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Investigating the Intersection between Climate Change and Animal Welfare within Yankari Game Reserve, Bauchi State, Nigeria

UMAR, AM; SANUSI, M; ABDU, I

Department of Animal Production, Faculty of Agriculture and Agricultural Technology, Abubakar Tafawa Balewa University, Bauchi.

**Corresponding author email: aumustapha@atbu.edu.ng*
**ORCID: https://orcid.org/0009-0005-7380-3140*
**Tel: +234 803 396 8800*

Co-Authors Email: msanusi@atbu.edu.ng, iabdu@atbu.edu.ng

ABSTRACT: The objective of this paper was to investigate the connection between climate change and animal welfare within Yankari Game Reserve, Bauchi State, Nigeria using four geospatial coordinates of the game reserve that is publicly available on websites and spooled over a 40-year period (1981 to 2020). Population data and other welfare issues were collected through interviews with personnel of the game reserve. Data was analysed using both qualitative and quantitative techniques and the results indicated that changes in temperature, rainfall pattern, atmospheric pressure affected the population of animals. Cases of abuse by holidaymakers and accidents along the road leading to the reserve affected the welfare and this consequently affected the population of animals especially the Tantalus Monkey and Water buck. Further indications regarding population of carnivores was affected when cases of bush burning were recorded. In conclusion, the evident impacts of climate change on ecosystems and habitats necessitate further research into its correlation with animal welfare, underscoring the urgent need for comprehensive understanding and action.

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Yankari Game Reserve is a large wildlife park located in Bauchi State, in north-eastern Nigeria. It covers an area of about 2,244 square kilometres and is home to several natural warm water springs, as well as a wide variety of flora and fauna. Its location in the heartland of the West African savannah makes it a unique way for tourists and holidaymakers to watch wildlife in its natural habitat. Yankari contains the largest surviving elephant population in Nigeria, one of the largest remaining in West Africa (Odunlami, 2000). The reserve was established in 1956 and opened to the public in 1962. Historically, records show that eight species of large mammals (African hunting dog, leopard, cheetah, giraffe, western kob, Korrigum, red fronted gazelle and bohor reedbuck) have become locally extinct in Yankari (Fada, 2015). Climate change is one of the most pressing issues facing humanity today. Rising temperatures, sea levels, and extreme weather events are having devastating impacts on natural ecosystems and human communities around the world. At the same time, the treatment of animals has become a major concern for many individuals and organizations. Animal welfare activists argue that all animals, including those used for food, clothing, and scientific research, have the right to be treated with respect and compassion (EC, 2018). The relationship between animal welfare and climate change may not be immediately obvious, but there is a growing body of evidence suggesting that the two are closely linked. For example, the meat and dairy industry is a major contributor to greenhouse gas emissions, and efforts to reduce the consumption of animal products can help to reduce these emissions. In addition, the exploitation of animals for various purposes often involves the destruction of natural habitats, which can exacerbate the impacts of climate change. A common example is the method of research techniques employed to reduce eructation of gases by ruminants. Some of these techniques despite having an impact on the output of the gasses, could be harming

**Corresponding author email: aumustapha@atbu.edu.ng*
**ORCID: https://orcid.org/0009-0005-7380-3140*
**Tel: +234 803 396 8800*

the animals. If humans are to be empathic, would such techniques be used without infringing on the rights of the individuals? Could such experiments be conducted without getting ethical approvals or even consent from such individuals? It is generally thought that it may be necessary to use laboratory animals in some cases to create improvements for people, animals, or the environment (NNREC, n.d). However, animal rights extremists often portray those who experiment on animals as being so cruel as to have forfeited any moral standing. But the argument is about whether the experiments are necessary and whether they are conducted in a humane way (BBC, 2014).

In West Africa, protected areas often face issues like small, isolated wildlife populations being squeezed by expanding human communities. This leads to problems such as conflicts between humans and elephants, and people encroaching on these protected lands (IUCN, 2014). However, with proper design and effective management, these protected areas can play a crucial role in tackling these challenges (Lopoukhine *et al*., 2012). Consequently, the objective of this paper is to investigate the connection between climate change and animal welfare of animals within Yankari Game Reserve, Bauchi State, Nigeria.

MATERIALS AND METHODS

The study was conducted in Yankari game reserve, located in northeastern Nigeria (9°45'16"N, 10°30'37"E; 9°75′44"N, 10°51′03"E). Yankari is a vast wildlife reserve covering 2,244 km² and is renowned as Nigeria's premier game reserve (Fada, 2015). The study was conducted using a mixed-methods approach, also called a mixed methods research (MMR).

