INNSPUB

Journal of Biodiversity and Environmental Sciences | JBES
ISSN: 2220-6663 (Print); 2222-3045 (Online)
Website: https://www.innspub.net
E-mail contact: info@innspub.net
Vol. 27, Issue: 2, p. 35-45, 2025

RESEARCH PAPER OPEN ACCESS

An assessment of the current scenario of biodiversity in Ghana in the context of climate change

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Key words: Biodiversity, Ecosystems, Climate change, Biodiversity indicators, Ghana

DOI: https://dx.doi.org/10.12692/jbes/27.2.35-45 [Published: August 09, 2025]

ABSTRACT

Climate change poses a significant threat to global biodiversity, with sub-Saharan Africa being one of the most vulnerable regions. Ghana, a biodiversity hotspot, faces increasing pressure from climate change, which threatens its diverse ecosystems, including forests, wetlands, and coastal areas. This study assessed the current state of biodiversity in Ghana using ten (10) biodiversity indicators. The study adopted a descriptive research design with a quantitative approach. Additionally, the study employed a convenience sampling technique to select 50 respondents, and the data were collected using a structured questionnaire. The questionnaire was validated using Cronbach's Alpha to ensure reliability, and the results were presented using minimum, maximum, mean, and standard deviation values for the assessed biodiversity indicators. The study revealed a generally low to moderate level of health across the assessed biodiversity indicators, with significant concerns highlighted in both terrestrial and aquatic ecosystems due to forest degradation, habitat loss, and climate change. Forest degradation emerged as a critical concern, with a mean score of 2.55 and a high standard deviation of 1.472, indicating significant variability across the country. The low mean scores for the remaining indicators suggest that Ghana's ecosystems were under considerable stress. The study proposes the strengthening and enforcement of policies to curb overexploitation of natural resources, particularly illegal logging and unsustainable mining practices, and the development and implementation of coherent climate policies that will integrate biodiversity conservation with climate adaptation and mitigation strategies in Ghana.

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INTRODUCTION

Climate change has emerged as a serious global threat that has proven to have an effect on natural ecosystems and biodiversity. Global average temperatures have increased by 0.7°C over the past century and are expected to rise further (Singh and Rao, 2023; Nickoloff *et al.*, 2025). Similarly, the average amount of precipitation worldwide has increased by 2% over the past 100 years, and this trend is probably going to continue, with devastating effects, such as flooding (Sarkar and Maity, 2021; Thackeray *et al.*, 2022; Gu and Adler, 2023).

Accordingly, Africa is one of the world's most climate-vulnerable continents (Atwoli *et al.*, 2022). Consequently, over the 20th century, Africa has warmed by 0.7°C overall, and warming is predicted to continue, with increases ranging from 0.2°C per decade (low scenario) to more than 0.5°C per decade (high scenario) (Ayugi *et al.*, 2023; Bedair *et al.*, 2023).

Temperature and precipitation patterns, as well as atmospheric pressure and humidity, are climatic controls that influence climate change. In addition to the erratic weather patterns and the receding global ice sheets, the accompanying increased sea level rise is one of the most well-known repercussions of climate change globally (Minunno *et al.*, 2023; Soeder, 2025). The essential foundation of both economic growth and human survival is biodiversity, as it contributes to preserving the ecological equilibrium. Ecological balance is essential for widespread biodiversity (Angon *et al.*, 2023). The values of biodiversity, both direct and indirect, support humans' survival. For instance, the direct value of biodiversity, consumptive use value and productive use value provide the essential needs of human beings.

The consumptive use value is the value placed on nature's products that are consumed directly, without passing through a market (Lebdioui, 2022; He and Jiao, 2023). These include food (plants), fish, fuel, and drugs and medicines. On the other hand, indirect values of biodiversity provide the benefits to human beings, supporting the existence of biological life and other benefits which are difficult to quantify (Ulrich *et al.*, 2023). These include social and cultural values. For example, many plants and animals are considered holy and sacred in some parts of the world and are worshipped, like the cow, snake, etc. In the Ghanaian society, great cultural value is given to forests and animals, as some see them as totems that must be protected.

Notwithstanding these, changes in land and sea use are contributing to the recent loss of biodiversity in many places (Davison *et al.*, 2021; Virtanen *et al.*, 2024). These have increased threats to biodiversity such as habitat loss, poaching of wildlife and man-wildlife conflicts. This calls for the conservation of biodiversity, as biodiversity is one of the important tools for sustainable development. The commercial, medical, genetic, aesthetic, and ecological importance of biodiversity emphasises the need for its conservation.

