990	2002	2012	2022
Colour composition (bands)	4/ 7/ 3	4/ 7/ 3	4/ 5/ 3	5/ 7/ 4

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E. *Analysis of the Influence of Climatic Variability on Land Use/Cover Dynamics*

A Spearman's rank order correlation analysis was conducted to evaluate the influence of key climatic parameter specifically minimum, mean, and maximum temperature, total annual precipitation, the Palmer Drought Severity Index (PDSI), and the Standardized Precipitation Index (SPI) on the dynamics of Land Use Land Cover (LULC) within the Badenou Classified Forest. The response variables consisted of the areal extent of each LULC class across three distinct transition periods (1990-2002, 2002-2012, and 2012-2022). This non-parametric method was selected due to its suitability for capturing monotonic, potentially non-linear relationships without assuming normality in the data, and for its robustness to outliers (Sokal and Rohlf, 2012). These characteristics are particularly advantageous in ecological studies, where threshold driven responses and non-normal data distributions are common. The resulting correlation matrix identifies significant monotonic associations between climatic variability and changes in LULC areas, providing insight into the potential climatic drivers of observed landscape transformations.

III. RESULTS

A. *Climate variability of the Badenou Classified Forest*

Temperature fluctuation

By analysing the temperatures within BCF, it is observed that the mean, minimum, and maximum temperatures display varied but relatively similar trends over the studied period **(Figure. 2)**. The mean annual temperatures between 1990 and 2022 range from 26.07°C (1992) to 28.60°C (2021), corresponding to an overall increase of 2.5°C over the 30 years. The year 2021 recorded the highest temperature in the series, while the years 1992 and 2012 showed values below the mean. The analysis of minimum temperatures from 1990 to 2022 reveals significant interannual variability, with fluctuations around an average of 20.89°C. The lowest values were recorded in 1992. Maximum temperatures from 1990 to 2022 show marked interannual variability, with notable fluctuations over time. The average maximum temperature over this period is 35.69°C, indicated by a reference line on the graph.

Dynamics of Precipitation

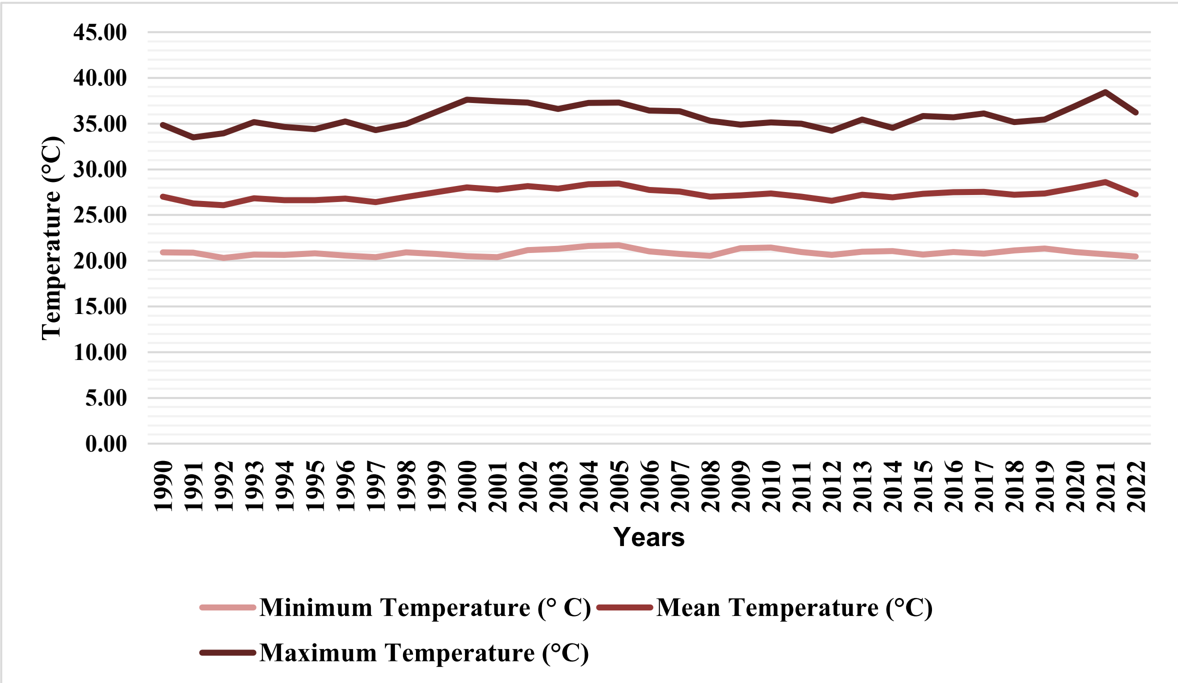

Figure 2. Trend curves of temperature variables in the Badenou Classified Forest from 1990 to 2022

The analysis of annual precipitation between 1990 and 2022, highlights significant interannual variability in the BCF region **(Figure. 3)**. The recorded values range from 888.8 mm in 2015, the driest year, to 1410.9 mm in 2003, which represents one of the highest rainfall peaks. The mean precipitation over the entire studied period is 1178 mm, with a standard deviation of 111.8 mm,

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indicating a humid tropical climate. Some years stand out for particularly low levels of precipitation, such as 2015 and 2017, with 888.8 mm and 976.3 mm, respectively. Conversely, the years 2003 and 2018 recorded precipitation levels significantly above the mean, reaching 1410.9 mm and 1334.6 mm, respectively. These fluctuations reflect an alternation between periods of high humidity and episodes of water deficit. Over the entire 32 years analysed, no clear trend of increasing or decreasing precipitation appears.