The research for this proposal was conducted through a combination of a literature review and expert interviews. Comprehensive review of the existing literature on the subject, including studies on the environmental impact of animal agriculture and the ethical implications of animal welfare was conducted. In-depth interviews with experts in the fields of animal welfare and climate change that are also a staff of the game reserve were conducted using an open ended questionnaire. The sample size for the survey was determined using the formula:

$$\text{Sample Size} = [z2 * p\,(1-p)] / e2 / 1 + [z2 * p\,(1-p)] / e2 * N] \quad (1)$$

Where N = population size; z = z-score; e = margin of error; p = standard deviation

Where e is the margin of error, commonly known as the accuracy level, is 5%, z is the score for a 95% confidence interval is 1.96, p is 0.5, and N is the population size (Bruce et al., 2008). For this analysis, the Statistical Package for Social Sciences (SPSS) version 21.0 was used. Findings from the literature review, interviews, and climatic data (Hersbach *et al*., 2023) obtained were synthesized to draw conclusions about the intersection of animal welfare and climate change. Racemization of amino acids as described by Bada (1985) was conducted on 11 samples of wild animal fragments to detect species changes possibly influenced by climate change.

RESULTS AND DISCUSSION

This location had a hot semi-arid climate over the 1981-2020 period. The climatology plot (figure 1) below shows the average daily maximum and minimum temperatures for each month of the year, along with typical monthly precipitation totals - all averaged over the 1981-2020 reference period. Average temperature (figure 2) over the reference period was 26.8°C.

Monthly average temperature ranged from 24.2°C (January) to 31.1°C (April). The mean annual total precipitation in this location was 633.4 mm. Monthly average precipitation ranged from 0.0 mm (February) to 201.5 mm (August) Figure 3 shows the mean total precipitation. The annual average wind speed in this location was 3.0 ms^{-1}.Monthly average wind speed ranged from 2.3 ms^{-1} (October) to 3.3 ms^{-1} (January), this is shown in figure 4.

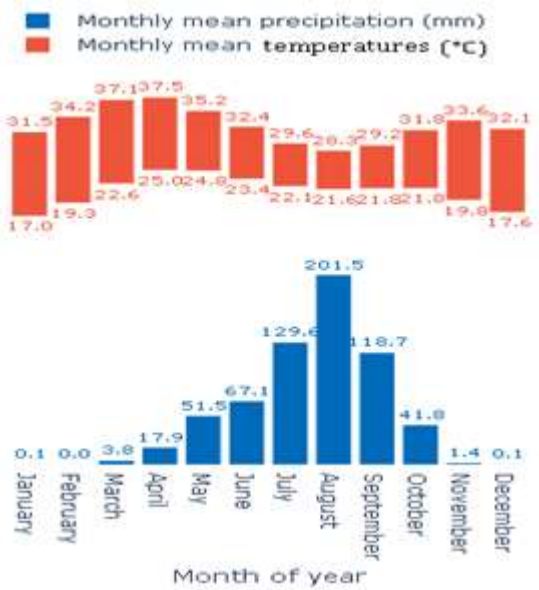

Fig 1: Overall Monthly Precipitation and Minimum/ Maximum temperatures over the reference period

