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LEVERAGING ARTIFICIAL INTELLIGENCE FOR CLIMATE RESILIENCE AND SUSTAINABLE NATURAL RESOURCE MANAGEMENT IN KENYA

BY

DR. THOMAS GISEMBA ONSARIGO

**CATHOLIC UNIVERSITY OF EASTERN AFRICA*

Abstract

Artificial Intelligence (AI) holds significant potential in enhancing climate resilience and supporting sustainable natural resource management in East Africa. Sustainable natural resource management requires a long-term stewardship of resources in order to meet current needs without compromising future generations. This can be achieved through adoption of AI which has emerged as a transformative tool in addressing critical environmental issues. As climate-related shocks intensify, AI technologies are providing rapid and accurate insights for monitoring environmental changes, forecasting risks and informing adaptive responses. This study sought to examine how leveraging AI for climate resilience aids sustainable natural resource management in Kenya. The study was guided by one objective; to examine how AI can support sustainable natural resource management. Socio-Ecological Systems Theory guided the study. The study is adopted a desk top /secondary data research design. The study relied entirely on existing data published between 2020 and 2025. The targeted secondary data was 188government reports, academic journals and records and development partner publications relevant to the study topic. The sample was filtered down to 40 articles and reports forming the sample size. Data in this study was purposefully sampled and by methodically choosing pertinent peer-reviewed journal and articles, the inclusion criteria being publication date between 2000-2025 on AI and climate resilience and sustainable natural resource management. Data collection included structured online searches, document screening, and extraction of key variables linked to AI adoption and sustainable natural resource management. Thematic content analysis was also used to categorize findings into themes and analyzed thematically based on the research objective. The study findings indicate that AI enhances natural resource management in Kenya at the micro system level through improved monitoring, yet faces significant barriers at the exosystem and macro system levels, including inadequate infrastructure, data scarcity, and limited local expertise among others. The study further found that these structural constraints threaten and undermine the potential of AI in promoting sustainability of natural resource management. The study concluded that successful AI integration requires moving beyond isolated technological applications to foster holistic, cross-sector collaborations and robust data governance. The study makes a recommendation on laying emphasize on the need for strengthening policy ecosystems through localized, ethical data practices, increased investment, and capacity building to bridge the digital divide. As with these innovations, AI's transformative potential will strengthen long-term climate resilience and reshape environmental governance.

Key words: Artificial Intelligence, Climate Resilience, Natural Resource Management, Environmental Sustainability

Introduction

The generation that destroys the environment is not the generation that pays the price. That is the problem– ***Wangari Maathai***

Kenyans have underutilized their natural resources for a very long time, increasing poverty and the overreliance on international aid. However, sustainable use of natural resources like; Air (Wind), Water, Wetlands, Land (earth/soil), Minerals, Forest, Wildlife and biodiversity, Energy (geothermal, wind, solar, and hydropower), Marine resources. These nine critical resources form the backbone of the nation's economic, social, and environmental well-being. Sustainable management is not merely a policy option, but an imperative for ensuring long-term prosperity. The integration of AI into these natural resource management will promote climate resilience and sustainable natural resource management.

Artificial intelligence (AI) is becoming a vital tool in tackling the intricate and interrelated problems brought on by climate change and the depletion of natural resources. Traditional methods of environmental monitoring and resource governance are failing to provide timely, data-driven, and adaptable responses as the frequency and severity of climate-related shocks continue to rise. The integration of AI into these sustainable development practices holds a significant promise for addressing contemporary environmental challenges and thereby providing mechanisms for sustainable natural resource management in Kenya and the world at large. This study examines the role of AI in promoting climate resilience and sustainable natural resource management in Kenya, positioning AI as a transformative enabler within changing environmental governance frameworks and socio-ecological systems.

Background to the study

There has been a continuous decline in biodiversity and ecosystems worldwide. Integrating Al into sustainable natural resource management is therefore critical in reversing the global decline of biodiversity and ecosystems. Chisika, Park & Yeom (2023) opines that trees and forested ecosystems play a crucial role in offering numerous ecosystem services to billions of people. The study established that AI is becoming increasingly important in forest management. AI facilitates the real-time monitoring of forest health, helps predict and prevent threats such as wildfires and illegal logging. The application of AI therefore contributes to sustainable forest management by preserving and effectively utilizing forest ecosystems.

Natural resources can generate significant wealth for a country by supporting livelihoods, food security, and the green economy, as well as producing trade and entrepreneurship at the local, national, and global levels. According to Hanushchyn et al. (2025) implementing AI in public administration to reduce shadowing and inefficient use of resources in particular, the case of AI usage to combat deforestation. The study lays emphasis on stakeholders' interests and decentralized arrangements of natural resource governance. The study concluded that the power relationships among stakeholders may have a big influence on how well governance frameworks for managing natural resources work.

