Artificial Intelligence: a panacea for Optimising Environmental Monitoring and Conservation

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Abstract

In the present digital era, the geographical information system GIS has been the major advanced tool for digitalising environmental conservation, monitoring, and management in research applications. However, in a constantly evolving world, the application of artificial intelligence (AI) in geographically inclined research, especially as it applies to Environmental Monitoring Management and Conservation, is imperative for standardised data collection and analysis. The methodology devises an in-depth review of literature that addresses the subject matter under discourse, especially as it relates to rugged and inaccessible remote environments. The paper affirms that artificial intelligence is an important tool with the propensity to revolutionise the methods of environmental management and conservation operations. The general Ecosystem Control Model is used as the conceptual model for the research work.

Keywords- Artificial intelligence, Panacea, Environmental, Monitoring, Conservation and Optimization.

Introduction

Ensuring a living earth through proper environmental management is sine-qua-non to environmental monitoring and conservation as the Information and Technology (IT) environment is continually changing and rapidly evolving. The earth and its dynamic components, which are the principal hosts of human existence, have witnessed significant changes arising from the antagonistic conduct of humans in the way and manner they engage in exploiting and exploring the resources of the environment, especially the forest region through indiscriminate logging. The evolution of Artificial Intelligence (AI) in ensuring precision approaches to environmental management is becoming key in today's environmental operations. Kurrupu (2023) believes that Artificial Intelligence is an indispensable tool for harnessing and integrating cutting-edge technologies that can unearth detailed information, data collection, data analysis, and accurate predictions on environmental matters. Therefore, the role of Artificial intelligence (AI) in environmental matters is paramount in biodiversity conservation, optimising the delicate balance of nature and human interference with the diverse components of the earth at varying levels of technologies and development. Onyebuchi et al. (2024) posited that "AI has emerged as a transformative force providing unparalleled capabilities for environmental monitoring and conservation". In light of this assertion, Nelson 2023, stated that AI offers a comprehensive view of ecosystems and habitats on global, regional, and local scales by advancing comprehensive, diverse, and real-time understanding of ecosystem health and stability, especially the forest. Kar et al. (2022) also noted that the impact of AI on habitat assessment is very glaring in the Amazon forest. Furthermore, Chisom et al. (2024) posit that AI tools are already being used as instruments of forest conservation and animal tracking to forestall the illegal and indiscriminate use of forest resources, including game poaching.

Considering the continuous and consistent increase of intractable environmental hazards and environmental degradation affecting the environment, especially the forest ecosystem, there is an urgent need to scale up environmental conservation and monitoring measures to fast-track the responses to environmental protection; hence, the continued advocacy for the application of AI devices. Franklin (2001) emphasised the role of remote sensing in detecting, recognising, or evaluating forest ecosystem hazards. Specifically, mention was made of changing trends in forest management, paying attention to the multi-scale and intricate problem of the 21st Century Environmental problems, which are almost insurmountable due to reliance on analogue tools such as manual (human labour) and aerial photographs. Digital tools such as remote sensing, GIS and artificial intelligence are crucial to environmental monitoring. Therefore, the complexity of environmental dynamics and spatial diversity requires the most current active and relevant tools to aid in environmental monitoring. A major limitation in using remotely sensed data for environmental monitoring and conservation is that precision and accuracy are not guaranteed.

Artificial Intelligence (AI), therefore, transcends the tedious system of analogue surveys, laborious human power, aerial photography and remote sensing, which specialises in fixing the coordinates of areas of data collection with limited interpretation of information. Therefore, it is suffix to say that AI – Artificial Intelligence is a panacea for optimising environmental monitoring and conservation, considering its precision in data collection, analysis prediction and interpretation of data on environmental monitoring and conservation (Dauvergne: 2022). This is the crux of this research paper, as AI tools will be examined as automated tools for better environmental monitoring, conservation and protection in the 21st century.

