

Role of AI Technology in Environmental Monitoring and Resource Management for Sustainable Agriculture

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Abstract

The agriculture sector plays an important role in human life as a primary source of food along with different sources. Unfortunately, global warming and various environmental issues, mainly in less advantaged nations, hamper the agricultural field. Today's agriculture sector faces major difficulties and obstacles, as do the observation and monitoring systems such as water, fields, cost, energy, fertilizer, diseases, etc. Environmental monitoring and resource management are critical for ensuring agricultural sustainability and reducing the effect of climate change. An eminent fact that human beings are considers as the very smart and talented species on earth. AI stands for artificial intelligence; it is a field of computer science that studies computer systems to mimic the behavior of human beings and helps with the best performance in the area of science and technology. It gives advanced devices in different areas, like environmental monitoring and resource management, healthcare as well as sustainable agriculture. Increasing demand of food and poor quality of agricultural soil resources, need to produce more and more food per unit area. For this amplified demand, AI technology can maintain environmental resource management in sustainable agriculture with different aspects. This review article explores the utilization of AI technology in managing environmental resources and monitoring for sustainable agriculture.

Keywords

Artificial Intelligence, Agriculture sector, food demand, Future Opportunities, Weather Predictions, Sustainable Agriculture.

1. Introduction

Artificial intelligence is a field within computer science that focuses on developing intelligent systems capable of distinguishing, analyzing, and appropriately reacting to various inputs (Spector 2006, Kamble and Shah 2018). There are various areas which contribute to AI which contains mathematics, biology, physiology statistics and last but not least computer science. AI's primary goal is to deliver a more transparent and explicable system that can help build a more capable system that can be used as an intelligent agent (Ghosh and Thirugnanam 2021).

Enhancing the agriculture sector with the aid of technology is more important because it is the foundation of any country. The agricultural sector will be able to generate roughly 50% more food than is currently produced in light of the global situation (Guin et al. 2023). The accomplishment of Artificial Intelligence technologies (AIT) has considerably played an important role in enhancement the situation of agricultural field. In sustainable agriculture, Artificial intelligence is used in the monitoring as well as study of soil with AI learning modals, improves the phase of crop sowing, progressing with the techniques of weeds and pests control; together with the crop harvesting and supply to the suitable places as well as reasonable rate (Barbedo 2020 and Talaviya et al. 2020).

With initiation of Artificial Intelligence, internet and sensor technology has advantaged to a big extent. In the monitoring and analysis of soil, AI can assist us to know about the soil and seed relationship. In this way, AI tells which seed should be elected for specific soil type (Varshitha and Choudhary 2021). IA can also expect in decreasing the use of dangerous inorganic fertilizers to boost the plant growth and development and also monitors the irrigation methods thus saving water (Sharma et al. 2023). In this review article, we will discuss about the modern Artificial Intelligence technologies which can boon for the environmental monitoring and environmental resource management in view of sustainable agriculture development. Additionally, this analysis aims to not only highlight the effects of AI but also offer recommendations for its ethical and successful integration into environmental monitoring and resource management for sustainable agricultural strategies (Kar et al. 2022, Silvestro et al., 2022).

1.1 Artificial Intelligence and Environmental Monitoring

Climate change which is mainly caused by the anthropogenic activities, obviously by rising temperature, unpredictable weather patterns as well as the rising

of sea-level. Habitat loss, a silent yet powerful force, destroys sanctuaries for numerous species, driving them to the brink of extinction (Goniewicz et al. 2023). For the future generation, any kinds of pollution (such as air, water and soil) leaving a toxic legacy. Resource reduction destroys the ecosystems and biodiversity. To face these challenges, the insufficiencies of classical monitoring methods happen to basic evident (Chisom et al. 2024).

