Journal of Energy Technology & Environment
www.nipes.org

A Survey on AI-Driven Strategies and Solutions for Environmental Conservation

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Article information

Article History
Received 23 December 2024
Revised 09 January 2025
Accepted 05 February 2025
Available online 12 March 2025

Keywords:
AI, AI-Driven, Environmental Conservation, AI-Strategies and Solutions

https://doi.org/10.5281/zenodo.15015723

https://nipesjournals.org.ng

Abstract

The study examines A Survey on AI-Driven Strategies and Solutions for Environmental Conservation: Insights from Conservation Professionals. The study focused on professionals and organizations working in environmental conservation and AI which includes World Wildlife Fund, Environmental Defence Fund, Ministry of Environment, National Environmental standards and Regulations Enforcement Agency, National Centre for Energy and Environmental, Nigerian Institute for Oceanography and Marine Research. A random sampling method was used for the selection of the respondents. The sample size were 200 respondents. Structured questionnaire was used for the collection of data. Descriptive statistics of mean and standard deviation was used to answer the research questions while the Inferential Statistics of Chi-square was used to test the hypotheses at 0.05 level of significance. The results revealed that, AI-driven strategies significantly improve the effectiveness of environmental conservation efforts in addressing issues like deforestation and wildlife preservation and AI-driven solutions significantly perceived to have a positive impact on the sustainability and future success of long-term conservation goals. The researcher recommended that: Conservation organizations and government agencies should allocate more funds and resources to support the adoption and development of AI technologies developing technical skills among conservation professionals is crucial for maximizing the potential of AI-driven strategies. Specialized training programs, workshops, and partnerships with technology institutions that can build the expertise required to implement and manage AI applications effectively in conservation, establishing data-sharing platforms that can enhance collaboration and knowledge exchange within the conservation community.
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1. Introduction

There is an urgent need for more creative and practical conservation solutions due to environmental degradation brought on by variables like pollution, deforestation, and biodiversity loss. Despite their relevance, traditional conservation strategies frequently fall short of the extent and complexity of environmental challenges brought on by resource exploitation, population increase, and climate

change. Artificial intelligence (AI) has emerged as a powerful tool to support and enhance conservation efforts through the use of advanced data analysis, real-time monitoring, predictive modeling, and automated decision-making.

The growing urgency of climate change and biodiversity loss has sparked a growing body of research on the relationship between artificial intelligence (AI) and environmental conservation. By utilizing AI's computational capabilities, this convergence seeks to address and lessen environmental issues while promoting sustainable practices in a variety of fields. AI's incorporation into environmental conservation activities is not just a technical breakthrough; rather, it is a crucial development to increase the effectiveness of sustainability initiatives [1].

Additionally, [2] investigation of AI in environmental monitoring and conservation assesses the technology's advantages for the environment, including its effects on disaster resilience, weather forecasting, ocean health, agriculture optimization, climate change mitigation, and water resource management. A research gap in the application of AI and decision support systems for environmental sustainability is shown by their qualitative study. Although it acknowledges the study's shortcomings, such as its limited focus on environmental sustainability without a thorough examination of global environmental policies, this viewpoint is essential for comprehending how AI can be used to advance environmental sustainability.

By tackling issues like waste management, water resources, agriculture, and climate change, artificial intelligence (AI) has the potential to support environmental sustainability on a worldwide scale [3,4]. It can be applied to the development of sustainable solutions in fields such as transportation, agriculture, water management, and energy and resource efficiency [5]. To reduce potential hazards related to AI technologies in sustainability, it is crucial to take into account user awareness, ethical and legal requirements, and other factors [6]. Furthermore, the sustainability of AI itself including its effects on society and the environment should be considered Research should concentrate on tackling the environmental and social sustainability concerns of AI through new approaches and algorithms in order to support its sustainable development.

[8] affirmed that the use of artificial intelligence (AI) into sustainability initiatives has become a ray of hope for creating a more robust and peaceful coexistence between humans and the environment in a time of unparalleled environmental difficulties. Ecosystems and human well-being are seriously threatened by climate change, biodiversity loss, pollution, and resource depletion, which emphasizes the urgent need for creative solutions. With its ability to analyze data, recognize patterns, and create predictive models, artificial intelligence (AI) has the potential to completely transform how we handle these challenging problems.