The standardised precipitation index (SPI)

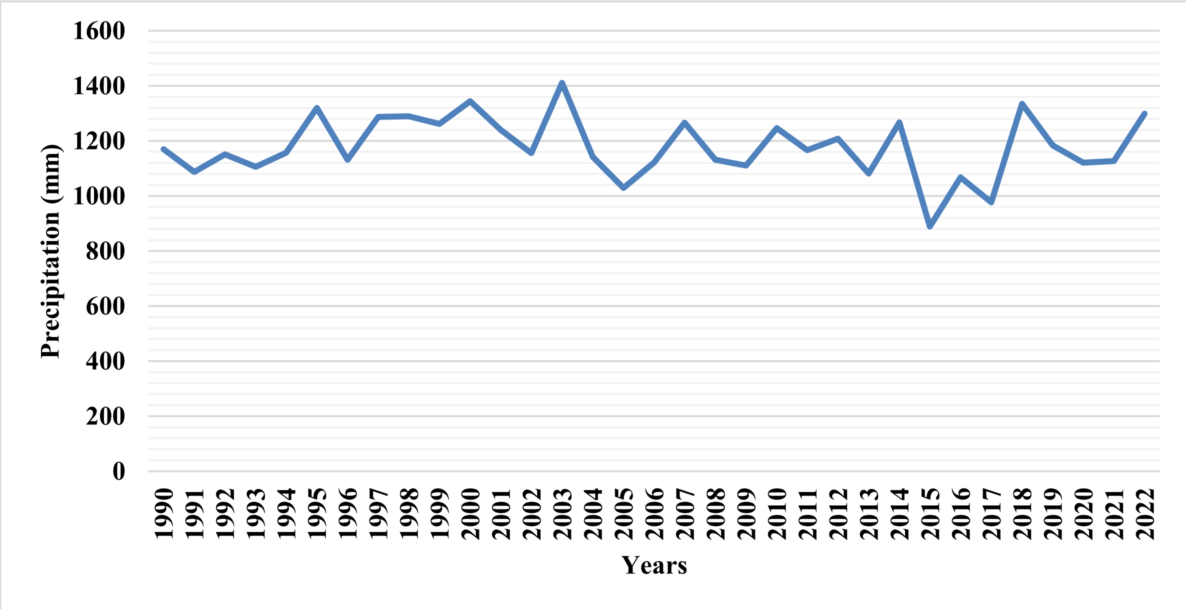

Figure 4. Curve of precipitation fluctuations in the Badenou Classified Forest from 1990 to 2022

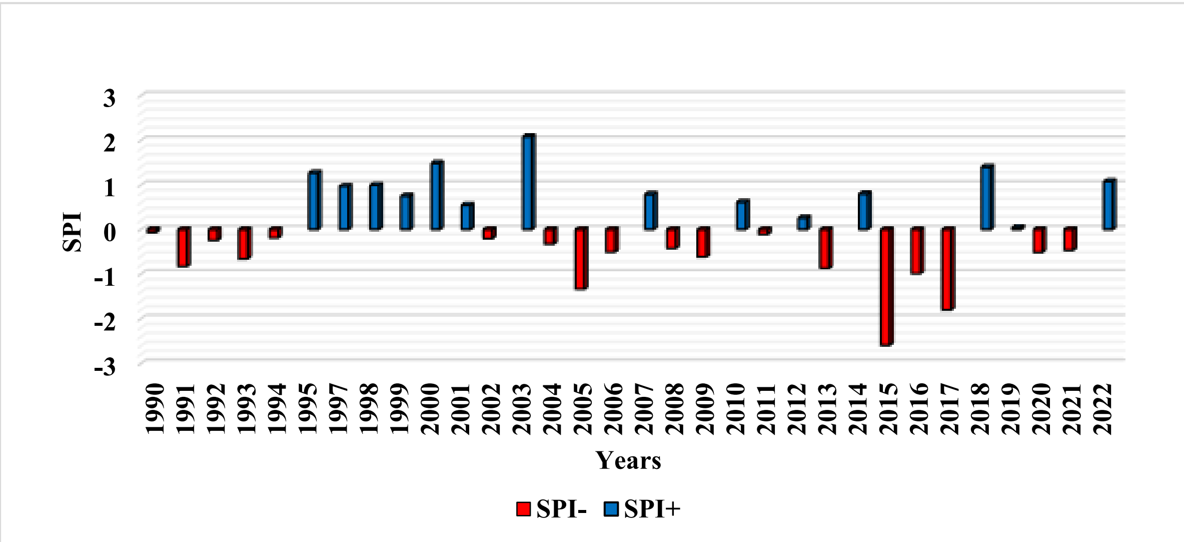

Figure 3. Trend curve of the SPI in the Badenou Classified Forest from 1990 to 2022

The standardised precipitation index (SPI) values at BCF fluctuate regularly, illustrating climatic cycles where some years are characterised by a water deficit while others record a precipitation surplus **(Figure. 4)**. The years 2005 (SPI = -1.33, moderate drought), 2015 (SPI = -2.59, extreme drought), and 2017 (SPI = -1.80, severe drought) are distinguished by strongly negative indices, indicating periods of marked drought. While 2000 (SPI = 1.48, moderate humidity), 2003 (SPI = 2.08, extreme humidity), 2018

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(SPI = 1.40, moderate humidity) and 2022 (SPI = 1.08, moderate humidity) show distinctly positive values, indicating episodes of excessive precipitation. The distribution of extreme values shows an intensification of rainfall variability after the 2000s, with more pronounced alternations between droughts and water surpluses.

Palmer Drought Severity Index (PDSI)

The evolution of the Palmer Drought Severity Index (PDSI) at BCF between 1990 and 2022, highlights significant fluctuations between periods of drought and humidity. Before 2015, the values oscillated around zero, with a relatively balanced alternation between drier and wetter phases **(Figure. 5)**. However, the PDSI classification table **(Table V)** highlights a predominance of drought periods, representing 63.63% of the years studied, with a notable distribution between mild droughts (18.18%), moderate droughts (18.18%), severe droughts (15.15%) and extreme droughts (12.12%).