Ghana has made significant strides in establishing the framework for biodiversity preservation and sustainable growth throughout the years. For example, the Ghanaian Parliament passed the Environmental Protection Agency Act, 1994 (Act 490), a year after the Convention on Biological Diversity (CBD) went into effect. The Environmental Assessment Regulations 1999 were also introduced five years later. The nation has also seen the adoption and amendment of a number of legislative instruments (LI), such as LI 1703 and LI 1652 modified, all of which support sustainable development and biodiversity protection, two of the three primary goals of the CBD (Botchway, 2021). Nonetheless, Ghana's lack of location and landscape-scale biological data is a hindrance to the conservation of biodiversity, as the available information on biodiversity is sparse, full of gaps and inconsistencies, and outdated (Afrifa *et al.*, 2023; Dzakpasu *et al.*, 2024; Aduko *et al.*, 2025).

Ghana is a biodiversity hotspot due to increasing pressure from climate change. The country's diverse ecosystems, including forests, wetlands, and coastal areas, are vulnerable to the impacts of changing

climatic conditions. Understanding the specific threats posed by climate change to Ghana's biodiversity is essential for effective conservation and management efforts. Ghana's biological resources have deteriorated throughout the previous century by various anthropogenic stresses, such as agriculture and infrastructural development (Ghartey-Tagoe *et al.*, 2020; Agodzo *et al.*, 2023). Existing literature highlights the interconnected relationship between climate change and biodiversity loss globally (Ortiz *et al.*, 2021; Shin *et al.*, 2022; Pfenning-Butterworth *et al.*, 2024), and studies have also documented the impacts of rising temperatures, changing precipitation patterns, and extreme weather events on ecosystems and species composition (Seastedt and Oldfather, 2021; Sabater *et al.*, 2023). However, there is a need for localised research to understand these impacts within the specific context of Ghana's biodiversity. Therefore, this paper examines the current scenario of biodiversity in Ghana in the context of climate change.

Ghana's biodiversity is notably diverse, featuring numerous species of plants, animals, and microorganisms. The country is home to approximately 3,600 plant species, including the indigenous West African cycad (Osei *et al.*, 2021). The fauna comprises around 221 species of amphibians and reptiles, 724 bird species, and 225 mammalian species (Ameade *et al.*, 2025; Ntiamoa-Baidu and Taye, 2025). Significant ecosystems include tropical high forests, savannahs, and coastal wetlands, each supporting unique biological communities. Despite the recognised richness in biodiversity, there exists a paucity of comprehensive data on many species, particularly neglected and underutilised species (NUS). These species are vital for nutrition, food security, and income generation in rural communities. However, limited research has been conducted to explore their diversity and potential, underscoring the need for more focused studies in this area.

Ghana's biodiversity faces several threats, primarily driven by human activities. Deforestation, often for agricultural expansion and logging, leads to habitat loss and fragmentation. Urbanisation exerts pressure on ecosystems, resulting in the degradation of wetlands and forests (Chakraborty *et al.*, 2023). Additionally, climate change exacerbates these challenges by altering habitats and species distributions. To mitigate biodiversity loss, Ghana has established various protected areas, including wildlife sanctuaries, forest reserves, and sacred groves. These areas play crucial roles in conserving biological diversity. However, challenges such as inadequate management and enforcement persist, necessitating enhanced conservation strategies and community involvement (Khater *et al.*, 2024).

Notwithstanding this, emerging technologies offer new avenues for biodiversity conservation. Green informatics, which integrates information and communication technology with environmental science, holds potential for monitoring and managing biodiversity (Paul, 2022; Nizamani *et al.*, 2024). Implementing such technologies in Ghana could enhance data collection and inform conservation policies.

MATERIALS AND METHODS

The study adopted a descriptive research design with a quantitative approach. The descriptive research design enabled the researchers to provide a detailed description of the population and findings. This approach facilitated the provision of precise and valid information on how climate change impacts biodiversity in Ghana and other geographical settings. It further allowed the researchers to employ suitable statistical tools, including SPSS and MS Excel, for analysing the collected data and presenting the findings in a way that ensured clarity. In addition, the sample frame for the study was made up of government officials, persons involved in non-governmental organisations (NGOs), civil society organisations (CSOs), development experts, and policy analysts in climate change and biodiversity.

