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An Assessment of Climate and Vegetal Resources of Tabalak Wetland Watershed

Soumaila Yacouba Amsatou[1], Adnan Abdulhamid[2] & Dan Guimbo Iro[3]

1 (Department of Geography Bayero University, Kano Nigeria)
2 (Department of Geography, Bayero University, Kano Nigeria)
3 (Department of Agronomy, University Abdou Moumouni, Niamey, Niger)

Abstract

The objective of this study was to assess how climate change and variability affect Tabalak wetland watershed vegetation. Thus, three (3) villages (Kéhéhé, Tabalak and Tsaouna) were identified according to their morphological units and their socio-economic activities to form the experimental sites where all the primary data were collected. GPS coordinates were used to identify the units of measurement. Fieldwork and forest inventory were also carried out in 63 plots, in which 48 on the east-west and 15 on the west-east axes. Our findings showed that in the last 40 years (1980-2020) there was increasing variability of temperature in Tahoua area including Tabalak watershed with mean values of 38.96°C in 1980 to 40.04 °C in 2020. The decadal changes are shown increase of 0.6 °C between 1980 and 2020 .For the vegetation cover, the composition shows degradation in plant cover with only 10 species belonging to 6 families in the area. However, diversity index, equitability index and regeneration rate are low.

Keywords: Wetland, Watershed, Temperature, Precipitation Vegetation and Tabalak.

Introduction

Sahel region of the tropical Africa is increasingly faced with harsh climatic conditions that aggravates the food insecurity coupled with high population growth, with insufficient agricultural and pastoral resources due to decline in soil fertility. The recent research of the United Nations (World Water Development, 2015) has demonstrated that a number of forces continue to seriously affect the natural water resources in the Sahel. Wetlands cover about 6% of the land surface and are often found at the interface between terrestrial ecosystems, such as forests and grasslands, and water, such as lake, rivers, estuaries, and oceans (IUCN, 2019). These areas comprise very important ecosystems: wetland has many purposes and thus dependable sources of nutriments for ecological and agricultural production potential in comparison with the surrounding dry lands, (Ramsar, 2000; Hautier et al. 2015; Huiran et al, 2018). Climate change is expected to intensify the loss and degradation of many wetlands. According to the Ramsar Convention's World Wetlands Report, over the last thirty years, several wetlands have disappeared. These areas are disappearing at an alarming rate, three times faster than forests, with serious consequences for the future of local and surrounding populations. Indeed, between 1970 and 2015, about 35% of the world's wetlands disappeared and the rate of loss has accelerated sharply (Ramsar, 2020). Sustainable management of wetlands needs to incorporate the full suite of services provided by a wetland and assess the factors threatening the ecosystem (Barros et al, 2018; Ramsar, 2000). In watershed level approach, the assessment of wetland ecological functions, impacts of land degradation and agriculture or livestock use is needed. Site specific, detailed ecological information is required before any sustainable management of wetland (Ministry of Environment and fight against Desertification, 2009).

Material and Methods

The study was conducted in the watershed of Tabalak wetland (Figure 1) in Tahoua region. The waterhole runs along the uranium road (Tahoua-Arlit road) for about ten kilometres, from the village of Kéhéhé to Tsaouna, passing through Tabalak. The waterhole is fifty (50) km from the town of Tahoua, around the geographical co-ordinates 15°05' North latitude and 05°39' East longitude (National Institute of Statistic NIS, 2012). The surface area of the water body varies according to the season from 50 ha to almost 1000 ha with an average depth of 2 m. The watershed is part of the Ader-Doutchi-Maggia plateau area. The average altitude of the watershed is between 300 and 500m with a high point reaching 746 metres (Communal Development Plan of Tabalak, 2010).