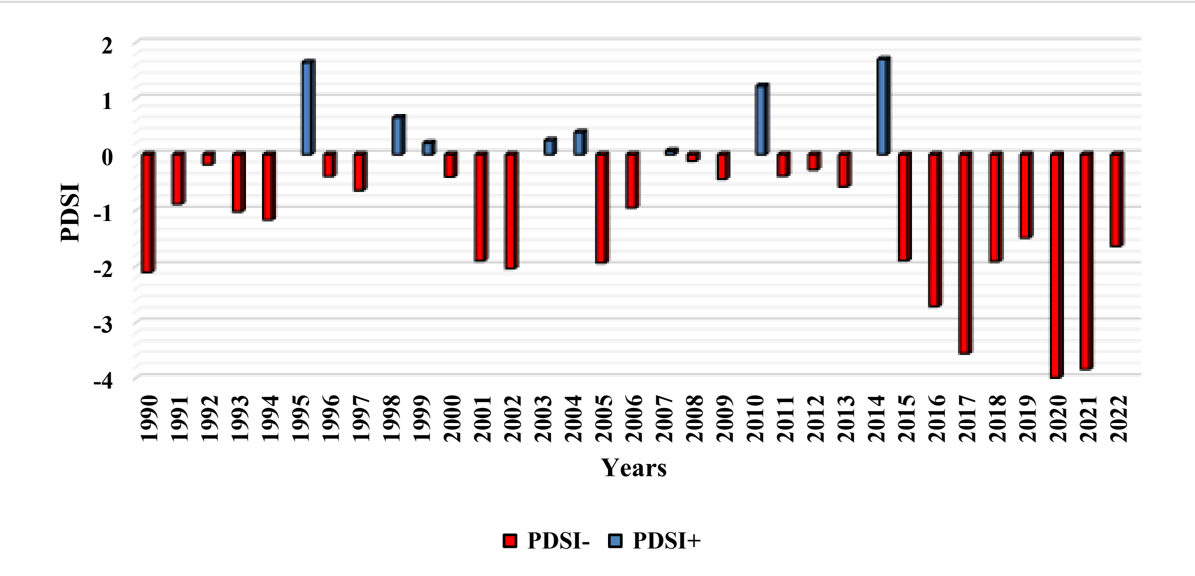

Figure 5. Trend curve of the PDSI in the Badenou Classified Forest from 1990 to 202

Table 5. Distribution of years of study according to PDSI categories at BCF

PDSI Categories	Light Humidity	Beginning of Humid Period	Near Normal	Beginning of Drought	Mild Drought	Moderate Drought	Severe Drought	Extreme Drought	Light Humidity
Years	1991, 1995, 2010	2019	1994, 1996, 2001, 2003, 2004, 2005, 2008	2011	2002, 2007, 2009, 2014, 2015, 2018	1990, 1993, 1999, 2000, 2006, 2012	1992, 1997, 2013, 2017, 2020	1998, 2016, 2021, 2022	1991, 1995, 2010
Number of Years	3	1	7	1	6	6	5	4	3
Proportion (%)	9.09	3.03	21.21	3.03	18.18	18.18	15.15	12.12	9.09

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B. *Dynamics of Land Use Land Cover in the Badenou Classified Forest*

The mapping of the Land Use Land Cover (LULC) of the vegetation at BCF discriminated 8 classes for the years 1990, 2002, 2012 and 2022 **(Figure. 7)**. These are gallery forest/dense dry forest (GF/DSF), open forest/wooded savannah (OF/WS), tree savannah/shrub savannah (TS/SS), sparsely populated shrub savannah (LDSS), fallow (FL), perennial crop (PC), bare land/rock outcrop/ Agricultural development (BL/RO/AD) and water bodies (WB). The overall accuracies of the various classifications for the 1990, 2002, 2012 and 2022 images are 95.98%, 95.60%, 92.65% and 94.39% respectively for Landsat TM, 7 ETM, 7 ETM and OLI-TIRS. The Kappa coefficients are valued at 0.93; 0.91; 0.87 and 0.87 respectively for images from 1990, 2002, 2012 and 2022.

The spectra of proportions (%) and areas in hectares of land use/cover in the BCF vary from year to year **(Table 6)**. In 1990, the BCF was characterised by a strong predominance of tree savannah/shrub savannah, occupying 43% or 14121.73 ha of the total area **(Figure. 8)**. In 2002, the landscape was still characterised by a predominance of savannah environments, with the tree savannah/shrub savannah class covering 42% equivalent to 13641.77 ha of the total area. At the same time, the forest cover shows a notable reorganisation. In 2012, a significant change in vegetation cover was observed, with a marked increase in the tree savannah/shrub savannah class, covering 51% or 1,686.12 ha of the total area. gallery forests/dense dry forests continue to decline, now accounting for 13%, while open forests/wooded savannahs have increased significantly to 21%. In 2022, the landscape is characterised by the marked predominance of tree savannah/shrub savannah, which occupies more than 53%, equivalent to 17555.26 ha of the study area. In terms of gallery forest/dense dry forest, we note a slight increase, accounting for around 19% of the surface area, while open forest/wooded savannah fell from 21% to 6%.