Furthermore, the study applied a convenience sampling technique, a non-probability sampling technique, to engage with the relevant experts, government officials, and NGOs/CSOs. Accordingly, the main purpose of convenience

sampling is to quickly and easily gather data from readily available participants, making it a cost-effective and time-efficient method for research (Akkaş and Meydan, 2024). In addition, the technique is particularly useful for exploratory research, pilot studies, or when specific populations are difficult to reach through other sampling methods (Andrade, 2021; Stratton, 2021). Thus, a target sample size of 50 respondents was selected conveniently to participate in the study.

The data for the study were entirely quantitative and primary. The primary quantitative data were collected using a questionnaire. The questionnaire was developed from previous studies published in reputable journals. To validate the research instrument, all questions with a scale were subjected to reliability tests using Cronbach's Alpha. A Cronbach Alpha of at least 0.700 is acceptable as it reflects the internal consistency of the research instrument in measuring the same constructs (Syed Kholed *et al.*, 2021). Consequently, the current state of biodiversity in Ghana was analysed using mean scores and standard deviations for ten (10) identified biodiversity indicators: forest degradation rate, crop population, domestic animal population, savannah ecosystems, population of forest species, total forest land size since 2015, aquatic weeds, aquatic animals, forest reserve size, and water bodies.

RESULTS AND DISCUSSION

Preliminary analyses

Cronbach's Alpha is a measure of internal consistency, indicating how closely related a set of items is as a group, with values ranging from 0 to 1. Higher values suggest greater reliability, with a commonly accepted threshold of 0.70 or above indicating acceptable reliability. The construct “The Current State of Biodiversity in Ghana” has a Cronbach's Alpha of 0.712, based on ten (10) biodiversity indicators, which were forest degradation rate, crop population, domestic animal population, savannah ecosystems, population of forest species, total forest land size since 2015, aquatic weeds, aquatic animals, forest reserve size, and water bodies. This value was above the 0.70 threshold, indicating acceptable reliability. This indicates that the items used to measure the current state of biodiversity were reasonably consistent, though there could be some room for improvement in the scale's design or item selection.

Demographic characteristics of the respondents

Table 1 provides a summary of the demographic characteristics of the 50 respondents involved in the study. The table includes information on gender, age, years of work experience, and highest level of education, presented as frequencies and percentages. In terms of gender, the majority of respondents were male, accounting for 55.3%, while females made up 44.7% of the respondents. Accordingly, Fernandez (2023) posits that the relationship between gender and biodiversity is multifaceted, encompassing how gender roles and inequalities influence the management and conservation of biodiversity. He further postulated that recognising and addressing gender dimensions is crucial for effective biodiversity policies, as women often play significant roles in resource management and are disproportionately affected by biodiversity loss, while also possessing unique knowledge and practices related to biodiversity.

In addition, men and women often have different roles, responsibilities, and knowledge concerning biodiversity due to cultural norms and societal structures (da Costa *et al.*, 2021; Oloko *et al.*, 2024). Women, in particular, are frequently key users of biodiversity for livelihoods and household needs, but are often excluded from decision-making processes and benefit-sharing in conservation efforts (James *et al.*, 2021).

Biodiversity loss can disproportionately affect women and men differently, with women sometimes facing increased burdens in collecting resources for survival (Allen, 2022).

Integrating gender considerations into biodiversity conservation strategies is essential for promoting equality, maximising the potential of both men and women in conservation, and achieving equitable

outcomes (Elias *et al.*, 2021), hence the interest of the researchers in the sex of the respondents.

Table 1. Distribution of respondents' demographic characteristics

Demographic characteristics	Frequency (N = 50)	Per cent (%)
Gender		
Male	26	55.3
Female	24	44.7
Age in years		
20-30	10	19.1
31-40	24	51.1
41-50	14	25.5
51-60	2	4.3
Years of work experience		
<5 years	9	19.1
5-10 years	16	32
11-15 years	12	23.4
>15 years	13	25.5
Highest level of education		
Basic	2	4.3
Diploma/HND	7	12.7
First Degree	19	40.4
Postgraduate	22	42.6