Conceptual Model

The General Ecosystem Control Model is the conceptual model adopted to simplify the complex web of interaction in the environment (Gross, 2003). This model is relevant in global environmental monitoring because it is structured and modelled so that environmental monitoring information is obtained globally by a standard on frequent and varying time intervals and time-lapses on a short-term to long-term basis. This model benefits global environmental monitoring because it facilitates the identification of natural and anthropogenic stressors (human). Stressors in environmental monitoring, according to Gross (2003), defined a stressor as a physical, chemical, or biological perturbation to the ecosystem that is either (a) alien to the environment or (b) natural to the environment. Stressors are responsible for significant changes in the forces of nature (Biosphere, Atmosphere, Lithosphere, Hydrosphere). Glaring changes in these spheres induced by anthropogenic activities include exploitation of water resources, use of pesticides, indiscriminate harvesting of forest resources, traffic emissions, ocean acidification, soil and water pollution, trampling, game poaching, land use change including air pollution and a host of others.

The application and suitability of this model in environmental monitoring are therefore relevant to this study as a result of its ability to compute continuous automated observation of changes in environmental attributes as occasioned by human-induced factors, natural extremities such as climate change and lots more; it can also be used to predict future environmental outcomes, based on data collected and analysed, such predictions makes it possible for adequate preparedness

for potential risk evaluation and management in environmental monitoring, and future outcomes of present-day environmental occurrences.

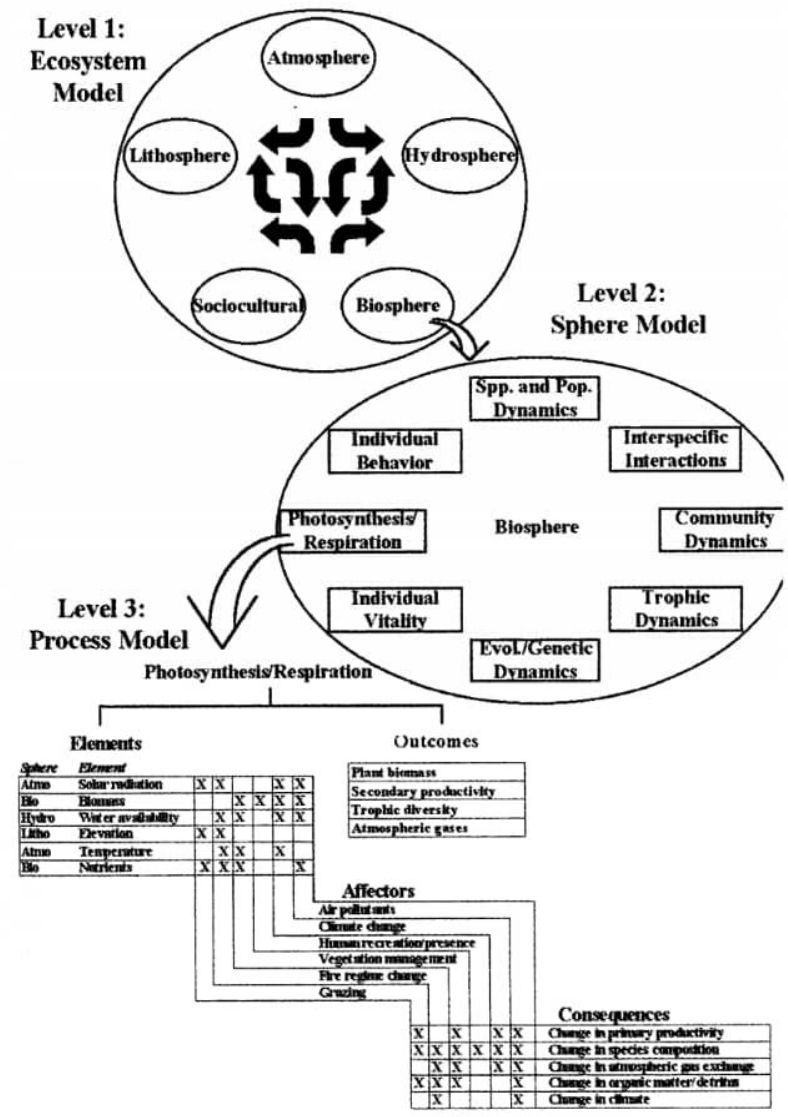

Fig. 1. General Ecosystem control model (Gross: 2003).