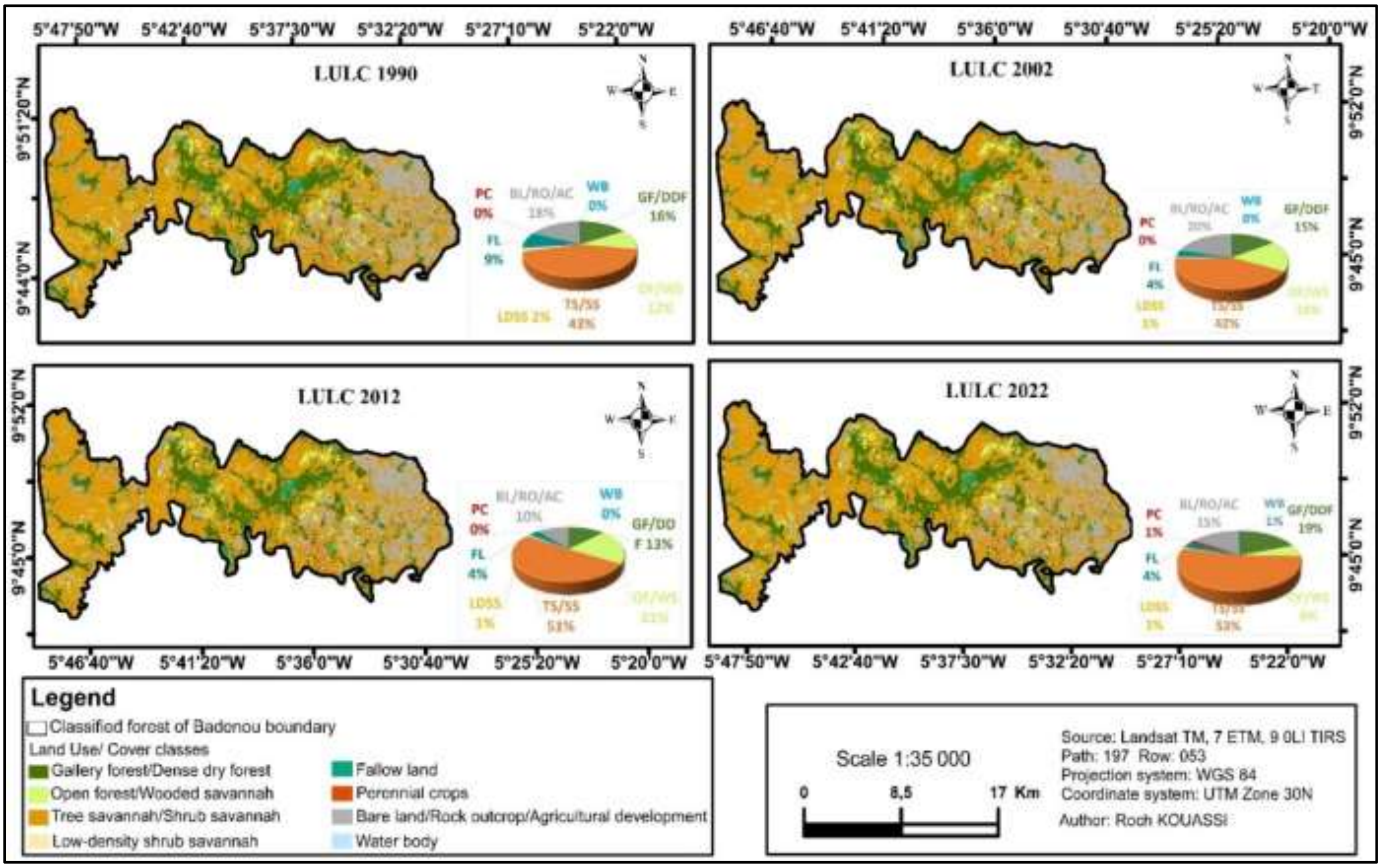

Figure 7. LULC classification map of BCF in 1990, 2002, 2012 and 2022

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Table 6. Land Use Land Cover area proportions of the different study periods

LAND USE LAND COVER	AREA_1990 (ha)	AREA_2002 (ha)	AREA_2012 (ha)	AREA_2022 (ha)
Gallery forest/ Dense dry forest	5312,42	4893,40	4099,96	6336,53
Open forest/ Wooded savannah	3828,51	5950,55	6969,14	2064,01
Tree savannah/ Shrub savannah	14121,73	13641,77	16686,12	17555,26
Low-Density shrub savannah	769,24	378,16	395,37	245,67
Fallow land	3042,08	1244,79	1224,04	1188,63
Perennial crop	16,09	19,67	71,41	387,64
Bare land/ Rock outcrop/Agricultural development	5753,30	6715,04	3402,37	5006,63
Water body	84,40	84,40	79,62	143,74