Since natural resources are limited, effective management is necessary to meet long-term objectives and that effective management of natural resources is necessary to ensure that present generations may meet their demands while protecting them for future generations. This becomes even more challenging in the age of climate change concerns. The study concludes that in light of the 2030 Agenda, economic, social, and environmental aspects should all be incorporated into sustainable development (Hanushchyn et al. 2025).

Kulkarni (2025)explored the transformative role of artificial intelligence in natural resource management, focusing on its applications across various sectors, including forestry, water resources, biodiversity conservation, and land use. The study findings were that as global challenges such as climate change, population growth, and environmental degradation intensify, effective management of natural resources is paramount. The study concluded that AI technologies, including machine learning, predictive analytics, and remote sensing, will be key in offering innovative solutions for monitoring, analyzing, and optimizing resource utilization. The integration of AI not only facilitates proactive management strategies but also promotes resilience and adaptability in natural resource systems, ultimately contributing to a more sustainable future.

Kulkarni (2025) explored the transformative role of artificial intelligence in natural resource management,

focusing on its applications across various sectors, including forestry, water resources, biodiversity conservation, and land use. The study findings were that as global challenges such as climate change, population growth, and environmental degradation intensify, effective management of natural resources is paramount. The study concluded that AI technologies, including machine learning, predictive analytics, and remote sensing, will be key in offering innovative solutions for monitoring, analyzing, and optimizing resource utilization. The integration of AI not only facilitates proactive management strategies but also promotes resilience and adaptability in natural resource systems, ultimately contributing to a more sustainable future.

Climate change is undeniably one of the most critical challenges facing the world today. In the USA according to Bano (2025), the role of AI in predicting and mitigating climate change demands innovative solutions, especially in the realms of prediction and mitigation. The study established that among the tools that offer significant promise is AI, which is reshaping the landscape of climate science by improving forecasting models, enhancing renewable energy systems, and driving policy changes towards sustainability. The study revealed that US thrives on innovation driven by the private sector, leading to the development of cutting-edge AI tools. The study recommends for global cooperation in AI governance, highlighting the importance of international collaboration to fully harness AI's potential for climate mitigation and sustainable natural resource management.

Akbar, Batool, Siddiqui & Habib, (2025), addressing climate change, pollution monitoring and sustainable resource management has proved to be a transformative tool in addressing critical environmental challenges. The study finding indicate that AI has significantly enhanced the accuracy of climate models and optimized renewable energy deployment, contributing to effective mitigation strategies. AI-driven systems offer real-time detection and analysis, surpassing traditional methods in precision and scalability. In sustainable resource management, AI optimizes agricultural practices, forest conservation, and water resource allocation, promoting efficiency and sustainability.

According to Kumar, et al. (2024), the frequency of weather and climate hazards has been increasing and so is the demand to anticipate climate variations with longer lead times. To meet the demand for relevant climate information in managing climate risks, the World Meteorological Organization has been proactive in developing and coordinating the required infrastructure based on the latest scientific advances, with cascading of forecast information from global to regional to national scales. This calls for the adoption of AI technology.

According to Neethirajan (2023) agriculture and Agri-Food industry in Canada provides significant economic benefits. Nevertheless, the emission of greenhouse gases remains the most pressing environmental issue associated with dairy farming, directly influencing climate change. These emissions are a concern not only for their contribution to global warming but also for their role in altering weather patterns, impacting ecosystems and biodiversity. The study concluded that the advent of Big Data and Al has revolutionized dairy farming, introducing enhanced efficiency, improved sustainability, and innovative management practices.

In Asia, Farhanet al. (2024) in their report a head of the AS conference, 2024 in Kuala Lumpur, analyzed how AI can alter global sustainability. The report indicated that AI can maximize resource utilization, improve decision-making and drive innovation while tackling data privacy, algorithmic bias, and the digital divide. The report emphasized that there is need for a strong governance structure to ensure ethical AI adoption and public trust. The report also stressed the necessity for AI technology access policies, especially for underprivileged areas and that collaboration between government, corporate, and civil society is necessary for using AI for sustainable development.

In India according to Yadav (2024) leveraging AI for sustainable development and environmental resilience is an innovative approach with immense potential for addressing the complex challenges of climate change and ecological degradation. The study established that Al has ability to process vast amounts of data and extract meaningful insights and can play a crucial role in promoting sustainable practices, optimizing resource utilization, and mitigating the impacts of climate change. The study established that by

harnessing AI technologies, policymakers, scientists, and environmentalists can develop more accurate models and predictive tools to assess the current state of the environment.