The age distribution of the respondents showed that the largest group of respondents was within the 31-40 years range, representing 51.1%, whereas the 51 – 60 age group were in the minority of the respondents (4.3 %), as indicated in Table 1. The age group of the respondents indicated that the sample for the study was predominantly composed of middle-aged respondents, which could reflect their active involvement in issues related to biodiversity and climate change. While there is not a simple linear "older means more knowledgeable about biodiversity" relationship, studies suggest that species knowledge generally increases with age and educational level, and environmental education is crucial for fostering biodiversity awareness and conservation attitudes across all ages, particularly in younger generations (Randler and Heil, 2021). However, despite increased media and classroom instruction, younger people still often exhibit lower awareness of biodiversity issues compared to older or professional groups (Ortega-Lasuen *et al.*, 2023). Older individuals, especially those with higher education levels or professions related to nature, often possess greater accumulated knowledge about species and ecosystems (Okui, Sawada and Yoshida, 2021). In Ghana, there is a concerning trend of declining ecological knowledge in younger generations, with children sometimes lacking the ability to identify common local species and being more familiar with pets or charismatic exotic species. While time spent in nature during childhood may not always predict adult engagement, routine exposure to green spaces in cities can increase personal connection to nature and biodiversity awareness (van Heezik *et al.*, 2021), as positive attitudes and a valuing of biodiversity are associated with exposure to and interaction with nature, and these can develop at different life stages.

Regarding years of work experience, the largest group had 5 - 10 years of experience, accounting for 32%, and the lowest number of respondents had less than 5 years of work experience (19.1%). This distribution indicates that the sample included a mix of early-career, mid-career, and experienced professionals, providing a range of perspectives on the current status of biodiversity. Accordingly, work experience, especially hands-on or direct experiences with nature, is strongly related to enhanced knowledge and awareness of biodiversity, with studies showing a positive correlation between increased nature experiences and a greater understanding of biodiversity (Yli-Panula *et al.*, 2018; Oliveira, Bajanca and Paramés, 2025). This is particularly true for professionals in fields related to nature and conservation, who often develop their expertise through practical engagement with the environment. Work involving fieldwork, research, or any engagement with natural environments provides opportunities to encounter diverse species, ecosystems, and ecological processes first-hand, building practical knowledge and identification skills (Saif *et al.*, 2024). Consequently, studies have indicated a gap in species literacy between biodiversity professionals and the general public, suggesting that professional experience significantly contributes to specialised knowledge in biodiversity (Randler and Heil, 2021). The highest level of education among the respondents was postgraduate degree holders, representing 42.6%, while the respondents with basic education formed the minority (4.3%).

Education plays a vital role in shaping attitudes and behaviours towards biodiversity conservation across

all age groups (Børresen *et al.*, 2023). Higher levels of education are generally associated with a greater understanding of biodiversity and its importance for ecosystem services and conservation efforts, though effective environmental education is key to fostering positive attitudes and actions towards biodiversity (Peter *et al.*, 2021; Børresen *et al.*, 2023). Increased urbanisation and a weakening connection to the natural world have led to a decline in public awareness of biodiversity, highlighting the crucial role of education in bridging this gap (Chen *et al.*, 2022; Amin *et al.*, 2023). Thus, with the highest percentage of respondents being postgraduate degree holders, public education can lead to effective biodiversity conservation in Ghana.

The current state of biodiversity in the context of climate change

The biodiversity indicators that the researchers used in assessing the current state of biodiversity in Ghana were forest degradation rate, crop population, domestic animal population, savannah ecosystems, population of forest species, total forest land size since 2015, aquatic weeds, aquatic animals, forest reserve size, and water bodies. The results of the assessment of the current state of biodiversity in Ghana are presented using minimum (Min), maximum (Max), mean, and standard deviation (SD) values, as shown in Table 2.

Table 2. The current state of biodiversity in Ghana

Current state	N	Min	Max	Mean	SD
Forest degradation rate	50	1	5	2.55	1.472
Crop population	50	1	4	1.96	0.550
Domestic animal population	50	1	4	1.89	0.521
Savannah Ecosystems	50	1	3	1.77	0.476
Population of forest species	50	1	3	1.70	0.507
Total forest land size since 2015	50	1	3	1.70	0.507
Aquatic weeds	50	1	3	1.66	0.562
Aquatic animals	50	1	2	1.60	0.496
Forest reserve size	50	1	2	1.60	0.496
Water bodies	50	1	3	1.55	0.583

The mean scores ranged from 2.55 to 1.55, indicating generally low to moderate levels of biodiversity health, with significant variation across the assessed indicators. The highest mean score was for forest degradation rate at 2.55, with a relatively high SD of 1.472. This suggests that forest degradation is a significant concern, but there was considerable variability in perceptions or experiences of this issue, possibly due to regional differences or varying levels of degradation across the country.