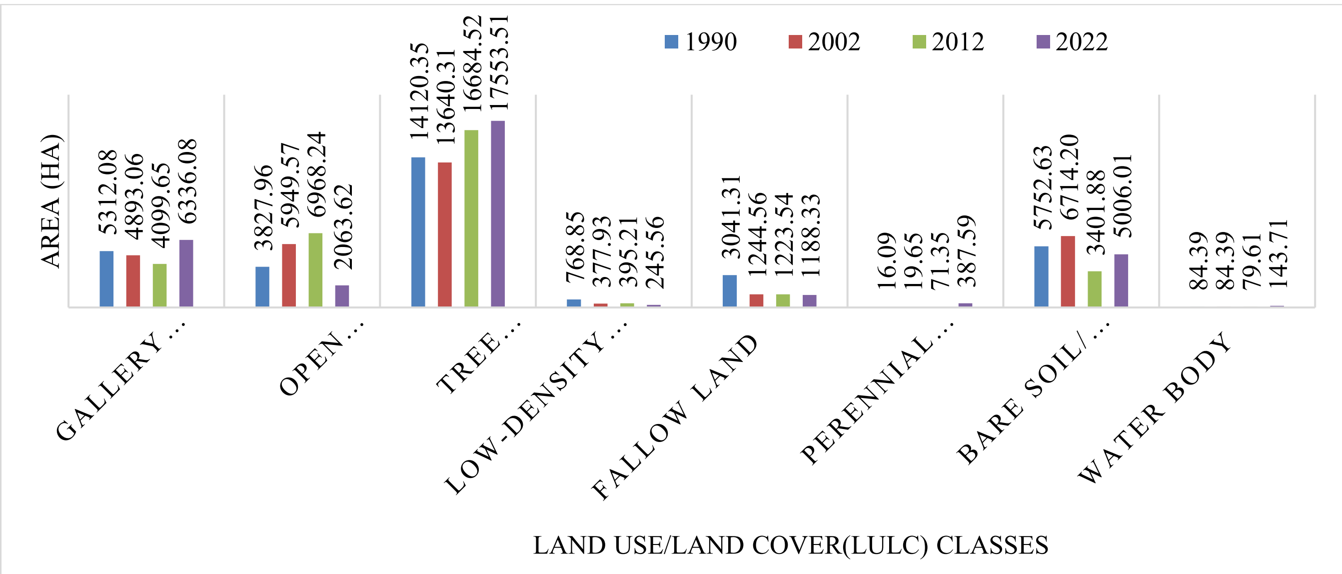

Figure. 8. Dynamic of LULC of BCF in 1990, 2002, 2012 and 2022

C. Influence of Climate Variability on the Dynamics of LULC in the BCF

The correlation conducted through the Spearman test shows that there are links between the dynamics of certain LULC and climatic variables. Thus, the results from the Spearman correlation test show that climatic variables, particularly precipitation, temperatures, as well as the PDSI (Palmer Drought Severity Index) and SPI (Standardized Precipitation Index) drought indices, significantly influence LULC dynamics. The variables that significantly explain the dynamics of different LULC are: mean and maximum temperatures, the Palmer Drought Severity Index (PDSI), and the Standardised Precipitation Index (SPI).

Influences of the mean temperature and the maximum temperature

The analysis of the correlations between temperature and LULC highlights significant and non-significant interactions, revealing the influence of thermal variations on the distribution and evolution of different LULC classes. The mean and maximum temperatures are strongly and negatively correlated with low density shrub savanna (LDSS) (-0.597, $p < 0.0001$; -0.613, $p < 0.0001$). Similarly, fallow lands (FL) are negatively correlated with mean temperature (-0.427, $p = 0.014$) and maximum temperature (-0.413, $p = 0.017$). At the same time, the perennial crop (PC) shows a positive correlation with the mean temperature (0.427, $p = 0.014$) and the maximum temperature (0.413, $p = 0.017$) **(Table 7).**

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Influences of the Palmer Drought Severity Index (PDSI)

The analysis of the correlations between the drought index (PDSI) and LULC reveals a negative correlation with several LULC categories, highlighting the impact of drought periods on vegetation and water bodies. Indeed, the negative correlation between the gallery forest/dry dense forest (GF/DDF) and the PDSI (-0.502, p = 0.003) shows that droughts do not affect this forest formation due to its location along watercourses, which ensures a permanent water supply. Moreover, the surface area of water bodies (WB) significantly decreases during periods of drought, as shown by the negative and significant correlation between water bodies and the PDSI (-0.545, p = 0.001). This confirms that periods of drought have a direct impact on the availability of surface water. On the other hand, some positive correlations are observed. Thus, the low density shrub savanna (LDSS) shows a positive correlation with the PDSI (0.384, p = 0.028), suggesting that this vegetation formation tends to increase with the intensification of droughts.

Influences of the Standardised Precipitation Index (SPI)

The SPI index, which measures precipitation anomalies, establishes several significant and non-significant relationships with LULC categories, highlighting the influence of precipitation variations on ecosystem dynamics and the distribution of different types of LULC. As a result, a positive and significant correlation is observed between the SPI index and precipitation (0.665, p < 0.0001), confirming that this index accurately reflects rainfall variability. Another significant relationship concerns bare land/rock outcrop/Agricultural development (BL/RO/AD), which is positively correlated with SPI (0.362, p = 0.039). Other correlations, on the other hand, are not significant. In this regard, the low density shrub savanna (LDSS) shows a weak positive correlation with SPI (0.126, p = 0.483), indicating that relative humidity conditions do not have a significant influence on this vegetation formation. Moreover, the relationship between Water Bodies (WB) and SPI (-0.076, p = 0.674) is negative but not significant.

Table 7. Spearman's test correlations between climatic variables and LULC in the Badenou Classified Forest

Variables		Gallery forest/ Dense Dry Forest (GF/DDF)	Open Forest/ Wooded Savannah (OF/WS)	Tree Savanna/Shrub Savanna (TS/SS)	Low Density Shrub Savanna (LDSS)	Perennial Crop (PC)	Fallow Land (FL)	Bare Land/ Settlement (BL/ST)	Water Body (WB)
Precipitation	Correlation value	-0.091	0.113	-0.264	0.245	-0.241	0.241	0.171	-0.224
	P-Value	*0.614*	*0.531*	*0.137*	*0.168*	*0.176*	*0.176*	*0.339*	*0.210*
	Coefficient of Determination	0.008	0.013	0.070	0.060	0.058	0.058	0.029	0.050
PDSI Value	Correlation value	-0.502	0.510	-0.348	0.384	-0.316	0.316	0.109	-0.545
	P-Value	*0.003*	*0.003*	*0.048*	*0.028*	*0.073*	*0.073*	*0.545*	*0.001*
	Coefficient of Determination	0.252	0.260	0.121	0.148	0.100	0.100	0.012	0.297

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SPI Value	Correlation value	0.057	-0.002	-0.304	0.126	-0.136	0.136	0.362	-0.076
	P-Value	*0.753*	*0.992*	*0.086*	*0.483*	*0.448*	*0.448*	*0.039*	*0.674*
	Coefficient of Determination	0.003	0.000	0.092	0.016	0.019	0.019	0.131	0.006
Minimum Temperature	Correlation value	-0.130	0.135	0.195	-0.393	0.231	-0.231	-0.167	0.009
	P-Value	*0.468*	*0.452*	*0.276*	*0.025*	*0.196*	*0.196*	*0.352*	*0.959*
	Coefficient of Determination	0.017	0.018	0.038	0.154	0.053	0.053	0.028	0.000
Mean Temperature	Correlation value	0.063	-0.031	0.132	-0.597	0.427	-0.427	0.123	0.266
	P-Value	*0.729*	*0.862*	*0.461*	*0.000*	*0.014*	*0.014*	*0.494*	*0.135*
	Coefficient of Determination	0.004	0.001	0.018	0.356	0.182	0.182	0.015	0.071
Maximum Temperature	Correlation value	0.011	0.018	0.178	-0.613	0.413	-0.413	0.082	0.170
	P-Value	*0.953*	*0.919*	*0.321*	*0.000*	*0.017*	*0.017*	*0.649*	*0.342*
	Coefficient of Determination	0.000	0.000	0.032	0.376	0.171	0.171	0.007	0.029