In Africa, according to Mbuvha, et al. (2024), Al has emerged as a critical and valuable tool for climate change adaptation and mitigation. Its effectiveness and potential are contingent upon overcoming significant challenges such as data scarcity, infrastructure gaps, and limited local AI development. Al is rapidly gaining traction as an essential tool for adaptation and mitigation to climate change and therefore its applications clearly demonstrate its ability to enhance climate resilience by improving predictive capabilities and enabling adaptive responses to climate change. AIs effectiveness is highly contingent upon the availability of robust datasets that capture the complexity of local environmental conditions.

According to Leal, Filho & Gbaguidi (2024), climate change poses significant threats to African countries. With increasing temperatures, erratic rainfall patterns, and extreme weather events impacting ecosystems, agriculture, water resources, and human livelihoods, AI will offer valuable support in climate change adaptation efforts in the field of agriculture with established guidelines that will promote innovation while addressing ethical and legal concerns.

Bawa (2025) examined the integration of AI into resource management for sustainable economic growth in Ghana. AI integration within resource management systems fosters sustainable economic growth amid persistent challenges of resource inefficiency and environmental degradation in resource-dependent economies like Ghana. The study concluded that instead of using the ancient traditional practices of smallholder farmers, such as the use of 'rain callers', the use of forest reserves as shrines, indigenous weather forecasting, and the use of bio-insecticide innovation, there is need for adoption and integration of AI-driven innovations to enhance operational performance and ecological balance across key sectors like energy, agriculture, mining, and water.

While AI emerges as a critical and valuable tool for climate change adaptation and mitigation, its effectiveness and potential are contingent upon overcoming significant challenges such as data scarcity, infrastructure gaps, and limited local AI development. Mbuvha, et al. (2024) therefore calls for a more understanding of modelling bimodal rainfall patterns in East Africa which is critical for agricultural planning and water resource management as these patterns have significant implications for the livelihoods of millions of people who depend on rain-fed agriculture and pastoralism.

Chisika, Park, & Yeom (2023) in their study established that there is need to a better understanding of the strategies needed to promote the role of AI in the development and sustainability of forests. Results from this study revealed that AI deployment in forestry is still in the infancy stages. The country has some AI technologies in use to promote forest management. Moreover, both public and private, local, and international organizations are actively involved in developing AI applications for forestry to consider the social, economic, and environmental facets of sustainable forest management.

According to Gesami & Nunoo (2024) the application of AI in monitoring and managing marine ecosystems to address the impacts of climate change on Kenya's Blue Economy is a critical component. The study assessed the threats posed by climate change to the ecosystems and explored the potential of AI solutions to enhance adaptation and resilience. The study revealed that climate change poses significant threats to Kenya's marine ecosystems, including coral bleaching, ocean acidification, sea-level rise, and disruptions to ocean currents. AI technologies therefore offer promising solutions for monitoring and managing these impacts, with applications in predictive modeling, resource optimization, and decision support. The research highlights the need for further exploration into specific AI applications tailored to Kenya's unique coastal challenges and the importance of incorporating diverse stakeholder perspectives.

Owiny (2025) examined the utilization of AI in Kenya, the legal, regulatory and ethical frameworks guiding its application on sustainable development. The findings were that, whereas AI is being embraced in Kenya across various sectors of the economy, there are no policy, legal, and regulatory frameworks to guide in the implementation in natural resource management. There are also scanty studies done on natural resource

management using AI, this study therefore delves into this.

Statement of the problem

Climate change poses an existential threat to Africa's sustainable resource management. Its impacts, ranging from increasingly frequent extreme weather events to shifting disease vectors and degraded ecosystems, are growing more complex and interconnected. Kenya has leveraged AI as an integrated, data-driven tool to strengthen climate resilience and advance sustainable natural resource management. In this context, AI-powered climate forecasting, early warning systems, and environmental monitoring would support evidence-based decision-making across agriculture, forestry, water, and biodiversity sectors.

Given Kenya's heavy reliance on rain-fed agriculture and natural resources, sustainable natural resource management would balance ecological integrity, social equity, and economic development, as emphasized in sustainable resource governance frameworks. AI applications ranging from predictive analytics to remote sensing and decision-support systems would enhance real-time data analysis, improve planning, and enable adaptive responses to climate risks, thereby aligning national development goals with long-term environmental sustainability.