Methodology

The methodology for eliciting relevant materials and methods for discussing the theme under interrogation is an in-depth review of relevant and current literature addressing the theme under consideration. This includes secondary and archival sources such as books, journals, Environmental periodicals and internet sources. To further accentuate the methodology, the relevance of models in environmental monitoring and conservation by the South Florida Ecosystem Restoration Working Group (2013), which adopts the simplified "Applied Science Strategy" from the general ecosystem control model, has been applied. Thus, acquired information is converted to technical information for

environmental monitoring and planning tools. This is supported by the World Commission on Environment (1987) on the need to embrace models relevant to addressing present and future environmental issues to reduce future environmental casualties.

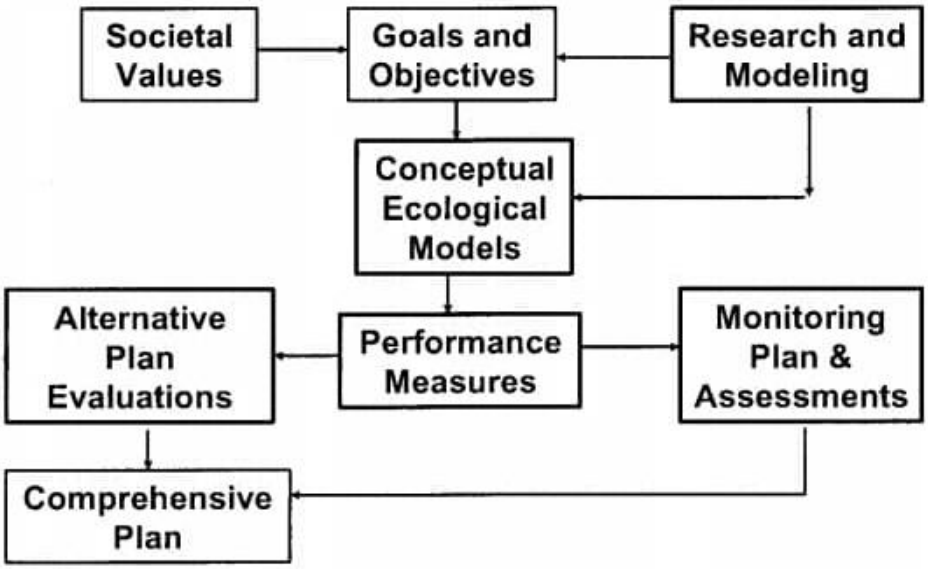

Fig. 2. Simplified Applied Strategy, South Florida Ecosystem Restoration Working Group (2013)

The Role of AI in Sustainable Environmental Monitoring and Conservation

Some processes that result in environmental deterioration and degradation are slow and gradual without glaring evidence of environmental damage, especially those that affect atmospheric factors and underground water. On the other hand, some are very glaring and visibly perceived, such as floods, earthquakes, volcanic eruptions, droughts, deforestation and desertification. Illango and Sridharan (2023) noted that the general knowledge of environmental awareness has increased considerably in the past decades, and this awareness must be matched with commensurate scientific knowledge-driven tools that help to ameliorate or mitigate environmental risk to the barest minimum.

The introduction of diverse advanced technologies is a major advancement that has significantly improved the discipline of environmental conservation, especially in the aspect of detection and control of areas that are prone to risks such as hazardous waste disposal, climate change and its impact, deforestation, earthquakes sea incursion and lots more (Bibri et al., 2024). Zwijinenburg & Ballinger (2023) also posited that internet access has spurred a revolution in tracking the linkages between armed conflict and environmental damage, offering new opportunities for environmental monitoring, conservation and protection.