IV. DISCUSSION

The results relating to climate variability showed a very noticeable dynamic of the climatic variables at Badenou Classified Forest over 32 years of study. Research indicates that the mean temperature (Tm) in the study area has increased by more than 2°C, demonstrating that this region is also experiencing the global warming effect highlighted by the **IPCC (2021)**. This local trend supports broader findings that Africa's temperatures are rising faster than the global mean, as noted by **Niang *et al*., (2014).** The temperature increase observed at the BCF site is not an isolated case; it is part of a wider pattern across Côte d'Ivoire, as confirmed by several other **(Kouassi *et al*., 2024; Kouao *et al*., 2024; Akobé *et al*., 2024; Dosio *et al*., 2020; World Bank, 2021; Sintayehu, 2018)**. The analysis of the correlations between climatic variables and LULC dynamics in the Badenou Classified Forest, highlights contrasting influences, with a dominant role of temperatures and drought indices.

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The significantly negative correlation between mean and maximum temperatures and low density shrub savannah (LDSS), suggests that the increase in temperatures tends to reduce the area of these formations. This phenomenon reflects a gradual transfer of a significant portion of these savannah to denser formations, particularly tree savannah/ shrub savannah (TS/SS), over the past three decades, as justified by the transition matrix. Indeed, the low density shrub savannah (LDSS) have decreased from 769.24 ha in 1990 to 254.67 ha in 2022, illustrating this large-scale dynamic.

However, this shift should not be perceived as degradation, but rather as a process of increased vegetation, marked by the gradual densification of low density shrub savannah (LDSS). Indeed, these habitats become denser thanks to the regeneration and recruitment of young trees. The increase in tree cover transforms these initially sparse formations into denser formations, to the benefit of tree savannah/shrub savannah (TS/SS). This observation is corroborated by positive correlations between the Palmer Drought Severity Index (PDSI) and low density shrub savannah (LDSS), with a correlation value of 0.384 ($p = 0.028$), suggesting an expansion of these formations during periods of increased drought.

On the other hand, other correlations are not statistically significant. Thus, the correlation between low density shrub savannah (LDSS) and the Standardised Precipitation Index (SPI) is weak (0.126, $p = 0.483$), indicating that relative humidity does not have a significant effect on this vegetation formation. This highlights the resilience of low low-density shrub savannah (LDSS) to climate variability, particularly the increase in temperatures and prolonged drought. Moreover, some low density shrub savannah are located along the waterways, between the gallery forests and the wooded savannahs/Open Forests, or at the tops of hills on ferruginous crusts, particularly in the western zone of the classified forest. This positioning provides them with constant access to water, thus promoting their development. The positive correlation between perennial crop (PC) and mean temperature (0.427, $p = 0.014$), as well as maximum temperature (0.413, $p = 0.017$), suggests that these cultivated species may be favoured in warmer climatic conditions. This trend could be explained by the better resistance to high temperatures or the adaptation of the cultivated species. Indeed, most perennial crops within this classified forest are dominated by cashew tree (Anacardium occidentale) and mango tree (Mangifera indica), two species well adapted to the climatic conditions in the north of the country, characterised by higher temperatures and lower rainfall than those observed in the southern forest zone **(Yao, 2019)**. A similar phenomenon is observed for fallow lands (FL), which are negatively correlated with average temperature (-0.427, $p = 0.014$) and maximum temperature (-0.413, $p = 0.017$), meaning that the increase in average and maximum temperatures leads to a reduction of these changing areas. These results confirm the gradual conversion of fallows (FL) into open forest/wooded savannah and tree savannah/shrub savannah (TS/SS).

As with low density shrub savannah (LDSS), the fallows are densifying and returning to their original formation. The analysis of transitions highlights the conversion of fallow lands into shrub/wooded savannas and light forests/wooded savannas. Since the classified forest is a protected area, the local populations enter it clandestinely to develop crops. In order to avoid surveillance by the Water and Forest agents, these populations prefer the lighter forests, whose soils are rich, and they camouflage these cultivated areas by deliberately leaving strips of untouched forest. Initially, these areas are exploited for annual crops (rice, cotton, food crops, and maize), then gradually replaced by perennial crops such as cashew and mango. This cycle of temporary anthropisation followed by natural regeneration highlights a complex dynamic between human activities, changes in plant cover and ecosystem resilience. The work of several authors confirms this trend, emphasising that this transition to perennial crops is motivated by economic and ecological considerations, ensuring economic stability and better climate adaptation **(Timité *et al.*, 2023; Konan *et al.*, 2023; N'Guessan *et al.*, 2019; Koffi *et al.*, 2019; Kpangui *et al.*, 2021).**

V. CONCLUSION

This study quantified the influence of climate variability on the spatio-temporal dynamics of Land Use Land Cover in the Badenou Classified Forest (Côte d'Ivoire) over a 32-year period (1990-2022). Our results highlight a marked regional climatic trend, characterised by a significant increase in the mean temperature of more than 2°C and an intensification of drought episodes, as evidenced by the PDSI and SPI indices. These climatic changes act as critical environmental stressors, modulating the structure and composition of ecosystems. Spearman's correlation analysis revealed complex and significant relationships between climatic variables and landscape dynamics. The increase in mean and maximum temperatures is correlated with a decline in low density shrub savannahs (LDSS) and fallow lands (FL), indicating a process of progressive vegetation densification favouring more shrubby and wooded formations (TS/SS). This phenomenon, which could be initially misinterpreted as degradation, appears in fact to be an ecological dynamic of ecosystem resilience and transformation in response to thermal and hydrological stress. Concurrently, the expansion of perennial crops (PC), favoured by higher temperatures, illustrates a mixed adaptation, both ecological and anthropogenic, in this protected landscape under pressure. The significant negative relationship between the PDSI and water bodies (WB) confirms the vulnerability of surface water resources to prolonged drought episodes. Conversely, the resilience of the gallery forest/dense dry forest (GF/DDF), less sensitive to climatic variations due to its privileged access to water, underscores the crucial role of riparian corridors as biodiversity refuges in a changing climate.