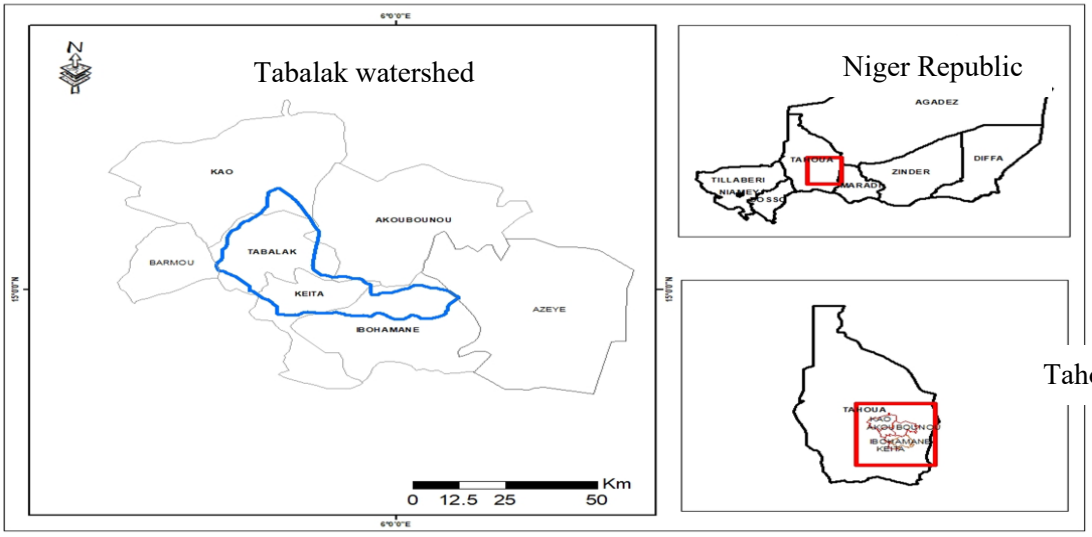


Figure 1: Watershed of Tabalak wetland

Selection of the Study Area and Sampling

The locations for data collection (Figure 2 and 3) were selected through literature review and field visits which made it possible to detect the major environmental issues due to climate change and humans activities in the watershed.

