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Article

Role of Artificial Intelligence for Environment Protection: An Analysis

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Abstract

Artificial intelligence emerges as a pivotal tool in environmental protection. This domain remains critical for sustaining natural resources vital to human survival. Escalating threats include climate change, air pollution, biodiversity loss. Existing literature explores AI's technical applications predominantly. It overlooks comprehensive ethno-legal frameworks governing environmental deployment. This reveals a significant research gap. This study investigates AI's capacity to enhance environmental governance while scrutinizing its ecological footprint. The objective is to evaluate AI's dual role. AI facilitates sustainable development through innovative solutions. It exacerbates resource consumption concurrently. The study proposes regulatory mechanisms aligned with constitutional mandates—Article 48A and 51A(g), Constitution of India. A mixed-methodology approach integrates doctrinal analysis with case studies. Legal texts include the Environment Protection Act 1986. Case studies dissect AI's efficacy. Google DeepMind achieves 40% energy reduction in data centers. SilviaTerra maps forest carbon via machine learning. Focus areas cover climate modeling, air quality forecasting, species monitoring, compliance enforcement. Preliminary results indicate AI optimizes environmental data processing—e.g., IBM Green Horizon's 72-hour pollution forecasts—yielding promising outcomes in predictive accuracy (spatiotemporal trends) and policy support. However, findings highlight AI's energy-intensive nature—e.g., high carbon emissions from large language models—underscoring unaddressed ecological costs. Implications suggest a balanced framework proves imperative. Reactive AI applications (e.g., Wildbook's species tracking) excel in enforcement, yet proactive measures—energy-efficient algorithms—demand prioritization to curb e-waste. This study bridges the gap by advocating adaptive legal standards. These mirror UNFCCC commitments. AI's environmental benefits must outweigh detriments. This ensures viability. It lays groundwork for future interdisciplinary research into scalable, ethically sound AI deployments, reinforcing sustainable development's economic, social, environmental triad.

Keywords: artificial intelligence; criminal law; ecological footprint; environmental protection; regulatory compliance; sustainable development

1.1. Introduction

The development of artificial intelligence (AI) has ramifications for varied sectors of society and poses legal challenges for environmental protection. AI is projected to have an impact on global productivity [1], equality [2], environmental issues [3], and a variety of other sectors in the medium and long term [4]. Impact of AI on sustainable development has been reported to be both positive [5] and negative [6]. AI has the potential to transform various human endeavours, like healthcare, education, husbandry, manufacturing and transportation. Thus, it's imperative to ensure that the development and operation of AI complies with ethical and ecological principles that uphold human rights and values and contribute to environmental preservation as well as its enhancement. The environment includes the natural resources that are vital for our actuality and well-being. The

environment is also a complex and dynamic system that is affected by a lot of different factors. It becomes a cause of serious concern to protect and conserve our environment as any natural calamity, pollution, loss of biodiversity negatively affects human health and development [7]. The inclusivity and balance among social, economic and environmental dynamics is key aspect for sustainable development. Sustainable development also requires the implementation of appropriate regulations to address the challenges and ensure responsibility of the actors involved.

AI can play a vital part in achieving sustainable development and environmental protection by furnishing innovative results for varied environmental issues, such as climate change, air pollution, species protection, and environmental compliance. AI can also help in enhancing the efficacy of environmental governance by easing the collection and analysis of data, by supporting the decision-making and policy-making processes. Also, by enabling the monitoring and enforcement of environmental laws and regulations. Still, AI has the potential to beget or complicate environmental problems by consuming large quantities of energy and resources, by generating electronic waste and emissions, and by dismembering natural ecosystems and biodiversity. Thus, it's essential to oversee the development and use of AI by applying relevant legal-ethical frameworks that ensure the protection of the environment and its rights.

2. Environment

The sum of all living and non-living things including their effect on human life is said to be termed as "Environment".

The environment can be classified into various types or components:

- i. **Natural environment-** It includes land, water, air, climate and vegetation
- ii. **Constructed environment-** Manmade structures as well as the installations, like buildings, roads, bridges, etc. represent the constructed environment
- iii. **Social environment-** This includes relationships as well as human interactions. Family, friends, community, and society make up for social environment
- iv. **Cultural environment -** The mortal values, beliefs, morals and practices constitute cultural environment

Article 48A in Part-IV of the Constitution of India states that

"The State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country."