However, existing literature reveals significant gaps that limit the realization of this situation, Mbuvha et al. (2024), Chisika, Park, and Yeom (2023), and Ayodele, Izuchukwu, and Abiola (2025) highlights the growing relevance of AI in climate adaptation and sustainable resource management in Africa, much of the scholarly work remain generalized at the continental level. There is limited empirical evidence tailored to Kenya's specific socio-ecological systems, institutional frameworks, and data environments. Additionally, challenges such as data scarcity, inadequate digital infrastructure, limited localized AI development, and weak integration of indigenous ecological knowledge with AI systems constrain effective implementation. Despite the availability of digital tools such as Geographic Information Systems, remote sensing, and AI-driven platforms (Erokhin & Komendantova, 2025), their practical application in strengthening climate resilience and sustainable natural resource management in Kenya remains underexplored.

This study therefore critically examines how AI can be strategically applied to strengthen climate resilience and promote sustainable natural resource management in Kenya. By focusing on localized data systems, context-specific AI frameworks, and the integration of indigenous knowledge with advanced analytics, the research sought to generate evidence-based recommendations for policymakers and practitioners by offering practical pathways for enhancing environmental monitoring, climate risk forecasting, and sustainable resource governance which will contribute to the development of an AI-enabled, climate-resilient, and ecologically sustainable future for Kenya.

Literature review

This section reviews literature based on the one objective;

How AI can support sustainable natural resource management

Biodiversity conservation and natural resource management are crucial for maintaining ecological balance and ensuring sustainable development in the USA. According to Ayoola, etal. (2024) integration of Big Data and AI technologies has revolutionized biodiversity conservation and resource management in the USA. The study established that the application of A facilitates the collection, analysis, and interpretation of vast datasets, which are crucial for understanding and addressing biodiversity loss. The study concluded that AI technologies, particularly machine learning and deep learning, have significantly enhanced the ability to analyze complex biodiversity data and that AI can process large volumes of data rapidly and accurately, identifying patterns and predicting future trends by using methods such as Geographic Information Systems (GIS), LiDAR, and RADAR, to track changes in land use and habitat conditions.

The integration of AI into sustainable development practices holds significant promise for addressing contemporary environmental, economic, and social challenges. According to Jones, et al. (2024), AI significantly enhances efficiency and effectiveness across various domains, including improved natural resource monitoring, optimized agricultural practices, and enhanced waste management processes. The results from the study underscore AI's potential in mitigating climate change and promoting biodiversity

through advanced predictive models and monitoring systems. This highlights the critical role of supportive policies and infrastructure in realizing AI's benefits for sustainable development.

According to Nishant, Kennedy, & Corbett (2020) AI will transform business practices and industries and has the potential to address major societal problems, including sustainability. Degradation of the natural environment and the climate crisis are exceedingly complex phenomena requiring the most advanced and innovative solutions. The true value of AI according to the study will not be in how it enables society to reduce its energy, water, and land use intensities, but rather how it facilitates and fosters environmental governance.

Energy efficiency is a crucial aspect of sustainability, as it directly impacts our carbon footprint. Durai, Manoharan, & Ashtikar, (2024) opines that AI is revolutionizing energy management systems by optimizing energy consumption, improving grid stability, and reducing waste. Smart grids use AI to balance supply and demand in real time, reducing the strain on our energy resources and lowering greenhouse gas emissions. The study established that AI is enabling predictive maintenance, making energy systems more reliable and reducing downtime. AI is at the forefront of climate modelling, providing researchers with the computational power and predictive accuracy needed to understand and combat climate change.

According to Toderas (2025) global challenges such as climate change, natural resource depletion, biodiversity loss, socio-economic inequalities, and threats to food security necessitate integrated and large-scale solutions for AI use as a tool with vast potential to address these complex issues. Globally, according to Kapatamoyo (2024), AI has been employed in diverse domains such as healthcare, finance, manufacturing, transportation, retail, and entertainment while in Africa, AI applications is emerging as a catalyst for socio-economic development and is being adopted in various sectors, including agriculture, healthcare, education, finance, and natural resource such as mining, wildlife conservation, and water resource management, contribute to environmental sustainability and biodiversity conservation.

Guhad, et al, (2025), in analyzing the policy, awareness and capacity of AI implementation In Kenya's Public Service in Light of The National AI Strategy 2025-2030, established that .AI is a driver of change, touching sectors as diverse as agriculture, healthcare, education, finance, and governance. The study further global conversation around AI is rapidly evolving, and Kenya has recognized the urgent need to place itself at the forefront of this technological revolution. The study further established that Kenya's Artificial Intelligence Strategy envisions the country as Africa's leading AI hub for model innovation, driving sustainable development, economic growth, and social inclusion while positioning itself as an AI research and application leader on the continent. The objectives of this strategy include establishing a robust governance framework for AI; enhancing adoption in key sectors such as agriculture, security, healthcare, education, and public service delivery; and fostering the growth of local AI ecosystems.