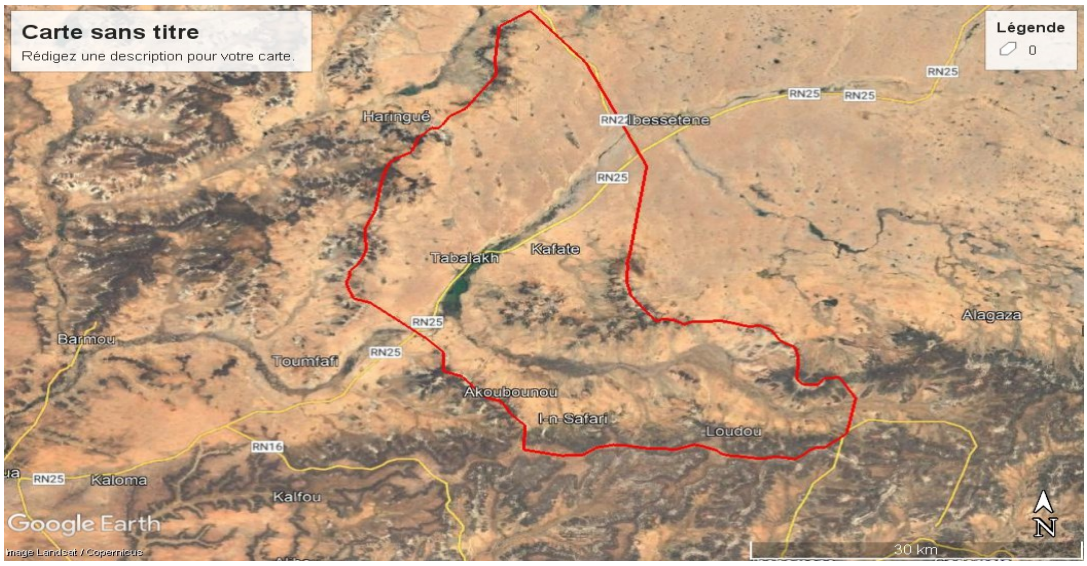


Figure 2: Delimitation of the study area on the Landsat image

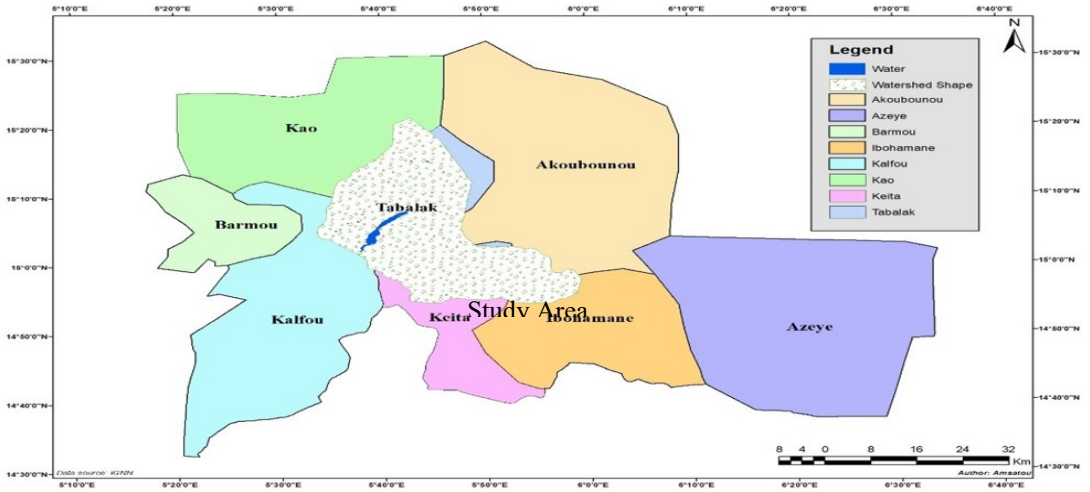


Figure 3: The study area in the Tabalak watershed

Methods of Vegetation Resources Data Collection

The systematic East-West and West- East radial transect sampling method was used. Survey lines converge at the Lake where all the water of the watershed runoff flow (Figure 4). The survey units are plots of 50 m x 50 m (or 2500 m²) which corresponds to the minimum area generally used for surveys in agroforestry parks in West Africa in the case of woody (Cottam, et al, 1956; FAO, 2015). These plots were placed along the survey lines with an equidistance of 200m; regeneration was inventoried in 5m x 5m (25 m².) plots within the survey plots (Donon et al. 2014). The first inventory plot was placed 500m from the village to avoid the effect of housing rights-of-way.

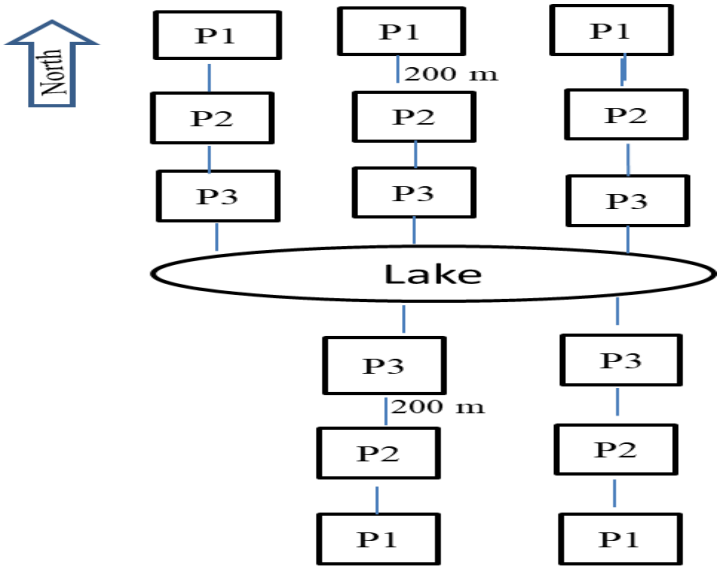


Figure 4: Layout of the survey plots on the woody vegetation inventory transects

A total of 63 plots were set up, in which 48 on the east-west axis and 15 on the west-east axis. Within each plot, surveys were conducted on: (i) dendrometric measurements of woody individuals including discards; (ii) parameters related to stationary conditions (geographic coordinates and types of morphological units) and (iii) the types of land use in the plot.