It was added in 1976 by the 42nd Amendment. In the case of *M.C. Mehta v. Union of India* (2002) [8], the Supreme Court heard a PIL in the matter of air pollution in Delhi. In the case of *Sachidanand Pandey & Ors. v. The State of West Bengal & Ors.* (1987) [9], the honorable Supreme Court held that Article 48A must be kept in mind whenever a matter regarding maintenance of the ecology is brought before the Court.

As per Article 51A(g) of the Constitution (Part IV-A)

"It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures."

Therefore, protection and improvement of natural environment is the duty of the State (Article 48A) and every citizen (Article 51A(g)) as well. Article 253, empowers the Parliament to make laws for giving effect to any international agreement or convention for the conservation of the environment [10]. India is a signatory to various international treaties and conventions for the protection of the environment. For example, UNFCCC [11], CBD [12], CITES [13], and Ramsar Convention on Wetlands.

3. Meaning and Definitions

Environment is derived from the French word "Environner". It means to encircle or surround. Environment is defined as the aggregate of water, air, land and the co-relationships that exist among

them and with the human species, other living organisms and materials. Cambridge Dictionary defines environment as the air, water, and land in or on which people, animals, and plants live [14]. The study of environment protection is not uniform or non-dynamic in nature. The subject is ever developing with time and advancements in technology. According to Section 2(a) of the Environment (Protection) Act, 1986, "environment includes water, air and land and the inter- relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property." As per the UN [15], the environment is the sum total of all external conditions and influences affecting the life and development of an organism. The WHO [16] states that environment is all the physical, chemical and biological factors external to a person, and all the related behaviours.

Development that ascertains the requirements of present without endangering the ability of future generations to meet their needs is known as sustainable development [17]. It is primarily grounded on the following three dimensions:

1. Economic
2. Social
3. Environmental

Sustainable development requires cooperation of varied stakeholders. Governments all around the globe, civil society, PSUs and international organizations need to closely work together to help the cause. It also requires the adoption of appropriate policies. This is of the prime importance to ensure the accountability as well as the transparency of actors involved. Both environment protection and sustainable development are closely linked. They are mutually supportive of each other. On one side, environment protection is a precondition and an important component of sustainable development because it ensures the availability various essentials required for human development. On the other hand, sustainable development is a means. It is one of the goals of environment protection because it promotes the equitable use of natural resources. So, it becomes quite important to explore AI's role in protection of environment as well.

4. Artificial Intelligence

Computer systems or algorithms that can carry out certain tasks demanding human intellect is said to be AI (artificial intelligence) [18]. It's an interdisciplinary field with convergence of varied fields of study. ML [19], deep learning, NLP [20], computer vision, speech recognition, robotics, expert systems and artificial neural networks all are covered under the scope of AI. Based on the degree of functionality and intellect, AI can mainly to classified into four following types:

1. Reactive machines
2. Limited memory machines
3. Theory of mind machines
4. Self-aware machines [21]
 - i. **Reactive machines-** They are the most basic type of AI. They only respond to present scenario, without using any past experience or memory. For example, the computer based chess-play named Deep Blue.
 - ii. **Limited memory machines-** These machines use some past experience or memory to inform their current actions. But they do not store or learn from that data as such. For example, a self-driving car. It only uses sensors and cameras to navigate the road and avoid obstacles.
 - iii. **Theory of mind machines-** They are the advanced type of AI. They understand and model the mental states, emotions, and beliefs of other agents. Then use them to interact and communicate further. An example of the same is Kismet. A robot that recognizes and expresses human emotions.

- iv. **Self-aware machines-** This is the ultimate type of AI. They have a sense of self consciousness. There is sense of reasoning and self-reflection about their own actions. Sophia, a humanoid robot is a perfect example. Sophia can carry out natural conversations. Saudi Arabia has also granted it a proper citizenship.