According to Chisika, Park & Yeom (2023), forest management in Kenya involves various activities aimed at maintaining and optimizing forest ecosystem functions and processed. Sustainable management of this ecosystem includes community engagement, public education, and conservation efforts for a long-term environmental, social, and economic balance. To improve the execution of these activities, several AI applications for forest management have recently emerged in the country, aiding in promoting sustainable forest management.

Methodology

This study adopted a secondary review research design. This design is also known as a desk review or secondary data analysis design which is a methodology that relies on the systematic collection and analysis of existing data and literature rather than gathering primary data directly from respondents. This design involves reviewing existing empirical studies, policy frameworks, technical reports, and case studies published between 2020 and 2026. The review initially targeted 188 academic articles from major scholarly databases but after a careful review, the list was filtered down to 44 articles for full analysis forming the target and sample size respectively.

Data in this study was purposefully sampled and by methodically choosing pertinent peer-reviewed journal

and articles, the inclusion criteria being publication date between 2000-2025. The key themes were extracted and organized and then analyzed thematically based on the research objective

Results/ Findings

This study reviewed previous literature between 2020–2025. The findings from the reviewed literature indicates that AI offers substantial opportunities for enhancing sustainable natural resource management in Kenya. Evidence shows that AI technologies such as remote sensing, machine learning, and geospatial analytics have strengthened environmental monitoring systems across key sectors including agriculture, water resources, forestry, wildlife, and marine ecosystems.

The study found that the integration of AI into participatory natural resource management and especially in forest management is emerging as a promising strategy for promoting sustainable forest management in developing countries. The study results show that the current data management system for executing community roles in forest management is inefficient, time-consuming, and susceptible to errors. However, with AI utilization, there is potential to enhance efficiency. This finding is true to a study by Chisika & Yeom (2024) on improving the role of communities in participatory forest management through artificial intelligence in Nairobi city.

The study found that there is need to adopt advanced technologies like predictive analytics and community engagement in enhancing wildlife conservation in Kenya's private conservancies.

Artificial intelligence is transforming natural resource management by increasing efficiency, accuracy, and sustainability in a variety of industries, including forestry, agriculture, and wildlife protection. AI algorithms, particularly machine learning, are used to automate data analysis, make better decisions, and allocate resources more efficiently. Forest management is one area where artificial intelligence can be extremely useful. AI tools also assist forest managers in conducting "controlled burns" to eliminate excess brush that could ignite wildfires. They can use artificial intelligence to predict when the weather is optimum for starting a fire without jeopardizing neighboring communities (Hanushchyn et, al.2025).

The study findings indicate that AI-driven modeling of forest ecosystem decline highlights a significant amplification of economic and financial instability due to the erosion of critical ecosystem services. These systems classify the resulting impacts into physical risks and transition risks, affecting stakeholders from individual households to the global macro economy This finding is in line with the study by Hanushchyn, et,al.(2025) which found that a well-documented decline of forest ecosystems in recent decades has had a substantial impact on economic and financial systems due to the loss of ecosystem services. These effects are felt by households, businesses, financial institutions, and the macro economy as a whole through physical risks and transition risks, which are associated with the process of moving toward a more sustainable economy. Businesses that are very vulnerable to hazards associated with deforestation not only help to sustain these cycles but also directly suffer from them.

Lower productivity, increased production costs, and a decline in market competitiveness are the results. Such effects on financial institutions could result in asset devaluation, higher default rates, and a lack of liquid assets, which would raise systemic risk and necessitate paying more attention to how environmental criteria are incorporated into risk analysis and management procedures

By synergizing evidence-based technologies like AI with community empowerment, the framework positions local stakeholders as pivotal actors in wildlife protection while advancing scalable solutions for habitat preservation. This finding is true to a study by Hapicha, (2025) whose findings were that in Kenya, local threats to biodiversity hotspots are increasingly driven by land-use change, illegal wildlife exploitation, climate variability, and expanding infrastructure development, all of which accelerate habitat fragmentation and ecosystem degradation. Critical ecosystems such as the Mau Forest Complex, Aberdare Range, Mount Kenya, and the Coastal Forests of Kenya face mounting pressure from agricultural expansion, logging, charcoal production, and settlement growth. Addressing these challenges requires innovative, data-driven, and context-specific approaches that integrate ecological monitoring, community participation, and adaptive policy

frameworks. AI offers significant potential to strengthen sustainable natural resource management in Kenya. AI-integrated satellite imagery has enabled more accurate and timely detection of deforestation, land degradation, illegal logging, and fluctuations in water bodies. In critical ecosystems such as the Mau Forest Complex and the Aberdare Ranges, AI-supported monitoring has improved early warning mechanisms and informed evidence-based environmental policy interventions.