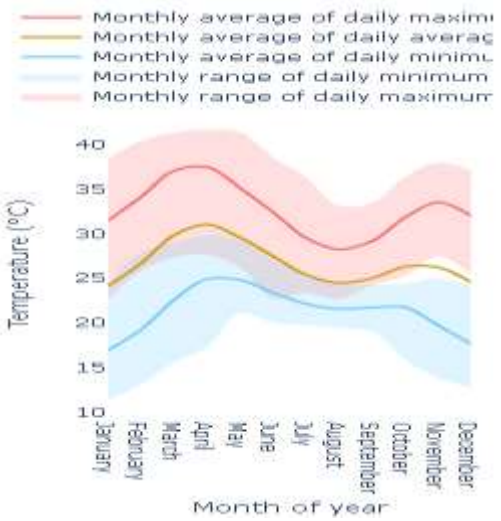

Fig 2: Average daily temperatures over the reference period

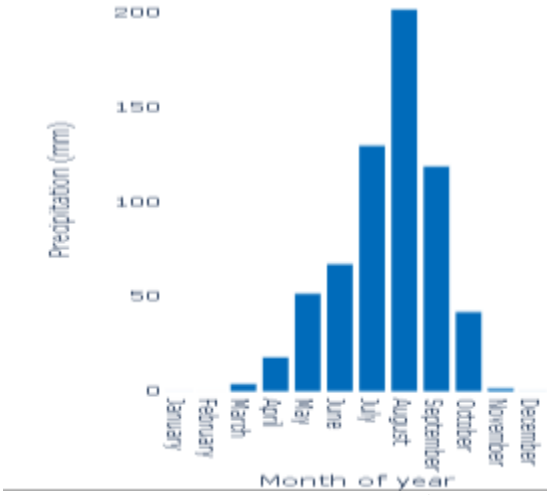

Fig 3: Average Monthly Precipitation over the reference period

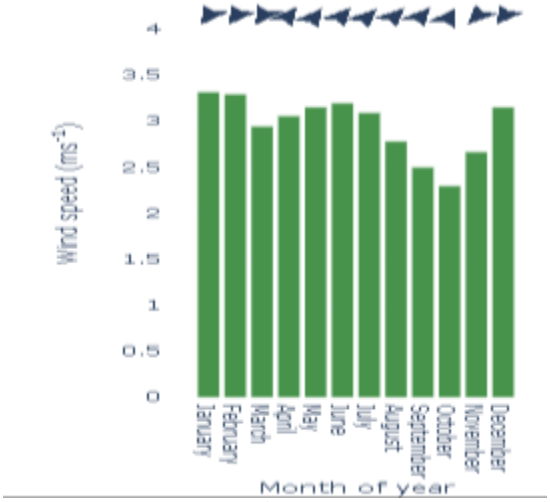

Fig 4: Average wind speed of Yankari game reserve over the reference period

Annual Temperature anomaly is shown in Figure 5. Warming stripes provide an at-a-glance view of yearly temperature trends in this location for the period 1981-2020. The colour of each stripe represents the temperature anomaly for a given year, or how much warmer (red) or colder (blue) that year was relative to the long-term reference period of 1981-2020. For the precipitation anomaly shown in Figure 6, the plot shows how varied each year in the 1981-2020 period is, or how much more (blue) or less (red) precipitation fell each year as a percentage relative to the long-term reference period of 1981-2010.

Rainfall in the area varied significantly over the years, with as little as 750 mm in 1986 and as much as 1610 mm in 2011. Notably, the periods from 1973-1974 and 1984-1986 experienced drought conditions, with mean annual rainfall falling below the reserve's average of 900-1000 mm. The recorded pattern is similar to findings of Fada (2005).

A total of One hundred and fifty two (calculated sample size), including pilot questionnaires, were distributed among the staff of the reserve who have met the criteria. Wildlife sightings in the reserve include elephants (*Loxodonta africana*), lions (*Panthera leo*), hippopotamuses (*Hippopotamus amphibius*), African buffalo (*Syncerus caffer*), and a wide variety of antelopes such as waterbuck (*Kobus defassa*), Oribi (*Ourebia ourebi*), Roan Antelope (*Hippotragus equinus*) and western hartebeest (*Alcelaphus buselaphus*). Other animals spotted are spotted hyenas (*Crocuta crocuta*), olive baboons (*Papio anubis*), patas monkey (*Erythrocebus patas*), warthogs (*Phacochoerus africanus*), and mongooses (*Herpestes spp*). These observations are consistent with the reports by Odunlami (2000) and Magama *et al*. (2018). Table 1 shows the estimated number of animals in the reserve as at the time of the interview in 2023.

We excluded waterbucks, warthogs, patas monkeys and baboons from the total count calculations because accurate counts were unlikely because they are so numerous, and therefore, not of conservation concern. While the counts of all species were lower than those in East African savannah ecosystems, the numbers observed were comparable to or greater than those from the last survey of the reserve (Omondi et al., 2006). Estimating the total number of elephants was particularly challenging.

Even in relatively open areas, counting herds accurately was very difficult" (Interviewee). However, results obtained here are similar to those of similar to the 348 counted by Omondi *et al*. (2006) and also similar to various studies cited by Fada (2005).