[9] goes into additional detail about how AI might help achieve the Sustainable Development Goals (SDGs) of the UN, especially when it comes to environmental sustainability. The use of AI in a variety of environmental domains, such as energy, water, biodiversity, and transportation, is covered in the study. He further contends that by putting human interests first and encouraging the use of sustainable and eco-friendly products, AI may play a crucial role in addressing global environmental concerns like climate change and biodiversity loss. This emphasizes the significance of taking prompt action to slow down environmental degradation and is consistent with the larger definition of sustainability, which aims to satisfy present demands without endangering the capacity of future generations to satisfy their own. Additionally, AI-driven solutions are increasingly used in policy development, helping governments and organizations make data-driven decisions on resource management and conservation priorities. By uncovering patterns and trends in environmental data,

AI can aid policymakers in devising targeted and timely conservation strategies that address specific issues like illegal logging, overfishing, and habitat destruction. This proactive approach enables more sustainable conservation practices that are responsive to dynamic environmental conditions [10].

[11] opined that AI has enormous potential to promote sustainable habits, from improving energy efficiency to lowering carbon footprints and optimizing resource utilization. In their exploration of the complex relationship between AI systems and environmental sustainability, [12] emphasize that AI has two types of effects: direct, through its own resource use, and indirect, through its applications. The study emphasizes how crucial stakeholder involvement is in guiding AI toward more sustainable results, implying that cooperative efforts can result in the development and application of AI systems that are by their very nature more ecologically friendly.

Notwithstanding its potential, there are a number of obstacles to overcome before AI may be used in conservation, including ethical, financial, and technical issues. Because creating AI solutions can be expensive and frequently calls for specialist knowledge, it might not be as accessible to enterprises with little resources. Concerns have also been raised regarding data privacy, AI algorithm biases, and the moral ramifications of automating some conservation tasks. Furthermore, cooperation between disciplines is necessary for AI to be effective in conservation because ecologists, data scientists, policymakers, and technology developers must all contribute to its successful application [13]

The combination of AI with environmental conservation is not only a technology advancement but a key step toward reaching sustainability. From climate change mitigation and sustainable agriculture to catastrophe resilience and water resource management, AI-driven solutions offer tremendous potential to tackle global environmental issues. The creation of data-driven policies and adaptive conservation plans catered to particular environmental circumstances is also made easier by these technologies.

1.1 Research Questions

1. How effective are AI-driven strategies in addressing environmental conservation challenges based on your perception?
2. What are the primary AI technologies used by conservation organizations?
3. What are the main barriers and limitations of implementing AI in environmental conservation?
4. How do conservation professionals perceive the sustainability and future potential of AI-driven solutions for long-term conservation?

1.2 Research Hypotheses

1. **$H0_1$:** AI-driven strategies are not significantly improve the effectiveness of environmental conservation efforts in addressing issues like deforestation and wildlife preservation.
2. **Ho_2**: AI-driven solutions are not significantly perceived to have a positive impact on the sustainability and future success of long-term conservation goals.

2. Methodology

This study used quantitative research design to evaluate the A Survey on AI-Driven Strategies and Solutions for Environmental. A cross-sectional survey approach was adopted to collect data from conservation professionals. The study focused on professionals and organizations working in environmental conservation and AI which includes World Wildlife Fund, Environmental Defence Fund, Ministry of Environment, National Environmental standards and Regulations Enforcement Agency, National Centre for Energy and Environmental, Nigerian Institute for Oceanography and Marine Research. A random sampling method was used for the selection of the respondents. The sample size were 200 respondents. Structured questionnaire (see appendix I) was used for the collection of data. The questionnaire consists of closed-ended questions using a four Likert scale from Strongly Agree, Agree, Disagree and Strongly Disagree. A pilot study was conducted with 20 respondents. The feedback from the pilot test respondents were used to refine the questionnaire before the full deployment.

The survey was administered electronically through platform of Google Forms to ensure wide reach and convenience. Descriptive statistics of mean and standard deviation was used for answering the research questions to calculate the average response for each survey item, indicating the general trend of participants' perceptions. However, the threshold or cutoff point for acceptance in this study is 2.50 (on a Likert scale of 1 to 4). This scale typically represents: 1= Strongly Disagree, 2 = Disagree, 3 = Agree and 4 = Strongly Agree. Acceptance Criteria: If the mean score is ≥ 2.50, the item is considered "accepted," meaning respondents generally agree with the statement. Rejection Criteria: If the mean score is < 2.50, the item is considered "rejected," meaning respondents generally disagree with the statement. However, the Inferential Statistics of Chi-square was used to test the hypotheses at 0.05 level of significance.