Traditional environmental monitoring methods are often constrained by their scale, scope and ability process higher amount of data. Observational techniques and different manual surveys struggle to keep rapid modification happening in ecosystem (<https://www.ppsthane.com>, Chisom et al. 2024). In this situation, the requirements for example sift in monitoring and conservation turns in to imperative. AI emerges as an illumination as a hope aimed the environmental monitoring and resource management. Artificial intelligence has the potential to change the way environmental resources are managed and monitored because it can do advanced predictive analysis, data processing, and pattern recognition. At the center of artificial intelligence, transformative ability lies, its potential to change huge and complex datasets of environment in to actionable approaches. By the sophisticated machine learning models as well as algorithms, Artificial intelligence discerns trends, patterns etc. that avoid conventional methods (Adebukola et.al. 2022, Fakiha 2023, Al-Mansoori and Saleem 2023).

Within the intricate dance of the earth's ecosystems, where each step and beat contributes to the harmonious balance of nature, the significant role of artificial intelligence (AI) grows as a force that is capable of change. Artificial intelligence is becoming increasingly important as a protector of biodiversity and a catalyst for sustainable environmental resource management and practices. It is utilized in a variety of contexts, including the tracking of elephant poaching methods in Africa and the identification of prohibited logging activities in the Amazon rainforest (Brickson et al. 2023, Dorfling et al. 2023).

1.2 Artificial Intelligence and Environmental Resource management:

Many Artificial Intelligence methods have been amplify to utilize in environmental/natural resource management as an alternative to traditional methods. Three *In-silico* challenges in environmental resource management are data analysis, data communication with management and optimization and control of data. AI Technologies can be a solution to these challenges/problems due to their capacity to

manage dynamic activities in environmental resources (Erdal Dursun 2025). Environmental resource management focuses on the technical as well as scientific understanding of resource and ecology and also ability of resources demand for survival. A method to implement *In-silico*/computational tools to address the challenges of environmental resource management is to use AI Technology because they have flexibility to deal with natural dynamics of environmental resources. There are many AI technologies that have been used in different area such as water and energy in concern to the environmental resource management (Erdal Dursun 2025, Huang et al. 2025).

Genetic algorithm is a search method that mimics the natural selection. Algorithm develops until it resolves the problems very easily (Chen et al. 2008). Genetic algorithms are also used in the optimization of model attributes of resource management (Kumar et al. 2012). A cellular automaton (CA) is a dynamic model that discrete in space, state and time. Application of this dynamic model is used to population density and economic activity and also replicate population dynamics of plant species (He et al. 2013). Fuzzy system is used in fuzzy sets deal with incomplete and rough data. It handles imprecise and incomplete data in different function like clustering, estimation and prediction. Multi-Agent System constitutes of network of agent that relate to achieve a goal. It has been broadly used in environmental resource management. Swarm Intelligence is a form of modeling of agent based which is inspired by colony of different social animals like ants or schools of fishes (Chen et al. 2008, Rulinda et al. 2012).

1.3 Artificial intelligence for Sustainable Agriculture

Artificial intelligence in sustainable agriculture includes different agricultural framings, weeds and pest control and crop monitoring. Many machine learning models used to determine the soil health, crop performance, weather conditions to increase the productivity and decrease the use of chemical usage. Artificial powered robotics system can also enhance the recycling and sorting processes of waste (Aijaz et al. 2025).

The use of GIS (Geographic Information System) in the irrigation process has helped to increase crop productivity by 35% and decrease the amount of water that is used for irrigation, according to a previous study that was conducted on alfalfa in the state of California. Apps (Applications) that are powered by artificial intelligence, primarily through the utilization of sensors, infrared rays, and

photographs, are able to assist in the analysis of the physiological properties of soil (Akenous et al. 2023). Thus, AI helps increasing the agricultural sector process assuring best production and profit for related farmers in their crops. Another application is the showing method incensement with the use of Artificial sowing app (Javaid et al. 2023).