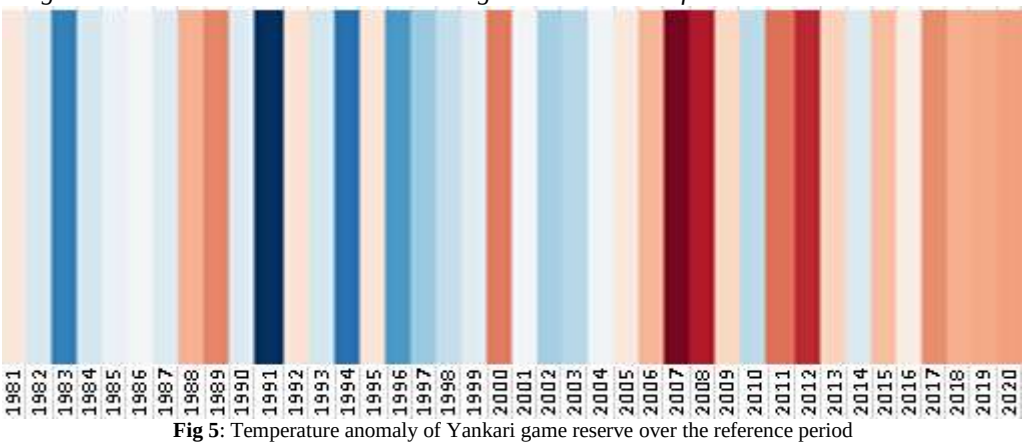

Fig 5: Temperature anomaly of Yankari game reserve over the reference period

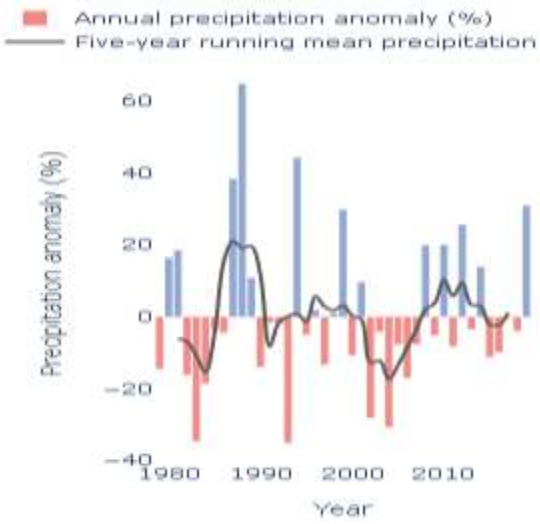

Fig 6: Precipitation anomaly of Yankari game reserve over the reference period

Table1: Animal Populations Based on Perceptions of Sightings in Yankari Game Reserve

Animal	Population
Buffalo	150-174
Roan Antelope	171
Waterbuck	Not threatened
Elephants	100-350
Warthogs	Not threatened
Patas monkey	Not threatened
Baboons	Not threatened
Hippopotamuses	15-25
Lions	20-50

The fire season in Yankari coincides with Nigeria's long dry season, beginning in November and lasting until March or April, with peak fire activity in December. Over the reference period studied, fires typically started in November and peaked in December, except for the years 1991/1992 and 2004/2005 season, which was higher in January. Fires usually ended in March, though some years extended into April. According to Fada (2015), there were no reports on whether rangers systematically burned the reserve, and fire activities outside Yankari's boundaries were not investigated. Our findings conclude that fire activities in Yankari are prevalent and consistent, showing a clear trend, although fire can have advantages (Abdulkarim *et al*., 2021). Regarding encroachment and human interference, there was a 27% recorded encroachment up to 1986, which increased by 48% between 1986 and 2013. Data gathering and acquisition faced challenges, just like a previous study by Fada (2015), whose encroachment estimates were subjective and based on visual estimates. Farming activities were prevalent at Yankari's border, indicating population growth and local community expansion. Interviews with reserve personnel in 2023 confirmed farmlands at the reserve's boundary. Although Yankari is exclusive and not open to surrounding communities, evidence suggests that locals interact with the reserve in various ways. Eleven fragments of carcass remains found within the reserve were subjected to amino acid racemization to determine specie changes that might have happened because of climate change. The stable carbon isotope data from these fossils indicate that no species characterization change has occurred systematically over the past 500 years. This finding provides valuable insights into the long-term stability of species composition within Yankari Game Reserve. Amino acid racemization results are shown in Table 2.

Table2: Amino Acid Racemization Test for Samples Found in Yankari Game Reserve

Sample ID	D/L ratio	Stable Carbon Isotope Value (δ13C) (%)	Specie Characterisation
1	0.45	-20.3	None
2	0.42	-19.8	None
3	0.47	-20.1	None
4	0.44	-20.2	None
5	0.46	-20.2	None
6	0.43	-19.9	None
7	0.45	-20.0	None
8	0.41	-20.4	None
9	0.44	-20.3	None
10	0.42	-19.7	None

Conclusion: The local communities surrounding Yankari Game Reserve primarily consist of agro-pastoralists, including crop cultivators and herders. As their populations grow, their reliance on Yankari increases. Grazing lands are being converted to farmlands, leading to competition for grazing between wild herbivores and local livestock. This competition can cause erosion of browse species and expose wild herbivores to diseases. The study also highlights a lack of records on fire and climate studies in the region. Fire significantly shapes savannah ecosystems, affecting biomass and structure. Structural changes from fires impact microclimate, resource distribution, and biodiversity. Understanding fire dynamics is crucial for conservation efforts. The number of wildlife species, especially African elephants, around the reserve is decreasing. Human-related factors likely contribute to this decline. However, non-elephant wildlife populations in Yankari have not significantly reduced due to poaching in recent years. Climate change may alter wildlife distribution and habitat preferences and also exacerbates factors such as habitat fragmentation, reduced water availability, and human-wildlife conflict. Therefore, to preserve Yankari's wildlife, implementing adaptive strategies considering climate change impacts is crucial. Monitoring population trends and habitat conditions, along with conservation measures, can protect vulnerable species.

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Data Availability Statement: Data are available upon request from the corresponding author.

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