The Chi-Square Test is a statistical method used to determine whether there is a significant association between categorical variables. It assesses how observed data compare to expected data under a specific hypothesis. The P-value indicates the probability of observing the data if null hypothesis is true. If $P \leq 0.05$, reject the null hypothesis; this indicates a significant result. Ethical guidelines was strictly followed throughout the study. Participation were voluntary, and informed consent was obtained from all respondents prior to survey participation. Confidentiality of the participants' information was maintained, and all data collected were used solely for research purposes.

3. Results and Discussion

Table One: AI-driven strategies in addressing environmental conservation challenges

	Mean	Std. Deviation	Decision
AI-driven strategies are effective in monitoring biodiversity and tracking species populations.	2.92	.727	Accepted
AI technologies effectively detect and prevent illegal activities (e.g., poaching, deforestation).	2.69	.463	Accepted
AI solutions improve resource allocation and decision-making for conservation efforts.	2.53	.837	Accepted
AI-driven approaches are effective in predicting and managing environmental threats (e.g., wildfires, invasive species).	2.61	.490	Accepted
AI applications contribute effectively to reducing pollution and improving waste management in conservation areas.	3.38	.926	Accepted

Weighed mean	**2.83**	Accepted at 2.50	

Table 1 indicated that weighted mean of the responses of the respondents on the level of effectiveness of AI-driven strategies in addressing environmental conservation challenges was 2.83 which shows the moderate level. However, on the criteria for a accepting the response (2.50) all the items accepted by respondents

Table Two: The primary AI technologies used by conservation organizations

	Mean	Std. Deviation	Decision
Machine learning models are widely used by conservation organizations to analyze environmental data.	2.75	.900	Accepted
Computer vision technology is commonly applied in conservation efforts to monitor wildlife and habitats.	2.84	.869	Accepted
Predictive analytics tools are frequently used by conservation organizations to forecast environmental changes.	3.14	.539	Accepted
Natural language processing (NLP) tools are often utilized to analyze conservation-related reports, documents, and social media data.	2.30	.617	Accepted
Conservation organizations commonly use drone and satellite-based AI technologies for real-time environmental monitoring.	3.14	.794	Accepted
Weighed mean	**2.83**	Accepted at 2.50	

The table two indicated that weighted mean of the responses of the respondents on the primary AI technologies used by conservation organizations was 2.83. However, on the criteria for a accepting the response (2.50) all the items accepted by respondents. This implies that the primary AI technologies used by conservation organizations were: Machine learning models are widely used by conservation organizations to analyze environmental data, Computer vision technology is commonly applied in conservation efforts to monitor wildlife and habitats, Predictive analytics tools are frequently used by conservation organizations to forecast environmental changes, Natural language processing (NLP) tools are often utilized to analyze conservation-related reports, documents, and social media data and Conservation organizations commonly use drone and satellite-based AI technologies for real-time environmental monitoring.

Table Three: Barriers and limitations of implementing AI in environmental conservation

	Mean	Std. Deviation	Decision
The high costs associated with AI technologies are a significant barrier to their implementation in conservation efforts.	3.30	1.082	Accepted
Limited technical expertise within conservation organizations hinders the adoption of AI-driven strategies.	3.14	.794	Accepted
Data privacy and security concerns restrict the use of AI in environmental conservation.	3.16	.765	Accepted
Lack of reliable data and data quality issues are major limitations to effective AI application in conservation.	2.93	.830	Accepted
Ethical concerns about AI usage (e.g., surveillance, automation) pose challenges for conservation organizations.	3.08	.727	Accepted
Weighed mean	**3.12**	Accepted at 2.50	

Table three indicated that weighted mean of the responses of the respondents on the main barriers and limitations of implementing AI in environmental conservation was 3.12 which shows high level.

However, on the criteria for a accepting the response (2.50) all the items accepted by respondents. This implies that the main barriers and limitations of implementing AI in environmental conservation were: high costs associated with AI technologies are a significant barrier to their implementation in conservation efforts**,** Limited technical expertise within conservation organizations hinders the adoption of AI-driven strategies. Data privacy and security concerns restrict the use of AI in environmental conservation, Lack of reliable data and data quality issues are major limitations to effective AI application in conservation and **e**thical concerns about AI usage (e.g., surveillance, automation) pose challenges for conservation organizations.