Finally, this research demonstrates that climate variability is a major ecological driver that interacts with anthropogenic pressures to reshape the landscapes of the sub-Sudanian sector. Our findings underscore the urgency of integrating climate scenarios into management and conservation plans. Adaptive strategies, such as enhancing the protection of gallery forests, promoting resilient species, and regulating agricultural activities on the periphery, are essential to preserve the ecological integrity of the Badenou Classified Forest and ensure the sustainability of its ecosystem services within a context of global change. These insights provide a valuable analytical framework, transferable to other similar ecosystems in West Africa, for anticipating changes and guiding evidence-based conservation policies.

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REFERENCES

1. Ago, E.E., (2016). Dynamics of carbon fluxes between the atmosphere and West African ecosystems: the case of forests and savannas under a Sudanese climate in Benin. Doctoral thesis, University of Liège Gembloux Agro Bio Tech, Brussels. 184 p.
2. Aka, K.S.R., Akpavi, S., Dibi, N.H., Kabo-Bah, A.T., Gyilbag, A. & Boamah, E., (2022). Toward understanding land use land cover changes and their effects on land surface temperature in yam production area, Côte d'Ivoire, Gontougo Region, using remote sensing and machine learning tools (Google Earth Engine). Frontiers in Remote Sensing, vol. 4, p. 1221757. doi:10.3389/frsen.2023.1221757.
3. Akobé, É. Y., Diawara, A., Yoroba, F., Kouassi, B. K., Yapo, A. L. M., Diba, I., Kouadio, K., Tiémoko, D., Koné, D. I., & Diedhiou, A. (2024). Trends in the occurrence of compound extremes of temperature and precipitation in Côte d'Ivoire. *Atmosphere, 16*(1), Article 3. https://doi.org/10.3390/atmos16010003
4. Al Hamndou, D., & Requier-Desjardins, M. (2008). Variabilité climatique, désertification et biodiversité en Afrique : s'adapter, une approche intégrée. VertigO - la revue électronique en sciences de l'environnement, 8(1). https://doi.org/10.4000/vertigo.5356
5. Ardoin S., Lubès-Niel H., Servat E., Dezetter A. & Boyer J. F., (2003). Analysis of the persistence of drought in West Africa: characterization of the situation in the 1990s. IAHS Publication, no. 278, pp. 223-228.
6. Bergaoui, M. & Alouini, A., (2001). Characterization of meteorological and hydrological drought: Case of the Siliana watershed in Tunisia. Sécheresse, vol. 12, no. 4, pp. 205–213.
7. Chatelain, C., (1996). Possibilities of applying high-resolution satellite imagery to the study of vegetation transformations in forested Côte d'Ivoire. Doctoral thesis, University of Geneva, Switzerland. 158 p.
8. Cornet A., (2002). Desertification at the crossroads of environment and development: a problem that concerns us. Sustainable Development Summit, Johannesburg, 2002: 93-130