Crop population and domestic animal population had mean scores of 1.96 and 1.89, respectively, with moderate SDs of 0.550 and 0.521. These scores indicate that crop and animal populations were perceived to be in a relatively stable but not thriving state, with some consistency in the responses given by the respondents. Savannah ecosystems, population of forest species, and total forest land size since 2015 all had mean scores below 2, with savannah ecosystems at 1.77 and the latter two at 1.70. The SDs for these indicators are relatively low (0.476 to 0.507), suggesting a consensus that these aspects of biodiversity were in a less-than-ideal state, though not at a critical stage.

Aquatic weeds and aquatic animals had mean scores of 1.66 and 1.60, respectively, with SDs of 0.562 and 0.496. These scores indicate that aquatic biodiversity was perceived to be under greater stress compared to terrestrial ecosystems, with aquatic animals showing the lowest mean score among the indicators. Forest reserve size and water bodies have the lowest mean scores at 1.60 and 1.55, respectively, with SDs of 0.496 and 0.583. These scores suggest that forest reserves and water bodies were being degraded, with limited variability in responses from the research participants, indicating widespread recognition of their poor condition.

Ghana's biodiversity, characterised by its rich array of plant, animal, and microbial species, plays a critical role in supporting ecosystems, livelihoods, and cultural practices. The findings from Table 2, which assessed biodiversity indicators based on a sample of 50 respondents, revealed a generally low to moderate level of biodiversity health across various ecosystems. Forest degradation emerged as a critical concern, with a mean score of 2.55 and a high standard deviation of 1.472, indicating significant variability in perceptions or experiences of this issue. This aligns with empirical evidence that deforestation, driven by agricultural expansion and logging, is a major driver

of habitat loss and fragmentation in Ghana (Kouassi *et al.*, 2021; Kyere-Boateng and Marek, 2021). The variability in the research participants' responses could be due to the differences in deforestation rates or the effectiveness of local conservation efforts. Similarly, the low mean scores for savannah ecosystems (1.77), population of forest species (1.70), and total forest land size since 2015 (1.70) suggest that these ecosystems were under considerable stress, consistent with studies highlighting the impacts of urbanization and climate change on Ghana's biodiversity (Danso *et al.*, 2021; Ayeni *et al.*, 2023).

Furthermore, aquatic ecosystems, particularly aquatic animals and water bodies, showed the lowest mean scores, 1.60 and 1.55, respectively, indicating severe stress on these habitats.

This is corroborated by research pointing to the degradation of wetlands and water bodies due to pollution, overfishing, and climate change (Danso *et al.*, 2021; Agodzo *et al.*, 2023). The relatively low standard deviations for these indicators suggest a consensus among respondents about the poor state of aquatic biodiversity. Forest reserves, with a mean score of 1.60, also highlighted the challenges of inadequate management and enforcement in protected areas, as observed by Afriyie *et al.* (2021) and Afriyie *et al.* (2021).

Despite the establishment of wildlife sanctuaries and sacred groves, the effectiveness of these conservation measures was often hampered by limited resources and community engagement.

CONCLUSION

The paper assessed the current state of biodiversity in Ghana using ten (10) biodiversity indicators by adopting a descriptive research design with a quantitative approach. The results revealed a generally low to moderate level of health across various ecosystems, with significant concerns highlighted in both terrestrial and aquatic environments. Forest degradation stood out as a critical issue, reflecting widespread habitat loss and fragmentation driven by agricultural expansion and logging. Savannah ecosystems, forest species populations, and overall forest land size were also under considerable stress, indicating the broader impacts of urbanisation and climate change. Aquatic ecosystems, particularly water bodies and aquatic animals, were in a particularly poor state, suffering from pollution, overfishing, and climate-related pressures. Forest reserves, despite their role in conservation, faced challenges related to inadequate management and enforcement, underscoring the need for improved resource allocation and community involvement in conservation efforts. The paper recommends the strengthening and enforcement of policies to curb overexploitation of natural resources, particularly illegal logging and unsustainable mining practices, and the development and implementation of coherent climate policies that integrate biodiversity conservation with climate adaptation and mitigation strategies.

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