Material

The characterization of woody vegetation of the Tabalak watershed was carried out using a batch of equipment for carrying out the forest inventory. Details on the use of these materials are given in the following matrix (Table 1)

Table 1: Equipment for forest inventory

Material	**Use**
GSP	Geo-referencing, orientation and measurement of distance between plots
50m tape measure	Delineation of plots
Trimmer's tape measure	Measurement of the trunk circumference of woody individuals at 1.30m
Graduated pole	Measurement of the total height of the trees
Four stakes	Marking of plots
Inventory sheets	Recording of parameters (dendrometric, environmental and land use)

Data Analysis

The analysis of the data consisted firstly of determining the demographic characteristics of the vegetation in the watershed. The list of tree species was established according to the Species Importance Value Index (SIVI) of each species. The description of the woody stand included the following global structural parameters: basal area, density, regeneration rate and ecological characteristics of the stand were reported by the Shannon-Weaver diversity index and the Piélou equi-repartition index (Brouwer, 2009).

Results

a) Temperature Variation

The analysis of the Monthly Average temperatures variation (Figure 5) revealed that, over the periods 1981-2021 only the months of January, August and December do not record more than 35° C on average over the year and March, April, May and June are the hottest months with average temperatures that can exceed 40°C. 2013 (40.26° C), 2009 (40.15° C), and 2017 (40.11° C) (figure 5) (National Directorate of Meteorology (NDM), 2021). The highest temperatures recorded were in the years 2020 (40.84 °C), 2010 (40.67 °C), 2016 (40.48 °C), corresponded to the dry periods for the Watershed.

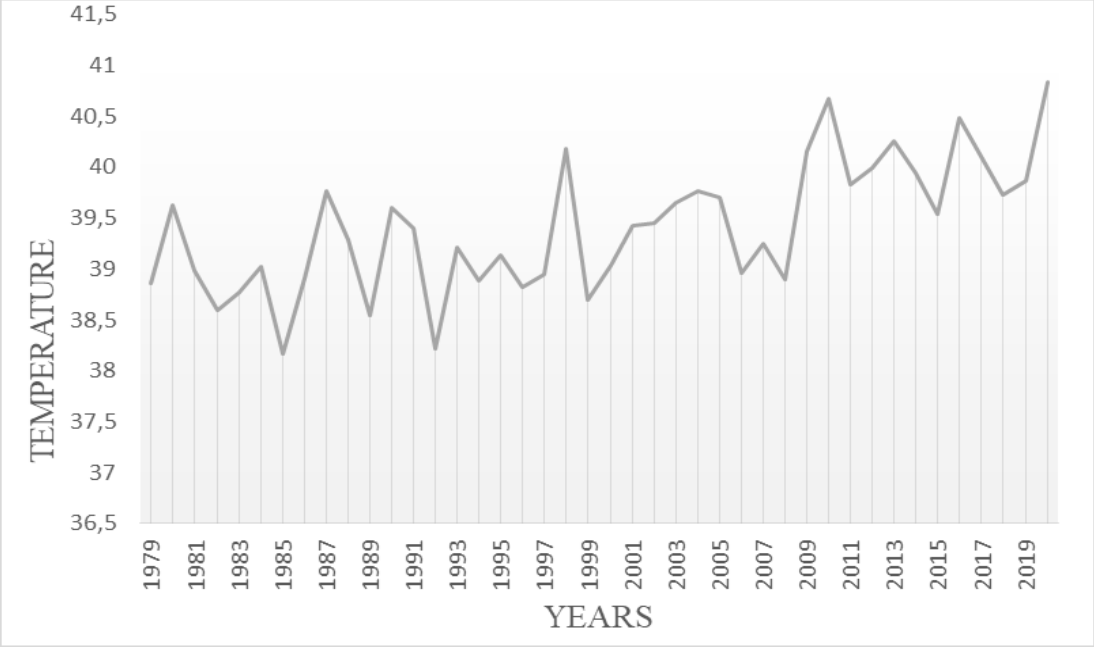


Figure 5 : Annual variation of maximum temperature data in Tahoua (1979-2019); National Directorate of Meteorology, 2021.

The analysis of a decade temperature data (Table 2) shows that the mean decadal change is 0.36 °C for the maximum temperature and 0.44° C for the minimum. The decade 2010 to 2020 was the hottest decade with 0.6° C decadal change, and the mean temperature rises from 1980 to 2020.