The findings further demonstrate that AI-driven predictive analytics and climate modeling tools are improving adaptive natural resource management. Machine learning applications have enhanced the forecasting of rainfall variability, drought events, crop performance, and water availability—factors that are vital in a country heavily reliant on rain-fed agriculture. AI-powered advisory platforms are also supporting precision agriculture by optimizing irrigation schedules, fertilizer usage, and pest management practices. This finding is true to a study by Ayodele, Izuchukwu & Abiola, (2025) who established that these innovations not only increase agricultural productivity but also minimize environmental degradation, illustrating AI's capacity to simultaneously promote ecological sustainability and economic resilience.

This study found that the application of AI in monitoring and managing marine ecosystems to address the impacts of climate change on Kenya's Blue Economy is a critical step. The study found that to assess the threats posed by climate change to these ecosystems and explore the potential of AI solutions is essential in enhancing adaptation and resilience. This finding is true to a study by Gesami & Nunoo (2024) in their examination of AI in marine ecosystem management and climate threats to Kenya's blue economy which revealed that climate change poses significant threats to Kenya's marine ecosystems, including coral bleaching, ocean acidification, sea-level rise, and disruptions to ocean currents therefore, AI technologies offer promising solutions for monitoring and managing these impacts.

The study found that the integration and adoption of AI in Water & Disaster Management in Kenya is critical. Water is a treasured commodity in most city households in Kenya and also a dreaded community when there is heavy rainfall. The findings from literature indicated that inclusion of AI is increasing the range of information that top management and other important decision makers must have access to in order to manage the water resource and its distribution to the consumers. In this case, AI applications enable better detection of anomalies, highly efficient data analysis, and offer real-time communication and efficiency

This finding complements a study by Kiplagat & Mutuku (2023) on AI inclusion and performance of sensor management system in Nairobi-city water and sewerage company in Kenya which found that Nairobi City Water and Sewerage Company face several challenges in the provision of its services to the clients which include; open and overflowing manholes, clogged sewers and ruptured sewers as a result of which the ecosystem and the general public's health are at risk. The study concluded that the inclusion of Al in fault detection, data mining, information inference and pattern recognition on the performance of sensor management system will save on the water wastage.

The generate finding from the literature review shows that AI improves decision-making, forecasting, and operational efficiency across environmental governance, biodiversity protection, energy management, and sustainable natural resource management and development. Most of the literature reviewed show that AI technologies have become a strategic approach to tackle challenges spanning from mining, wildlife conservation, precision agriculture, forest monitoring, water resource management and community-based natural resources management. This finding from literature is complemented by a study by Kapatamoyo (2024) whose finding state that in mineral exploration, AI algorithms analyze geological and geophysical data to identify potential mineral deposits, leading to cost reductions and time savings. In water resource management, AI-based models assess groundwater availability, monitor water quality, and predict risks such as droughts and floods, enabling informed decision-making for conservation and sustainable natural resource management. AI-powered systems also track changes in forest cover, biodiversity, and illegal logging activities in forestry. In wildlife conservation, AI-driven technologies

monitor animal movements, prevent poaching, and mitigate human-wildlife conflicts. These advancements underscore the transformative potential of AI in various natural resource management sectors.

Discussion of the findings.

This study sought to examine how AI can strengthen climate resilience and sustainable natural resource management in Kenya, guided by Ecological Systems Theory. The findings from the 2020–2025 literature review demonstrate that AI technologies particularly remote sensing, machine learning, predictive analytics, and geospatial systems are increasingly enhancing environmental monitoring, forecasting and governance across key sectors. In agriculture, water, forestry, wildlife, and marine ecosystems, AI has improved real-time data analysis, early warning mechanisms, and adaptive planning. These findings align with Ecological Systems Theory, which emphasizes the interdependence between human systems and environmental systems.

AI functions as an integrative tool linking multiple ecological layers community (micro system), institutional governance (meso system), national policy (exo system), and broader global climate dynamics (macro system) thereby strengthening systemic resilience.

The findings on participatory forest management further illustrate the relevance of Ecological Systems Theory. Existing community-based forest management systems in Kenya are often inefficient and prone to data inaccuracies. However, AI-supported platforms improve data management, transparency, and coordination between communities and institutions. In critical ecosystems such as the Mau Forest Complex and Aberdare Range, AI-integrated satellite monitoring has enhanced early detection of deforestation and land degradation. These improvements demonstrate how technological innovation can strengthen interactions between local stakeholders and broader environmental governance systems. By embedding AI within community-based frameworks, sustainable forest management becomes more adaptive, participatory, and evidence-driven.