The evolution of AI can be sketched back to the ancient times. Ancient philosophers and mathematicians tried formalizing the nature and principles of human reasoning. Nonetheless, the modern age of AI began in the mid-20th century, with the development of digital computer. The formalization of the concepts of computation and algorithms is an important developmental stage. In the year 1956, John McCarthy modeled the term "artificial intelligence" at the Dartmouth Conference. He discussed the possibility of creating machines that can think and act like humans among fellow researchers [22]. Since then, AI has gone through several phases of development. The current and future trends of AI are driven by various factors, like the availability as well as the quality of data, improvement and innovation of algorithms, computing power, certain standards and regulations, integration of varied domains. Certain large language models (LLMs) are useful application of AI at present. For example, GPT-3.

5. Meaning and Definitions

John McCarthy is known as the father of Artificial Intelligence. Artificial Intelligence (AI), a term coined by emeritus Stanford Professor John McCarthy in 1955, defined as "the science and engineering of making intelligent machines" [23]. Earlier the machines were programmed to behave in a simpler binary manner, like playing chess, but, today, we emphasize on machines that can learn, at least somewhat like human beings do [24]. Artificial intelligence is an offshoot of computer wisdom which deals with machines/software that perform tasks which generally bear mortal mind. AI can be broadly classified into two of the following categories:

1. Narrow AI
2. General AI

The former adheres to the AI systems that are designed to carry out specific tasks or functions. Face recognition, speech recognition, natural language processing, and machine learning are exemplifications of Narrow AI. The latter refers to the AI systems that are competent of performing any intellectual task that a human can do, like sense, solve problem, novelty, and self-consciousness. General AI is still a hypothetical and aspirational thing, whereas narrow AI is already a reality and considerably used in multihued disciplines and operations.

Environment protection is the practice of preventing& reducing the dangerous effects of human activities on the natural environment [25]. Environment protection can be classified into two broad species:

1. Proactive
2. Reactive

Proactive environment protection refers to the geste that is taken to help or avoid environmental problems and challenges, like as pollution, biodiversity loss, deforestation, desertification, and climate change. Reactive environment protection refers to the actions that are taken to respond or acclimatize to environmental problems and challenges, like restoration, conservation, recuperation, and adaptability. Proactive and reactive environment protection is complementary and interrelated, and both are essential for attaining sustainable development.

Artificial intelligence and environment protection are closely linked and mutually advantageous. AI can play a vital part in enhancing environment protection, by furnishing innovative results and instruments for varied environmental issues. Therefore, it becomes quite important to further analyze the scope of AI for environment protection.

6. Contribution of Artificial Intelligence for Environment Protection

AI can play a vital part in enhancing environment protection, by furnishing innovative results and instruments for varied environmental issues and disciplines, like climate change, air pollution, species and niche protection, and environmental compliance. Environmental governance can be enhanced by the deployment of AI. It can ease the collection and analysis of environmental data, by supporting the decision- making and policy- making processes, also by enabling the monitoring and enforcement of environmental laws and regulations. But still, AI also has the potential to effectuate or complicate environmental challenges, by consuming large amounts of energy and resources, by generating e-waste and emissions, and by dismembering natural ecosystems and biodiversity. Thus, it's essential to regulate and oversee the development and use of AI, by establishing and applying apt legal and ethical frameworks and principles, to ensure the protection of the environment and its rights. Application of AI can be useful in environment protection in the following ways:

