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# Application of Artificial Intelligence in Forest Research and Management: A Review

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Abstract- Artificial Intelligence is deals with automatic presentation, collection and use of information that attempt to to utilise human thought. The development of AI application involve the advanced technology in computer science. The role of artificial intelligence in the field of forest facilitate the efficient surveillance, administration and preservation of forest. The conservation strategies also constitute the the restriction from pandemic situations in forest. Now a days forest fire is also create challenge for the conservation of biodiversity and forest strata. Likewise such kind of similar situations are to be controlled by the usage of artificial intelligence. The objective of this paper is to present a comprehensive review of how AI are to be utilised in forestry sector and the conservation of biodiversity worldwide. The application of AI technology enhances the availability of extensive data pertaining to forest and biodiversity in the utilisation of cloud computing, digital and satellite technology the facilitate the wider acceptance and implementation of AI technology. In this paper the application of AI in forest research and management is to be understood in the context with the monitoring of the forest and assessment. For the detection and prevention of the forest from wildfire and for the precision forestry the application of AI is to be applied.

Keywords- Artificial Intelligence, AI, Surveillance, Forestry, Wildlife, Forest Fire, Biodiversity Conservation

## **I. INTRODUCTION**

The India State of Forest Report (ISFR) 2023 shows that the country's Forest and Tree cover now spans 827,357 square kilometres, covering 25.17% of the nation's total land area. This includes 715,343 square kilometres (21.76%) of forest cover and 112,014 square kilometres (3.41%) of tree cover. Meanwhile forest play crucial role in the maintenance of climate and healthy environment. Forests provide a sustainable environment for the survival of millions of animals. It is home to several species including snakes, turtles, crocodiles, insects, birds, butterflies, monkeys, and other wild animals. It provides an ecosystem for the animals to thrive. The forest floor

is also a rich medium for microorganisms, which are essential for the conversion of dead matter into nutrients. Forests are also home to indigenous people who depend on them for their livelihood.

Forests maintain the ecosystem by absorbing greenhouse gases like carbon dioxide that are believed to be the reason for climate change. Carbon is stored in the biomass within the forests. Tropical forests alone harbour a huge amount of carbon (around a quarter of a trillion tons) that can be disastrous if it is released into the atmosphere. Forests provide a sustainable environment for the survival of millions of animals.

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Forest-based water tables, rivers, streams, and lakes are critical sources of water. The green cover preserves the water reserves from sun radiation. The Amazon forest is home to the world's largest watershed and river system.Globally, around 90% of the species including various plants and animals thrive in forests. They offer the necessary habitat and support biodiversity. They are home to the genes of biodiversity. Photosynthesis is a critical function of plants to generate food and energy. Plants, shrubs, and trees absorb carbon dioxide from the atmosphere during the daytime and release oxygen. According to an estimate, an acre of mature trees can provide oxygen for 18 people. They act as giant lungs purifying the air in the atmosphere by removing carbon dioxide and maintaining balanced levels of oxygen that we breathe every day. Trees absorb odours and pollutant gases like ammonia and sulphur dioxide out of the air. These toxins are trapped in the leaves and barks.

Forests provide green cover which absorbs the Sun's radiation and keeps the temperature down. They regulate atmospheric temperature through evapotranspiration and breeze. Forests also promote rainfall that helps in maintaining the water table and a cool climate. Deforestation has the opposite effect causing the global temperature to rise dramatically. Dead leaves and broken branches ultimately are converted to soil through the decomposition process and this conversion enriches the soil with nutrients. Microorganisms present in the soil convert the biodegradable material to simpler particles that can be utilized by the plants again.

Trees have very strong roots that hold the soil intact in cases of floods or any other reasons that cause soil erosion. They are very critical in hilly areas or stream slopes as they slow the runoff and keep the soil

intact. Uncontrolled soil erosion can destroy the fertile soil leading to barren conditions.