In wildlife conservation, the findings reveal that predictive analytics and AI-enabled surveillance can help manage threats such as poaching, habitat fragmentation, and climate-induced migration patterns. Ecosystems including Maasai Mara National Reserve and Tsavo National Park face increasing pressures from land-use change and infrastructure expansion. AI-driven modelling strengthens ecological forecasting and conservation planning, allowing policymakers and private conservancies to anticipate risks. This reflects Ecological Systems Theory by demonstrating how technological systems can mediate interactions between human economic activities and natural habitats.

The findings also highlight AI's contribution to climate-smart agriculture and water resource management. Machine learning models enhance rainfall and drought forecasting, improving resilience in Kenya's rain-fed agricultural systems. AI-powered advisory platforms promote precision agriculture, optimizing irrigation, fertilizers, and pest control while reducing environmental degradation. In urban water systems, AI-supported sensor management improves fault detection and reduces water wastage, as seen in the Nairobi City Water and Sewerage Company. These developments strengthen adaptive capacity across ecological and urban systems, promoting sustainability at both rural and metropolitan levels.

Similarly, the literature indicates that AI integration in marine ecosystem governance is vital for safeguarding Kenya's Blue Economy. Climate change threats such as coral bleaching and sea-level rise require predictive monitoring and rapid response systems. AI-enhanced marine surveillance and data analytics improve ecosystem monitoring and adaptive management. From an ecological systems perspective, this demonstrates how AI supports resilience across interconnected terrestrial and marine systems, ensuring sustainable resource utilization. Overall, the findings confirm that AI enhances decision-making quality, forecasting accuracy, operational efficiency, and participatory governance, positioning it as a transformative tool for sustainable environmental management in Kenya.

Conclusion

The study concludes that AI holds significant potential to strengthen climate resilience and sustainable natural resource management in Kenya and by extension Africa. AI technologies enhance environmental monitoring, predictive modeling, biodiversity conservation, water management, agriculture, and

marine ecosystem governance. By aligning with Ecological Systems Theory, the study demonstrates that sustainable resource management requires integrated, multi-level interventions that recognize the interdependence of communities, institutions, ecosystems, and technological systems.

However, the successful adoption of AI depends on strengthening data infrastructure, improving institutional coordination, fostering community engagement, and developing context-specific AI solutions tailored to Kenya's socio-ecological realities. AI is not a standalone solution but a catalytic tool that enhances systemic interaction, adaptive governance, and long-term sustainability.

References

Akbar, N. S., Batool, G., Siddiqui, S., & Habib, M. B. (2025). Leveraging AI for environmental solutions addressing climate change, pollution monitoring and sustainable resource management. *Materials Research Proceedings*, *48*.

Alukwe, J. et al., *AI for Carbon Emission Management and Climate Planning in Kenya* (2024).

Artificial intelligence for climate resilience: advancing sustainable goals in SDGs 11 and 13. (2024). Discover Sustainability.

Artificial intelligence in marine ecosystem management: addressing climate threats to Kenya's blue economy. (2024). Frontiers in Marine Science.

Ayodele, O. J., Izuchukwu, A., & Abiola, D. S. (2025). Leveraging Artificial Intelligence for Climate Change Mitigation in Africa: A Sustainable Approach. *World Journal of Innovation and Modern Technology*, *9*(6).

Ayoola, V. B., Idoko, I. P., Eromonsei, S. O., Afolabi, O., Apampa, A. R., & Oyebanji, O. S. (2024). The role of big data and AI in enhancing biodiversity conservation and resource management in the USA. *World Journal of Advanced Research and Reviews*, *23*(2), 1851-1873.

Bano, S. (2025). The role of AI in predicting and mitigating climate change: A comparative study of US and China's approaches. *The Critical Review of Social Sciences Studies*, *3*(1), 664-675.

Chisika, S., & Yeom, C. (2024). Improving the role of communities in participatory forest management through artificial intelligence: the case of Nairobi city park community forest association. *International Forestry Review*, *26*(1), 1-15.

Chisika, S., Park, J., & Yeom, C. (2023). Public perception on the role of Artificial Intelligence in the sustainable management of tree and forest resources in Kenya.

Durai, S., Manoharan, G., & Ashtikar, S. P. (2024). Harnessing artificial intelligence: Pioneering sustainable solutions for a greener future. In *Social and ethical implications of AI in finance for sustainability* (pp. 89-117). IGI Global Scientific Publishing.

Erokhin, D., & Komendantova, N. (2025). Leveraging Digital Tools for Climate Change Adaptation: Opportunities, Challenges, and Pathways Forward. *Oxford Research Encyclopedia of Natural Hazard Science*.