- a) **Climate Change-** By the use of advanced models and simulations, AI can be helpful in forecasting and projecting the impact of climate change. The integration of multiple sources of data helps in more accurate predictions. AI can also be helpful in mitigating climate change. This can be achieved by means of optimised deployment and integration of renewable energy sources. Adoption of certain technologies to enhance the energy efficiency of buildings and industries is a technological driven concept. It reduces the greenhouse gas emissions and overall carbon footprint. For example, Google's DeepMind has developed an AI system. It can reduce the energy consumption of its data centers by up to for forty percent, by means of reinforcement learning to optimize the cooling systems [26]. Microsoft's AI for Earth supports projects that use AI to address climate change [27]. SilviaTerra uses data form satellites and ML techniques to map forest carbon stocks [28].
- b) **Air Pollution-** AI can aid in monitoring process as well as help forecast the levels and sources of air pollution, by means of various detectors and networks. The deployment of machine learning and deep learning methodologies can break down the spatiotemporal patterns and trends of air quality. AI can also help in reducing and preventing air pollution, by relating and controlling the major polluters and emissions, by optimizing the transportation and mobility systems, by promoting the use of electric and hybrid vehicles, and by developing and enforcing clean and effective solutions and technologies. For example, IBM's Green Horizon project developed an AI system. It can forecast air pollution up to 72 hours in advance, by using big data analytics and cognitive computing to process rainfall data, traffic data, and historical data [29]. BreezoMeter, a start- up company, developed an AI system. It can supply real- time and hyper local air quality data and recommendations. It adopts ML and cloud computing to integrate data from varied sources, like satellites, ground sensors, and weather stations [30].
- c) **Species and Habitat Protection-** Data processing by means of deep learning can help AI in the identification of various endangered species as well as their habitats. AI can also help in safeguarding the same, by tracking and covering their movements. It helps prevent the illegal activities and risks, like poaching, logging, and fishing by developing smart and adaptive technologies. For example, Wildbook, developed an AI system that can recognize and record individual animals like whales, sharks, and giraffes. It uses computer vision and machine learning to analyze the data uploaded by researchers and scientists [31]. Conservation Metrics, a start- up company, developed an AI system which monitors the biodiversity as well as the health of ecosystems, by means of machine learning and deep learning to analyze the sounds and noises recorded by aural detectors [32].
- d) **Environmental Compliance-** AI can help in authenticating and validating the compliance as well as the performance of varied actors with respect to the environmental laws and regulations.

Natural language processing and machine learning is used to further process the data from different sources like various reports, documents, and databases. AI can be help in the administration of environmental laws and regulations. It can detect the violations and non-compliances of the same. For example, the EPA [33] developed an AI system that assess and ranks the compliance and threat of the installations regulated by the Clean Air Act. It uses ML and data mining techniques [34]. The WRI [35] developed an AI system that monitors the implementation of nationally determined contributions (NDCs) under Paris Agreement [36].

There are various benefits and challenges of AI for environment protection. Some of the benefits are as follows:

- i. The innovation of the environmental solutions
- ii. The optimization of environmental governance and management
- iii. Accessibility of data
- iv. Engagement of environmental stakeholders and various actors

Some of the challenges to the same include:

- i. The reliability of information
- ii. The complexity and uncertainty of environmental models
- iii. The ethics and accountability of various decisions and actions

7. Conclusions

In this chapter, the role of artificial intelligence for environment protection has been discussed. There are various legal as well as ethical challenges of technology in the environmental domain also. Environment provides with essential resources for the survival and well-being of life on Earth. Environment is an ever evolving system which very complex& is affected by various human/non-human factors. For example, environmental pollution, deforestation, etc. are some of the major threats to the same. They have negative impact on the human health too. Therefore, it is imperative to take urgent and effective actions to promote sustainable environmental development. AI can play a decisive role in enhancing environment protection by means of innovation. It can help improve the efficiency of the governance and policy making process. AI is capable of processing large amounts of data to solve current environmental problems and help predict upcoming issues as well. It can be deployed to mitigate any threats that may arise in upcoming times. AI technology that can contribute to environment protection to help achieve sustainable development. AI cannot be considered as a panacea. Labeling AI as a magic bullet is not fair enough as it has its own set of challenges. It can have varied ethical, social, legal, and environmental implications. Therefore, AI should be developed and used in a responsible manner. As AI demands rigorous evaluation and assessment, effective legal frameworks must be put in place for due regulation and accountability. Hence, comprehensive use of new age technology must be adopted to promote sustainable development for environment protection.

References

1. Daron Acemoglu & Pascual Restrepo, Artificial Intelligence, Automation and Work.
2. Tolga Bolukbasi et al., *Man Is to Computer Programmer as Woman Is to Homemaker? Debiasing Word Embeddings*, 29 in *ADVANCES IN NEURAL INFORMATION PROCESSING SYSTEMS* (2016), https://papers.nips.cc/paper_files/paper/2016/hash/a486cd07e4ac3d270571622f4f316ec5-Abstract.html (last visited Dec 24, 2023).
3. Mohammad Sadegh Norouzzadeh et al., *Automatically Identifying, Counting, and Describing Wild Animals in Camera-Trap Images with Deep Learning*, 115 *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES* E5716 (2018).
4. Max Tegmark, *Life 3.0: Being Human in the Age of Artificial Intelligence* (2017).

