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The Future of Environmental Monitoring and Climate Change Adaptation in the Artificial Intelligence Age

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ABSTRACT

Understanding the current weather conditions of different countries within the African continent, along with their agricultural and development status, is crucial for establishing the novel use of AI in environmental monitoring and climate adaptation. Africa, being the second-largest continent in the world, indicates the urgency to forecast and prioritise climate-related disasters accurately, which is possible using artificial intelligence (AI). This study investigates the future of environmental monitoring and climate change adaptation in the AI age. The study employed a desktop research method, utilising credible journals and publications from verifiable sources. The findings revealed that AI has been deployed globally in sustainable forest management, conservation, and environmental monitoring, with great potential in agriculture. The study recommends skill analysis to determine the climate-specific areas to prioritise, with a reporting timeline to measure progress.

Keywords: Artificial intelligence, climate adaptation, climate change, environmental monitoring, sustainable development

INTRODUCTION

Artificial intelligence (AI) is a strategic approach in effective environmental monitoring, which is expected to improve pollution source detection and the accuracy of predicting and mitigating environmental risks, which is critical to wellbeing (Olawade et al., 2024) and leverage ecosystem services for sustainable biodiversity and conservation (van Rees et al., 2022). An AI-driven environmental monitoring approach provides new insights into improving the global capacity for climate adaptation and mitigating its impacts (Shaikh et al., 2024).

Critical challenges include hazard forecasting, risk communication of extreme weather conditions to the affected population (De Perez et al., 2022), and decision-making (Reichstein et al., 2025). The surge in anthropogenic activities has increased the need for ecosystem management, environmental monitoring, resource conservation, and a concise framework to integrate AI prediction systems. This framework aims to enhance data collection, analysis, and decision-making by developing accurate forecasts and responses to future environmental changes through case studies (Xiang & Meadows, 2025) in key areas as sustainable forest management and conservation (Wang et al., 2025). Environmental monitoring is critical in natural resource management. It requires the integration of geomatics in the development of long-term solutions (Moro et al., 2023).

The role of AI in Natural Resource Management

AI has advanced usage in natural resource management and forecasts of potential disasters to facilitate early warnings proactively, resource allocations and decisions during flooding, earthquakes, drought or wildfires (Albahri et al., 2024). With the use of AI, multiple hazard monitoring can be conducted, which is advantageous due to the increasing frequency of occurrence resulting in loss of life, destruction of infrastructure and socioeconomic disruption—the assessment of threats to the marine ecosystems. In a study carried out in Kenya, AI technology was tailored to Kenya's unique coastal challenges to enhance resilience and sustainability in aquatic ecosystems (Gesami & Nunoo, 2024). A significant development in efforts towards Africa's preparedness for climate change is the establishment of an AI research facility in Ghana (AMCHAM, 2025). AI provides options that enhance activities and present options for future engagements to tackle environmental issues (Xiang &

Meadows, 2025). Studies have shown that AI can be an indispensable tool in achieving environmental monitoring, sustainability, conservation, and preservation of the Earth's ecosystem (Dahake et al., 2024). Hence, there is a rise in exploring AI in biodiversity analysis, deforestation detection and assessing forest health (Chisom et al., 2024).

Proficiency of AI in Agriculture and Food Security

The agricultural sector is critical in Africa, especially for the future of farms in food production to feed the growing population that is deprived of incentives to expand their small-holding farms (Devez, 2011). Countries in sub-Saharan Africa continue to import agricultural products and rely heavily on rain-fed agriculture, with limited use of irrigation. Despite the vast agricultural potential and the fact that most of the population depends on agriculture for their livelihood, they have minimal benefit from the potential of the agricultural value chain and trade (Shimeles et al., 2018). As food insecurity rises, more difficulties arise in the area of fertiliser availability. However, the use of AI algorithms has shown proficiency in optimising crop yield with minimal water usage in communities (Mana et al., 2024).

Global Use of AI in Environmental Monitoring

The multifaceted roles of AI in environmental protection have been demonstrated by International Business Machines Corporation (IBM) (Sharma, 2025). IBM collaborated with the Beijing Environmental Protection Bureau to develop an advanced air quality forecasting and decision support system. IBM has expanded globally, collaborating with China, India, South Africa, the U.K., and the U.S. on clean air, renewable energy, pollution forecasts, linking traffic, air pollution and health safeguards (IBM, 2015). In California, AI and satellite data were used to map the wildfire damage that occurred in 2020. This process enabled the detection of over 4 million acres that were impacted, which aided recovery and rebuilding of fire-damaged areas (Roman, 2025).

African Case Studies of the Implementation of AI in Climate Change

The use of AI in predicting soil properties in Benin and in producing grains such as beans, maize, and rice in Burkina Faso has been successfully achieved. Further, the monitoring of water resources and the progress of sugar cane production in Côte d'Ivoire has been phenomenal. The management of soil water storage in landscapes and the prediction of crop yield were carried out in Ghana. In Nigeria, management of crops, water, soil, and livestock breeding has been attained (Degila et al., 2023).

East Africa is exploring AI-driven innovative farming technologies to eradicate poverty, maximise harvests, and address food security. The increase in farming efficiency provided opportunities for female farmers (Foster et al., 2023). In 2023, approximately $2.9 million and $15 million were invested in tech startups in Nigeria and Kenya's agricultural sector to deploy AI in redefining agriculture (Keeffe, 2024). In Ghana, Google research launched an AI research centre to ensure innovative solutions in collaboration with local universities and the policy makers' research centre. The team of researchers adapted machine learning and Google's unique features to reduce the harm of locusts, improve flood forecasts and host community workshops to expand entrepreneurs working on sustainability development goals (Matias, 2022). Statistics show that about 85-90% rain-fed agriculture generated about 70% employment in sub-Saharan Africa in 2000 (Wudil et al., 2022). About nine countries were identified, and over 50% of the population was undernourished, which includes Mali, Somalia, South Sudan, Burkina Faso, and Niger (Omotayo et al., 2019). Thus, African countries are responsible for preventive measures to address food-borne diseases by adopting appropriate safety measures, especially for older people who can be adversely affected (Oduoye et al., 2023).

DISCUSSION

AI is a state-of-the-art approach to preventive safety, enabling the simultaneous monitoring of multiple projects, forecasting, and managing risks in agriculture and food security, which is critical to most of the population. It is evident from this study that AI can improve conservation and sustainable development efforts across the African continent, which will enable better preparation for climate change. However, there is a need to match the cost of deploying African-centred AI solutions and AI-based environmental interventions (Taylor & Munoriyarwa, 2024) with the investment requirement and regulations to balance the delivery of emission reduction targets with innovation (Obonyo, 2024). The timeliness of the availability of funds to facilitate emission cuts will help in the preparedness of affected communities to transition to clean energy and address climate-related disasters (Tekie, 2024).

CONCLUSION

Choosing the most appropriate tool that works best for Africa will drive the AI approach to smart farming, environmental monitoring, disaster prediction and other environmental or socioeconomic concerns. Close guidance is needed from nations that have successfully deployed AI

to monitor the environment and adapt to climate change. To achieve this, more dialogue and collaboration with the government, educational institutions, and entrepreneurs are necessary to generate environmental statistical data that can enable effective resource management.

Recommendation

This study recommends that Africa align its skills with the United Nations Sustainable Development Goals and climate-related policies, enabling investors to identify critical areas for prioritisation and providing an accurate economic baseline for annual progress measurement.

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