Farhan, K. A., Onteddu, A. R., Kothapalli, S., Manikyala, A., Boinapalli, N. R., & Kundavaram, R. R. (2024). Harnessing artificial intelligence to drive global sustainability: Insights ahead of SAC 2024 in Kuala Lumpur. *Digitalization & Sustainability Review*, *4*(1), 16-29.

Gesami, B. K., & Nunoo, J. (2024). Artificial intelligence in marine ecosystem management: addressing climate threats to Kenya's blue economy. *Frontiers in Marine Science*, *11*, 1404104.

Government of Kenya. (2024). National Artificial Intelligence Strategy 2025–2030. Ministry of ICT and Digital Economy.

Guhad, A., Kangogo, C., Onyango, E., Moriasi, E., Getembe, E., Karigi, F., ... & Atamba, W. (2025). Analysing The Policy, Awareness and Capacity of Ai Implementation in Kenya's Public Service in Light of the National Ai Strategy 2025-2030.

Hanushchyn, S., Zarichniak, A., Akimova, L., Kyrianova, O., Khotskyi, O., & Akimov, O. (2025). The Role of Artificial Intelligence in

Natural Resource Management: Issues of Transparency and Efficiency.

Hapicha, E. M. H. (2025). Integrating Predictive Analytics and Community Engagement in Kenya: A Framework for Technology-Driven Wildlife Conservation in Private Conservancies. *National Security: A Journal of the National Defence University-Kenya*, *3*(1), 50-67.

Jones, J., Harris, E., Febriansah, Y., Adiwijaya, A., & Hikam, I. N. (2024). Ai for sustainable development: Applications in natural resource management, agriculture, and waste management. *International Transactions on Artificial Intelligence*, *2*(2), 143-149.

Kapatamoyo, M. (2024). Artificial Intelligence in Natural Resources Management: Selected Case Studies from Africa.

Kiplagat, R. K., & Mutuku, M. (2023). Artificial intelligence inclusion and performance of sensor management system in Nairobi-city water and sewerage company, Kenya. *J. Bus*, *11*(3), 182-188.

Kulkarni, S. (Ed.). (2025). *Artificial Intelligence-driven Models for Environmental Management*. John Wiley & Sons, Incorporated.

Kumar, A., Scaife, A. A., Merryfield, W. J., Coelho, C. A., Kolli, R. K., Fröhlich, K., ... & Hovsepyan, A. (2024). World Meteorological Organization (WMO)-Accredited Infrastructure to Support Operational Climate Prediction. *Bulletin of the American Meteorological Society*, *105*(11), E2126-E2143.

Leal Filho, W., & Gbaguidi, G. J. (2024). Using artificial intelligence in support of climate change adaptation Africa: potentials and risks. Humanities and Social Sciences Communications, 11(1), 1-5.

Mbalisi, C. N., & Nwaiwu, N. S. (2025). AI And Africa's Environmental History: Harnessing Past Climate Patterns Towards Building a Sustainable Future. *Nigerian Journal of Arts and Humanities (Njah)*, *5*(1).

Mbuvha, R., Yaakoubi, Y., Bagiliko, J., Potes, S. H., Nammouchi, A., & Amrouche, S. (2024). Leveraging AI for climate resilience in Africa: Challenges, opportunities, and the need for collaboration. *arXiv preprint arXiv:2407.05210*.

Moghayedi, A., Michell, K., & Awuzie, B. O. (2024). Analysis of the drivers and barriers influencing artificial intelligence for tackling climate change challenges. *Smart and Sustainable Built Environment*.

Muhindi, W. (2025). Integrating Artificial Intelligence, ICT and Innovation for Climate-Resilient Child Protection Systems in Kenya. *JBMI Insight*, *2*(12), 64-77.

Neethirajan, S. (2023). Navigating to Net Zero: Leveraging Big Data, AI, and Benchmarking for Sustainable Climate Action and Emissions Reduction

Nishant, R., Kennedy, M., & Corbett, J. (2020). Artificial intelligence for sustainability: Challenges, opportunities, and a research agenda. *International journal of information management*, *53*, 102104.

Ochola, G. O., Kamau, S. K.(2025), *AI-Aided Assessment of Wetland Impact in Kenya*

Owiny, P. (2025). Catching up with technology: Utilization of artificial intelligence in Kenya: Issues, opportunities and challenges. *Opportunities and Challenges (February 01, 2025)*.

Tasha, Sandiponi (2025). *A Review of Artificial Intelligence Applications in Climate Change Mitigation*. International Journal of Environment and Climate Change.

UK FCDO AI for climate-smart agriculture and food security in Kenya initiative (2026).

Yadav, A. (2024). Leveraging artificial intelligence for sustainable development and environmental resilience. In *Exploring ethical dimensions of environmental sustainability and use of ai* (pp. 140-165). IGI Global Scientific Publishing.