Table 2: Annual Average variation of Temperature data in Tahoua per decade from 1980 to 2020 (NDM, 2021).

Years	Mean Temperature (°C)		decadal change (°C)	
	Maximum	Minimum	Maximum	Minimum
1980 - 1989	38.964	17.9017	_	_
1990 -1999	39.11	18.5792	0.146	0.6775
2000 - 2009	39.429	18.7376	0.319	0.1584
2010 - 2020	40.041	19.2119	0.612	0.4743
Mean	**39.386**	**18.6076**	**0.359**	**0.436733**

b) Precipitation Variation

The analysis of the annual average values of the precipitation (1979-2019) (Figure 6): reveals an inequality in the spatial coldest and warmest months. The poor spatial distribution of annual averages (Figure 6) of recorded rainfall shows a large disparity

between the minimum average of 72.68mm in 1984 and the maximum average of 226.52mm in 1999.

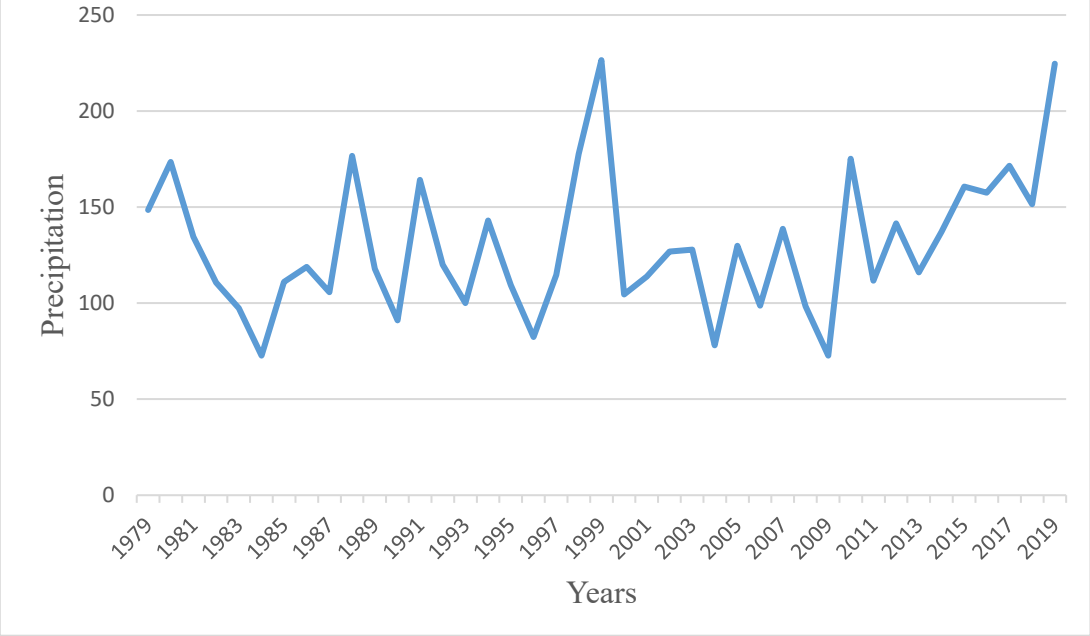


Figure 6: Annual variation of precipitation data in Tahoua (1981-2021); National Directorate of Meteorology, 2021

c) Characterization of Tabalak Wetland Watershed Vegetation

Table 3. Preponderance values of species in the Tabalak watershed

Families	Plant Species	Relative Frequency	Relative Density	Relative Dominance	IVI
Mimosaceae	*Acacia seyal*	15.87	41.15	11.76	68.78
Mimosaceae	*Acacia nilotica*	9.52	15.43	28.11	53.06
Mimosaceae	*Acacia raddiana*	23.8	16.72	9.55	50.07
Mimosaceae	*Prosopis juliflora*	15.87	9	14.64	39.51
Balanitaceae	*Balanites aegyptiaca*	12.69	8.36	7.62	28.67
Meliaceae	*Azadirecta indica*	3.17	1.28	14.25	18.7
Mimosaceae	*Faidherbia albida*	3.17	1.6	8.8	13.57
Rhamnaceae	*Ziziphus mauritiana*	7.93	4,18	0.07	12.18
Caesalpiniaceae	*Bauhinia rufescens*	4.76	0.96	5.16	10.88
Myrtaceae	*Eucalyptus camaldulensis*	3.17	1.28	0	4.45
Total = 6	10	100	100	100	300

Source: Calculated values, 2022

The analysis from Table 3 shows that, *Azadirecta indica and Eucalyptus camaldulensis* are exotic plants to the area, and their relative frequencies is 3.17. This means that, their rate of growth seen to be competitive to each other.