In Andhra Pradesh, India, the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) launched a pilot project with 175 farmers under Microsoft sponsorship with the goal of increasing production by 30% while lowering pre-cropping investment. The agriculturist obtained alerts about the ideal days and times for cropping, getting ready the land, and implementing organic and inorganic fertilizers. The app was useful and displayed the required information and results from clicking on the images that the agriculturists had submitted from the use site or end.

An additional investigation was also declared, which consisted of maximizing pesticide and herbicide control via the development of machine learning technology as well as combined software applications by BRT (Blue River Technology). This instructional instrument can assist in differentiating between healthy and diseased plants. Using this technique, the “see and spray” initiative in Arkansas, USA, reduced the optimum quantity of land-based weedicide costs (per acre). Separate research on agricultural harvesting was also conducted in Japan, and the results showed that artificial intelligence-based robots can harvest tomato crops faster than humans (Ghosh and Thirugnanam 2021).

2. Conclusion

The suitability of Artificial intelligence technology is an environmental monitoring and resource management depends on the case. AI continues to emerge rapidly its impact on environment is obvious. It’s capability to give exact predictions and monitoring increase the of environmental management practices. AI improves the efficacy and efficiency of environmental management techniques by offering accurate forecasts and real-time monitoring. To mitigate the global warming/climate change, various stockholders come together and consider incorporating environmentally as well as sustainable agriculture friendly consideration of AI technology. Regarding these considerations, the responsibility of policy makers is more and most important. AI Technologies can be providing the rapid development in various aspects in reference to the environmental monitoring and natural resource management for the sustainable agriculture.

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8. References

1. Spector, L. (2006). Evolution of artificial intelligence. *Artif. Intell.* 170(18), Pg. **1251–1253**
2. Kamble, R., Shah, D (2018). Applications of artificial intelligence in human life. *Int. J. Res.* 6(6), Pg. **178–188**
3. Ghosh, M., & Thirugnanam, A. (2021). Introduction to artificial intelligence. In *Artificial Intelligence for Information Management: A Healthcare Perspective* (Pg. **23-44**). Singapore: Springer Singapore.
4. Guin, A., Sahoo, S., Samanta, S., Maity, N., & Bera, B (2023). Advancements in Agricultural Technology: A Historical Perspective. *Smart and Sustainable Agricultural Technology*, 243.
5. Barbedo, J.G.A. (2020). Detecting and Classifying Pests in Crops Using Proximal Images and Machine Learning: A Review. *Artif.Intell.* 1(2), Pg. **312 - 328**.
6. Talaviya, T., Shah, D., Patel, N., Yagnik, H., Shah, M. (2020). Artificial Intelligence in Agriculture Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides. *Artif. Intell. Agric.* 4, Pg. **58–73**.
7. Varshitha, D. N., & Choudhary, S. (2021). An AI solution for soil fertility and crop friendliness detection and monitoring. *International Journal of Engineering and Advanced Technology*, 10(3), Pg. **172-175**.