9. Diawara A., Yoroba F., Kouadio K. Y., Kouassi K. B., Assamoi E. M., Diedhiou A., & Assamoi P., (2014). Climate Variability in the Sudano-Guinean Transition Area and Its Impact on Vegetation: The Case of the Lamto Region in Côte D'Ivoire. Hindawi Publishing Corporation Advances in Meteorology, Volume 2014, 11p. http://dx.doi.org/10.1155/2014/831414
10. Dosio, A., Lennard, C., & Spinoni, J. (2022). Projections des indices de température et de précipitations journalières basées sur des simulations du modèle climatique régional CORDEX-Afrique corrigées des biais [Projections of daily temperature and precipitation indices based on bias-adjusted CORDEX-Africa regional climate model simulations]. *Climatic Change, 170*(1), Article 13. https://doi.org/10.1007/s10584-022-03307-0
11. Guiguindibaye, M., Belem, M.O. & Boussim, J.I., (2013). Characteristics of fires in a fire in the Sudanian savannah of Chad. International Review of Biological and Chemical Sciences, vol. 7, no. 3, pp. 1147–1156.
12. Guillaumet, J.-L. & Adjanohoun, E. (1971). The vegetation of Côte d'Ivoire. In: Avenard, J.-M., Eldin, M., Girard, G., Sircoulon, J., Touchebeuf de Lussigny, P., Guillaumet, J. L., Adjanohoun, E., Perraud, A. The natural environment of Côte d'Ivoire. Paris: ORSTOM, (50): 161–263.
13. Hatfield, J. L., & Prueger, J. H. (2015). Temperature extremes: Effect on plant growth and development. *Weather and Climate Extremes*, *10*(Part A), 4–10. https://doi.org/10.1016/j.wace.2015.08.001
14. IPCC, (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change: https://www.ipcc.ch/report/ar6/wg1/
15. Koffi K. E., Kouadio, K. E., & N'Guessan, K. E., (2019). Impact of subsistence farming on vegetation cover dynamics in the Indénié-Djuablin region (Eastern Côte d'Ivoire). African Agronomy, Special Issue (8) / AGRIEDAYS 2019, 85-97.
16. Konan G. D., Kpangui, K. B., Kouakou, K. A., & Barima, Y. S. S., (2023). Typology of cocoa-based agroforestry systems according to the cocoa production gradient in Côte d'Ivoire. International Journal of Biological and Chemical Sciences, 17(2), 378-391.
17. Kouao J.-M., Tagnon B., Koffi B., Kouassi A. M., Kouassi K. A., & Gone, D. L. (2024). Climate Variability and Recent Interannual Climate Trends in West Africa: The Case of Côte d'Ivoire. ESI Preprints. https://doi.org/10.19044/esipreprint.10.2024.p235
18. Kouassi, N. R. G., Dibi, N. H., Nanan, K. K. N., Yao, N. O., (2024). Impacts of climate variability on the spatio-temporal dynamics of plant formations in the forest-savannah transition zone: the case of the Lamto Scientific Reserve, Central Côte d'Ivoire. International Journal of Current Science Research and Review, 7(12), 8924-8942. DOI: 10.47191/ijcsrr/V7-i12-32
19. Kpangui K. B., Kouakou A. A., Kouassi K. A., & Barima, Y. S. S., (2021). Impacts of the installation of cocoa plantations in the forest-savannah contact zone of Biankouma in Ivory Coast. African Agronomy, 33(2), 57-68.https://www.researchgate.net/publication/370769474_IMPACTS_DE_L'INSTALLATION_DES_CACAOYERES_SUR_LA_DYNAMIQUE_DU_PAYSAGE_EN_ZONE_DE_CONTACT_FORET-_SAVANES_DE_BIANKOUMA_OUEST_COTE_D'IVOIRE
20. McKee, T.B., Doesken, N.J. & Kleist, J., (1993). The relationship between the frequency and duration of droughts and time scales, in Proceedings of the 8th Conference on Applied Climatology, vol. 17, no. 22, pp. 179–183.
21. N'Guessan, A. E., N'dja, J. K., Yao, O. N., Amani, B. . H. K., Gouli, R. G. Z., Piponiot-Laroche, C., Zo-Bi, I. C., & Hérault, B. (2019). Drivers of biomass recovery in a secondary forested landscape of West Africa. Forest Ecology and Management, 433, 325–331.https://doi.org/10.1016/j.foreco.2018.11.021
22. Niang, I., Ruppel, O.C., Abdrabo, M.A., Essel, A., Lennard, C., Padgham, J. & Urquhart, P., (2014). 'Africa', dans Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., Field, C.B., Dokken, D.J., et al. (eds.)]. Cambridge: Cambridge University Press, pp. 1199–1265.
23. Omotoso, A. B., Letsoalo, S., Olagunju, K. O., Tshwene, C. S., & Omotayo, A. O. (2023). Changements et variabilité climatiques en Afrique subsaharienne : une analyse systématique des tendances et des impacts sur l'agriculture. Journal of Cleaner Production, 137487. https://doi.org/10.1016/j.jclepro.2023.137487
24. Palmer, W.C., (1965). Meteorological drought. U.S. Weather Bureau Research Paper No. 45. 58 p.

25. PNUE/UNEP. (2020). Emissions Gap Report. Disponible à : Emissions Gap Report 2020
26. Sighomnou D. (2004). Analysis and redefinition of Cameroon's climatic and hydrological regimes: prospects for the evolution of water resources. Doctoral thesis, University of Yaoundé 1, Cameroon, 279 p.
27. Sintayehu, D. W. (2018). Impact of climate change on biodiversity and associated key ecosystem services in Africa: A systematic review. Ecosystem Health and Sustainability, 4(9), 225-239. https://doi.org/10.1080/20964129.2018.1530054
28. Sokal, R.R., Oden, N.L. & Thomson, B.A., (2012). A Problem with Synthetic Maps. Human Biology, vol. 84, no. 5, pp. 609–621. doi:10.1353/hub.2012.a503922.
29. Svoboda, M.D. & Fuchs, B.A., (2016). Handbook of Drought Indicators and Indices, vol. 2. Geneva, Switzerland: World Meteorological Organization. 53 p.https://digitalcommons.unl.edu/droughtfacpub/117/
30. Timité, N., Koua, K. A. N., Kouakou, A. T. M., & Barima, Y. S. S., (2023). Spatio-temporal dynamics of agroforestry parks in the Sudanian zone of Côte d'Ivoire from 1990 to 2020 in a context of cashew expansion. International Journal of Biological and Chemical Sciences, 17(2), 484-504.
31. United Nations Environment Programme. (2022). Spreading like wildfire – The rising threat of extraordinary landscape fires. A UNEP Rapid Response Assessment. https://www.unep.org/resources/report/spreading-wildfirerising-threat-extraordinary-andscape-fires.
32. Vissin, E. (2007) Impact de la variabilité climatique et de la dynamique des états de surface sur les écoulements du bassin béninois du fleuve Niger. Thèse Doctorale, Université de Bourgogne, Spécialité : Hydro climatologie, Bourgogne, 311 p.https://theses.hal.science/tel-00456097
33. World Bank. (2021). République de Côte d'Ivoire 2021-2030 - Maintenir une croissance élevée, inclusive et résiliente après la COVID–19: Une contribution du Groupe de la Banque mondiale à la Stratégie de developpement à l'horizon 2030. © World Bank. http://hdl.handle.net/10986/36454 License: CC BY 3.0 IGO."
34. Yao N., O., (2019). Dynamics and ecological value of vegetation in the sub-Sudanese sector; case of the department. Doctoral thesis, Laboratory of Botany, Félix Houphouët-Boigny University, Cocody - Abidjan, Côte d'Ivoire, 229 p.
35. Yao, F. Z., Reynard, E., Ouattara, I., N'go, Y. A., Fallot, J.-M., & Savané, I. (2018). A new statistical approach to assess climate variability in the White Bandama watershed, Northern Côte d'Ivoire. *Atmospheric and Climate Sciences*, *8*(4), 402-423. https://doi.org/10.4236/acs.2018.84027

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