5. Combining satellite imagery and machine learning to predict poverty | Science, <https://www.science.org/doi/10.1126/science.aaf7894> (last visited Dec 24, 2023).
6. Rachel Courtland, Bias Detectives: The Researchers Striving to Make Algorithms Fair, 558 NATURE 357 (2018).
7. About the United Nations Environment Programme, UNEP - UN ENVIRONMENT PROGRAMME, <http://www.unep.org/who-we-are/about-us> (last visited Dec 25, 2023).
8. Writ Petition (Civil) 13029 of 1985.
9. 1987 AIR 1109.
10. The Constitution of India.
11. United Nations Framework Convention on Climate Change.
12. Convention on Biological Diversity.
13. Convention on International Trade in Endangered Species of Wild Fauna and Flora.
14. environment, (2023), <https://dictionary.cambridge.org/dictionary/english/environment> (last visited Dec 26, 2023).
15. United Nations Environment Programme (UNEP).
16. World Health Organization.
17. 1987: Brundtland Report, <https://www.are.admin.ch/are/en/home/media/publications/sustainable-development/brundtland-report.html> (last visited Dec 26, 2023).
18. NITI Aayog, Responsible AI for All, 2022, https://www.niti.gov.in/sites/default/files/2022-11/Ai_for_All_2022_02112022_0.pdf (last visited Dec 25, 2023).
19. Machine Learning.
20. Natural Language Processing.
21. 4 Types of AI: Getting to Know Artificial Intelligence, COURSERA (2023), <https://www.coursera.org/articles/types-of-ai> (last visited Dec 25, 2023).
22. Artificial Intelligence, Logic and Formalizing Common Sense, <http://jmc.stanford.edu/articles/ailogic.html> (last visited Dec 26, 2023).
23. Vaidy Rajaraman, John McCarthy – Father of Artificial Intelligence, 19 RESONANCE 198 (2014).
24. Stanford University, Human-Centered Artificial Intelligence, <https://hai.stanford.edu/sites/default/files/2020-09/AI-Definitions-HAI.pdf> (last visited Dec 25, 2023).
25. About the United Nations Environment Programme, *supra* note 8.
26. DeepMind AI Reduces Google Data Centre Cooling Bill by 40%, GOOGLE DEEPMIND (2016), <https://deepmind.google/discover/blog/deepmind-ai-reduces-google-data-centre-cooling-bill-by-40/> (last visited Dec 26, 2023).
27. AI for Earth - Microsoft AI, <https://www.microsoft.com/en-us/ai/ai-for-earth> (last visited Dec 26, 2023).
28. SilviaTerra wants to bring the benefits of carbon offsets to every landowner everywhere | TechCrunch, <https://techcrunch.com/2021/01/08/silviaterra-wants-to-bring-the-benefits-of-carbon-offsets-to-every-landowner-everywhere/> (last visited Dec 26, 2023).
29. I. B. M. Corporation, IBM Research Launches Project “Green Horizon” to Help China Deliver on Ambitious Energy and Environmental Goals, <https://www.prnewswire.com/news-releases/ibm-research-launches-project-green-horizon-to-help-china-deliver-on-ambitious-energy-and-environmental-goals-265983691.html> (last visited Dec 26, 2023).
30. Kayla Schulte, ‘Real-Time’ Air Quality Channels: A Technology Review of Emerging Environmental Alert Systems, 9 BIG DATA & SOCIETY 20539517221101346 (2022).
31. Overview - Wild Me Documentation, <https://docs.wildme.org/product-docs/en/wildbook/introduction/> (last visited Dec 26, 2023).
32. seabirds, Wildlife Monitoring Technology | Conservation Data Analysis, CONSERVATION METRICS, <https://conservationmetrics.com/> (last visited Dec 26, 2023).
33. Environmental Protection Agency, United States.
34. OECA US EPA, Next Generation Compliance: Strategic Plan 2014-2017, (2014), <https://www.epa.gov/compliance/next-generation-compliance-strategic-plan-2014-2017> (last visited Dec 26, 2023).

35. World Resources Institute.
36. National Determined Contributions under the Paris Agreement. Synthesis Report by the Secretariat, https://unfccc.int/sites/default/files/resource/cma2021_08_adv_1.pdf (last visited Dec 26, 2023).

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