Table Four: Conservation professionals perceive the sustainability and future potential of AI-driven solutions for long-term conservation

	Mean	Std. Deviation	Decision
AI-driven solutions have strong potential to support sustainable, long-term conservation goals.	3.00	.787	Accepted
The use of AI in conservation will become increasingly essential for addressing future environmental challenges.	2.22	.418	Accepted
AI technologies provide sustainable tools for monitoring and managing ecosystems over time.	3.38	.926	Accepted
AI-driven conservation strategies are adaptable to the changing needs of environmental conservation.	2.76	.797	Accepted
Conservation professionals view AI as a reliable and long-term solution for preserving biodiversity.	2.92	.932	Accepted
Weighed mean	2.86	Accepted at 2.50	

Table four indicated that weighted mean of the responses of the respondent's conservation professionals perceive the sustainability and future potential of AI-driven solutions for long-term conservation was 2.86. However, which shows the moderate level. However, on the criteria for a accepting the response (2.50) all the items accepted by respondents

Table Five: AI-Driven strategies to improve the Environmental conservation efforts in addressing issues like Deforestation and Wildlife Preservation

	Chi-square	df	P- value	Decision
Effectiveness AI-Driven strategies to improve the environmental conservation efforts in addressing issues like deforestation and wildlife preservation	61.716	5	0.000	Significant

Table five above revealed that the Chi- Square value of 61.716^{a} was computed and the p- value 0.000 was observed. Hence, the study rejected the hypothesis that say AI-driven strategies are not significantly improve the effectiveness of environmental conservation efforts in addressing issues like deforestation and wildlife preservation. This implies AI-driven strategies significantly improve the effectiveness of environmental conservation efforts in addressing issues like deforestation and wildlife preservation.

Table Six: Positive impact of AI-Driven solutions on the sustainability and future success of long-term conservation goals.

	Chi-square	df	P- value	Decision
Positive impact of AI-Driven solutions on the Sustainability and future success of long-term conservation goals.	74.642	3	0.000	**Significant**

Table six above revealed that the Chi-Square value of 74.642 was computed and the p-value 0.000 was observed. Hence, the study rejected the hypothesis that say AI-driven solutions are not significantly perceived to have a positive impact on the sustainability and future success of long-term conservation goals. This implies that the AI-driven solutions significantly perceived to have a positive impact on the sustainability and future success of long-term conservation goals

3.1 Discussion

The finding of the study indicated that AI-driven strategies significantly improve the effectiveness of environmental conservation efforts in addressing issues like deforestation and wildlife preservation" highlights the transformative impact of artificial intelligence on conservation practices. This result underscores AI's capacity to enhance real-time monitoring, predictive modeling, and strategic decision-making in ways that traditional methods may fall short. The finding agreed with that of [14]. The finding of his study shows that transformative power of AI in environmental conservation is evident in its diverse applications, from remote sensing and wildlife protection to climate change prediction and adaptation. The result also was in line with that of [15] their study indicated that Tech-Driven Solutions for Environmental Conservation by AI Collaboration Processes show how AI technologies can revolutionize energy optimization by enabling intelligent control systems, integrating renewable energy sources, and enabling precision energy optimization

The finding also revealed that AI-driven solutions are perceived to have a positive impact on the sustainability and future success of long-term conservation goals. The result agreed with that of [16] on their study AI-Driven Risk Management and Sustainable Decision-Making. According to their result, the People theme explores AI's role in enhancing well-being and equality. It emphasizes efforts to eradicate poverty and hunger, promote health and education, and achieve gender equality. These findings reflect a comprehensive approach to leveraging AI for human-centric sustainable development. The finding also was in line with that of [17]. According to their result, through an insightful exploration of the contemporary urban landscape and the identification of successfully applied AI and AIoT solutions, stakeholders gain the necessary groundwork for making well-informed decisions, implementing effective strategies, and designing policies that prioritize environmental well-being.

4. Conclusions

This study's findings demonstrate that AI-driven strategies significantly enhance the effectiveness of environmental conservation efforts, particularly in addressing challenges such as deforestation and wildlife preservation. AI-driven solutions are perceived as valuable tools for promoting the sustainability and future success of long-term conservation goals. By enhancing monitoring capabilities, improving resource efficiency, and enabling predictive analytics, AI technologies have proven to be highly effective in addressing complex environmental challenges

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