Regarding to the plant species frequency; analysis indicated that, the *Acacia seyal* and *Prosopis juliflora* species have the highest frequency values of 15.87% each one. This showing that, there is competition between exotic and indigenous plant species in the Tabalak watershed. With regard to relative density and relative dominance, analysis shows that *Acacia seyal* and *Acacia nilotica* have the highest relative density values 41.15% and relative dominance values 28.11% respectively.

On the species importance value index, which assesses the ecological importance of plant species, the analysis shows that *Acacia seyal* has the highest species importance value index in the area 68.78%, follow by *Acacia nilotica* 53.06% the second highest, *Acacia raddiana* 50.07% and *Prosopis juliflora* 39.51 %. All these plant species being indigenous and exotic are from the same family (Mimosaceae). The basal area is 13.3 m^2/ha with a density of 28 individuals/ha and regeneration rate of 7.6%.

The Shannon-Weaver index (bits) is 1.73 and Piélou Equitability is 0.3.

Discussion

The climatic analyses shows an increasing decadal change of the maximum and minimum temperatures in Tahoua over the last 40 years (1980-2020). These temperature variations led to a decrease in the annual rainfall heights, which resulted in a poor spatial distribution of annual average rainfall. This has led to the watershed degradation, a phenomenon that affects both water and vegetal ressources, by threatening the Tabalak Lake of silting up due to the loss of vegetation cover in the watershed, which may eventually lead to its disappearance, even though it plays an extremely important role for birds and in the socio-economic life of the entire population of the region. These high temperatures combined with the rainfall hazards have resulted in the aridification of the area and the progressive destruction of the vegetation cover. These results confirm those found by Ahmed Oumarou (2001) in his study on the diagnostic analysis of the Niger River Basin, which found that average temperatures vary between 16°C and 43°C between the generated a gradual increase of 0.16 °C every 10 years.

According to Mohammed et al. (2015), Carteney (2011) and FAO (2014) this increasing average temperature variability is recorded in all Sahelian countries and has distribution of rainfall in Tahoua. The Tabalak watershed has a very low rainfall. The poor agricultural seasons recorded in recent years are not necessarily due to the annual insufficiency of rainfall, but may be due to the climatic disruption that has caused its poor distribution in time and space. These results confirm those found by Genta et al (1998). Falloon et al (2009), Feyen et al (2009), Fischer et al (2001) and Ahmed et al

(2001) in their study on the diagnostic analysis of the Niger River Basin, who found that rainfall takes the form of tornadoes that, can have high intensities exceeding 100 mm/h. The number of rainy days increases from north to south with the cumulative rainfall. Rainfall is also characterized by great variability in space and time, with a tendency for dry years to persist for over two decades. (IPCC, 2000). The vegetation composed of only 10 species belonging to 6 families. This floristic composition of Tabalak watershed is very low compared to Soro et al (2019) in theirs study. Analysis of the Floristic Diversity of some of the Buyo Dam (Ivory Coast) who finds 723 plant species from 99 plants families.

The floristic composition of the watershed is both dependent on climatic conditions (notably rainfall and temperature) and the pressure that the riparian population exerts on its vegetal resources. The values of the global parameters are also low. The density differs according to the type of morphological unit, thus the density is high in the low glacis and valley (40 species/ha) and very low on the sand dune (4 species/ha).

Conclusion

The Tabalak Lake is threatened by silting up due to the loss of vegetation cover in the watershed, which may eventually lead to its disappearance.

The Watershed restoration produces many economic, social and environmental benefits. In the environmental field, it allows the conservation of water, soil and biodiversity and helps people to mitigate and adapt to climate change and variability.

Acknowledgements

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