Forest is an important component of the water cycle process. They regulate evaporation, condensation, and precipitation of the water. They also nourish the aquifers thereby replenishing groundwater supplies. Trees allow the rainwater to flow down the trunk into the soil thereby preventing the stormwater from carrying pollutants to the ocean. They act as giant sponges that filter water and recharge the water table.

Forests have a lot to offer to human beings. Every component of a tree including leaves, branches, stem, bark, fruits, seeds, and root are useful. Forests provide wood, timber, raw materials, vegetables, and fruits, which have significant economic value. The timber is used in construction and making furniture. Wood is also essential in the production of paper. The rubber extracted from trees is used to make several products. Even green waste has economic significance.

Millions of trees are chopped off every year to support the increasing need of human beings.

We have to take proactive measures to preserve forests and increase the green cover in the interest of millions of living beings that depend on them. Thus, there are two types of benefits of forests on an economic front and they are direct benefits and indirect benefits. For instance, the contribution of forests towards the national income of India is increasing gradually.

The indirect economic benefits consist of rendering the climate that increases the relative humidity of the atmosphere and therefore the precipitation increases by the forest. Sustainable feeding offspring water supply and reduction in violent floods are regulated by the forest and also makes the floor of the water in the river continuous.

Al is used for transforming forest research and management by automating tasks, analysing vast datasets, and enabling more efficient decisionmaking. Al helps with tasks like forest monitoring, Tarun A. Shinde. International Journal of Science, Engineering and Technology, 2025, 13:2

fire detection, biodiversity assessment, and even precision forestry. Specifically, AI algorithms can analyse satellite imagery and drone data to track deforestation, identify illegal logging, and monitor tree health.

# II. APPLICATION OF ARTIFICIAL INTELLIGENCE IN FOREST RESEARCH AND MANAGEMENT



#### **1. Forest Monitoring and Assessment**

The application of AI in forest monitoring is to be assess basically in three manner. These are such as follows:

#### **Deforestation and Illegal Logging**

Al can analyse satellite data and aerial imagery to detect changes in land use, identify areas of deforestation, and pinpoint potential illegal logging activities.

#### **Forest Health and Disease Detection**

Al algorithms can analyse aerial and satellite imagery to detect stress in trees, signs of disease, and other issues affecting forest health.

#### **Biodiversity Monitoring**

Al can be used to identify and classify different species, track their populations, and assess biodiversity hotspots.

# 2. Fire Management Wildfire detection and Prevention

Al can be used to analyse weather patterns, vegetation data, and other factors to predict wildfire risk and detect wildfires in real-time.

#### **Fire Response and Management**

Al-powered drones can be used for aerial reconnaissance, water dropping, and other firefighting operations.

#### **Precision Forestry**

Precision Forestry is the use of tools and technology to collect data to make decisions for site specific management. It aims to improve wood quality, protect the environment, reduce waste, and increase profits.

#### **Optimising Planting and Harvesting**

Al can help optimize tree planting locations, spacing, and harvesting schedules based on soil conditions, climate, and other factors.

#### **Improving Timber Yield and Quality**

Al can be used to assess tree growth rates, predict timber yield, and optimize harvesting practices in the case of precision forestry.

#### **Other Applications**

The other applications under the implementation of AI technology in forest management include the topics such as:

#### **Estimating Carbon Stocks**

Al can be used to estimate the amount of carbon stored in forests, which is crucial for climate change mitigation efforts.

#### **Ecosystem Services Assessment**

Al can be used to assess the various benefits that forests provide, such as water purification, air quality regulation, and biodiversity conservation

## **III. CONCLUSION**

Al presents a transformative opportunity for forest management in India. By harnessing the power of Al, India can address critical challenges in forest conservation, enhance the sustainability of its forest resources, and lead by example in the use of technology for environmental stewardship. This Tarun A. Shinde. International Journal of Science, Engineering and Technology, 2025, 13:2

proactive approach not only strengthens forest 6. Kim, K.S.; Park, J.H. A survey of applications of conservation efforts but also supports India's commitments to climate change mitigation and biodiversity preservation. Thus, AI for Forest Management could very well be a cornerstone of 7. achieving a greener, more sustainable future.