Some of these new vistas opened through Artificial Intelligence include:

1. **Integrated Machine Learning** (ML): These AI devices are very relevant to environmental monitoring and geospatial content, as they are readily available tools to identify illegal settlements, evaluate and analyse floods and track the flows of displaced persons. Dorfling et al. (2023) aptly considered AI as a guardian of biodiversity and

catalyst for sustainable environmental practices due to its transformative potentials, which are beneficial in the following ways.

2. **Microsoft AI for Earth programmes** adopt conservation drones, which perform task tasks with high precision and accuracy, as issues such as principal environmental catastrophes, ozone depletion, and climate change are seamlessly addressed. Therefore, AI is more reliable than remote sensing devices that fix coordinates in stressed areas without much data analysis. Kar et al. (2022) further noted that AI techniques are indispensable tools in the 21st Century as AI and a combination of other technologies, such as Geographical Information Systems and Remote Sensing, will advance knowledge in environmental monitoring and conservation as postulated in no distant time.
3. **AI-powered Robotic drones** will take centre stage in patrolling and monitoring ecosystems. These tasks are carried out with a high degree of precision, and Robotic drones will handle the laborious input of humans, and analogue devise with less precision and accuracy will be less active; this is because, irrespective of the nature of the terrain, AI-enhanced drones can navigate rugged terrains and perform the task better. They can also access the overall state of any ecosystem under survey, almost eliminating threats to humans handling the task.
4. **The AI-sensor network** is capable of transmitting data on various parameters, such as the state of the soil, water quality, air quality, etc.
5. **AI-powered Visual Assistants**—Chisom et al. (2024) identified them as appropriate and standard allies in shaping the future of environmental conservation and monitoring. AI virtual Assistants are driven by sophisticated AI algorithms and analyse vast data sets to project optimal resource allocation, predict emerging threats, and safeguard environmental conservation and monitoring efforts.
6. **AI-neural network** devices are also relevant in prediction of pollutants in the atmosphere as well as forecasting the levels of concentration of pollutants in the atmosphere.

Policy Implication of the Study/ Recommendations

Several policy implications/ recommendations can be deduced from the discourse arising from this paper.

i. AI—Artificial Intelligence is undoubtedly an indispensable tool for environmental monitoring and conservation because its function in assessing environmental quality is much more detailed and precise than others.
ii. The Nigerian government should deploy techniques for training AI experts in environmental monitoring to safeguard the Nigerian environment at all development levels and Environmental Impact Assessments.
iii. Data collection, analysis and evaluation are crucial to environmental monitoring and conservation. Since AI tools enhance data collection infrastructure, data collected and analysed will aid in tackling environmental challenges.
iv. Recognising our limitations to technology and the high cost of the Internet is the soul of AI applications. There is a need to scale up the availability of these basics because they are special catalysts for the new conservation paradigm, especially in a developing country like Nigeria.
v. Inclusive collaboration on AI skills is also recommended. Whang et al. 2023 and Ukoba et al. 2023 also accentuated the role of AI and machine learning applications in environmental monitoring.

Conclusion

The confluence of the paper is the sophistication and precision of the AI paradigm over other forms of devices deployed in environmental conservation and monitoring in the earth system, which has witnessed significant human impacts across all spheres of human existence. As the level of expectation for the various systems of prediction outcome of events and forecasting is increasing, there is a need to embrace the AI paradigm concerning its special attributes, such as its ability to handle tasks that humans perform more accurately without the aid of humans, they can also work non-stop, without human interference.

Since Robotic AIs are resistant to nature's hazards, they can penetrate various environments with difficult environmental attributes. The future will be different from today, so it is expedient to promote the application of AI in environmental monitoring and conservation because AI is crucial in tackling the rapidly changing environment in the 21st century. AI's multidisciplinary character allows it to have a wide spectrum of applications. Its enhanced environmental monitoring and conservation applications are undoubtedly a panacea for optimising effective environmental monitoring.

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