8. Sharma, S., Verma, K., & Hardaha, P. (2023). Implementation of artificial intelligence in agriculture. *Journal of Computational and Cognitive Engineering*, 2(2), Pg. **155-162**
9. Kar, A.K., Choudhary, S.K. and Singh, V.K., (2022). How can artificial intelligence impact sustainability: A systematic literature review. *Journal of Cleaner Production*, Pg. **134120**.
10. Silvestro, D., Goria, S., Sterner, T. and Antonelli, A., (2022). Improving biodiversity protection through artificial intelligence. *Nature sustainability*, 5(5), Pg. **415-424**.
11. Goniewicz, K., Khorram-Manesh, A., & Burkle, F. M. (2023). Beyond boundaries: Addressing climate change, violence, and public health. *Prehospital and Disaster Medicine*, 38(5), Pg. **551-554**.
12. Chisom, O. N., Biu, P. W., Umoh, A. A., Obaedo, B. O., Adegbite, A. O., & Abatan, A. (2024). Reviewing the role of AI in environmental monitoring and conservation: A data-driven revolution for our planet. *World Journal of Advanced Research and Reviews*, 21(1), Pg. **161-171**.
13. <https://www.ppsthane.com/blog/environmental-monitoring-methods>
14. Adebukola, A. A., Navya, A. N., Jordan, F. J., Jenifer, N. J., & Begley, R. D. (2022). Cyber Security as a Threat to Health Care. *Journal of Technology and Systems*, 4(1), Pg. **32-64**
15. Fakiha, B., 2023. Enhancing Cyber Forensics with AI and Machine Learning: A Study on Automated Threat Analysis and Classification. *International Journal of Safety & Security Engineering*, 13(4).
16. Al-Mansoori, S. and Salem, M.B., 2023. The Role of Artificial Intelligence and Machine Learning in Shaping the Future of Cybersecurity: Trends, Applications, and Ethical Considerations. *International Journal of Social Analytics*, 8(9), Pg. **1-16**.
17. Brickson, L., Zhang, L., Vollrath, F., Douglas-Hamilton, I. and Titus, A.J., 2023. Elephants and algorithms: a review of the current and future role of AI in elephant monitoring. *Journal of the Royal Society Interface*, 20(208), p.20230367.
18. Dorfling, J., Siewert, S.B., Bruder, S., Aranzazu-Suescun, C., Rocha, K., Landon, P.D., Bondar, G., Pederson, T., Le, C., Mangar, R. and Rawther, C.,

- (2022). Satellite, Aerial, and Ground Sensor Fusion Experiment for Management of Elephants and Rhinos and Poaching Prevention. In *AIAA SCITECH Forum* (Pg. **1270**).
19. Dursun, E. (2025). The Effects of Artificial Intelligence Applications in Natural Resource Management. *Acta Globalis Humanitatis et Linguarum*, 2(2), Pg. **147-155**.
 20. Huang, L., Duan, Q., Liu, Y., Wu, Y., Li, Z., Guo, Z., & Kinney, P. L. (2025). Artificial intelligence: A key fulcrum for addressing complex environmental health issues. *Environment International*, 109389.
 21. Chen, S.H., Jakeman, A.J., Norton, J.P., (2008). Artificial Intelligence techniques: An introduction to their use for modelling environmental systems. *Mathematics and Computers in Simulation* 78, Pg. **379-400**.
 22. Kumar, K., Hari Prasad, K.S., Arora, M.K., (2012). Estimation of water cloud model vegetation parameters using a genetic algorithm. *Hydrological Sciences Journal* 57. Pg. **789-776**.
 23. He, C., Zhao, Y., Tian, J., Shi, P., (2013). Modeling the urban landscape dynamics in a megalopolitan cluster area by incorporating a gravitational field model with cellular automata. *Landscape and Urban Planning* 113, Pg. **78-89**.
 24. Rulinda, C.M., Dilo, A., Bijker, W., Stein, A., (2012). Characterising and quantifying vegetative drought in East Africa using fuzzy modelling and NDVI data. *Journal of Arid Environments* 78, Pg. **169-178**.
 25. Aijaz, N., Lan, H., Raza, T., Yaqub, M., Iqbal, R., & Pathan, M. S. (2025). Artificial Intelligence in Agriculture: Advancing Crop Productivity and Sustainability. *Journal of Agriculture and Food Research*, 101762.
 26. Akenous, F. Z., Sbbbar, N., Ech-chatir, L., & Meddich, A. (2023). Artificial Intelligence, Internet of Things, and Machine-Learning: To Smart Irrigation and Precision Agriculture. In *Artificial Intelligence Applications in Water Treatment and Water Resource Management* (Pg. **113-145**). IGI Global.
 27. Javaid, M., Haleem, A., Khan, I. H., & Suman, R. (2023). Understanding the potential applications of Artificial Intelligence in Agriculture Sector. *Advanced Agrochem*, 2(1), Pg. **15-30**.