In order to enhance the advantages and availability of technologies such as AI in the forest industry, the implementation of the following measures is necessary:

- Interdisciplinary collaborations between the 8. forest department and technologists in AI applications.
- Affordable and Efficient computing resources
- Utilisation of wireless technology such as sensor ٠ networks, digital recording devices, drones, etc
- Creation of computationally efficient algorithms for rapid analysis of large-scale data.

# REFERENCES

- 1. Raihan A. A comprehensive review of artificial intelligence and machine learning applications in energy sector. Journal of Technology Innovations and Energy 2023; 2(4): 1-26. doi: 10.56556/itie.v2i4.608 Rana, P., & Miller, D. C. (2018). Machine
- 2. learning to analyze the social-ecological impacts of natural resource policy: insights from community forest management in the Himalaya. Environmental Research Indian Letters.
- 3. Kim, K.S.; Park, J.H. A survey of applications of artificial intelligence algorithms in ecoenvironmental modelling. Environ. Eng. Res. 2009, 14, 102-110.
- 4. Imada, A. A literature review: Forest management with neural network and artificial intelligence. In International Conference on Neural Networks and Artificial Intelligence; Springer: Cham, Switzerland, 2014; pp. 9–21.
- 5. Liu, Z.; Peng, C.; Xiang, W.; Tian, D.; Deng, X.; Zhao, M. Application of artificial neural networks in global climate change and ecological research: An overview. Chin. Sci. Bull. 2010, 55, 3853-3863.

- artificial intelligence algorithms in ecoenvironmental modelling. Environ. Eng. Res. 2009, 14, 102–110. [Google Scholar] [CrossRef]
- Gomes, C.; Dietterich, T.; Barrett, C.; Conrad, J.; Dilkina, B.; Ermon, S.; Fang, F.; Farnsworth, A.; Fern, A.; Fern, X.; et al. Computational sustainability: Computing for a better world and a sustainable future. Commun. ACM 2019, 62, 56–65. [Google Scholar] [CrossRef]
- Shi, Z.R.; Wang, C.; Fang, F. Artificial Intelligence for Social Good: A Survey. arXiv 2020, arXiv:2001.01818. [Google Scholar]
- Christin, S.; Hervet, E.; Lecomte, N. Applications 9. for deep learning in ecology. Methods Ecol. Evol. 2019, 10, 1632–1644. [Google Scholar] [CrossRef]
- 10. Jha, K.; Doshi, A.; Patel, P.; Shah, M. A comprehensive review on automation in agriculture using artificial intelligence. Artif. Intell. Agric. 2019, 2, 1–12. [Google Scholar] [CrossRe]
- 11. Imada, A. A literature review: Forest management with neural network and artificial intelligence. In International Conference on Neural Networks and Artificial Intelligence; Springer: Cham, Switzerland, 2014; pp. 9-21. [Google Scholar]
- 12. Liu, Z.; Peng, C.; Xiang, W.; Tian, D.; Deng, X.; Zhao, M. Application of artificial neural networks in global climate change and ecological research: An overview. Chin. Sci. Bull. 2010, 55, 3853–3863. [Google Scholar] [CrossRef]
- 13. Khan, S.; Gupta, P.K. Comparative study of tree counting algorithms in dense and sparse vegetative regions. Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci. 2018, 5, 801-808. [Google Scholar] [CrossRef]
- 14. India State of Forest Report 2019. Available online: https://fsi.nic.in/forest-report (accessed on 15 June 2021).
- 15. Sinha, B.; Kala, C.P.; Katiyar, A.S. Enhancing Livelihoods of Forest Dependent Communities through Synergizing FDA Activities with Other Development Programs; RCNAEB Sponsored Project; Indian Institute of Forest Management (IIFM): Bhopal, India, 2010.

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