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EVOLVING LANDSCAPE FOR ARTIFICIAL INTELLIGENCE IN ENVIRONMENTAL PROTECTION- FROM HUMAN INTELLIGENCE TO MACHINE INTELLIGENCE

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ABSTRACT

The concept of Machine and Technology over Man power has been on the rise since the time of Industrial Revolution and has evolved multifold in each phase of Industrial Revolution. With time, man has tuned himself into being and working as one with technology. One such product of recent advancements is the use of Artificial Intelligence in providing solutions to even the most complex human issues, starting from health-care and governmental service like military to resource management. AI has proved to be the game-changer in providing a positive solution for problems in most sectors. One such sector that has been benefiting most from AI and its application is Environment and measures in its sustenance. AI, with its advancement in algorithms' computational power and data availability, expanded its scope to overcome the issues, viz.,climate change, deforestation, species extinction, etc. With this background, this article makes an attempt to explore the role of AI in environmental protection and analyze its innovative solution to monitor, analyze and manage the natural resources of our planet.

Keywords: *Artificial intelligence, environmental protection, climate change, human issues, and technology.*

INTRODUCTION

A Healthy Environment is the most important component for sustenance of life on earth. In recent decades, global warming and climate change have been taking a toll on environmental health across the world, thereby indirectly affecting each and every organism, its life and health, on resources, its use and so on. Sustaining the environment without compromising on ecosystem and its balance in supporting life of organisms is presently the sole purpose of all the environmental conservation organizations. This concept of 'Sustainability' had its inception in the United Nations Document, *"The Brundtland Report"* (Our Common Future: Report of the World Commission on Environment and Development, 1987), by the name *"Our Common Future"*, wherein the "World Commission on Environment and Development" formulated sustainability to be "Development that satisfies the needs of the present without jeopardizing the capability of future generations to meet the needs". However, man and his efforts alone will not suffice in achieving this goal and thus Artificial Intelligence, a recent development in the field of study is aiding in addressing major environmental sustainability issues and in dealing with the global environment crisis.

A question may rise as to how technology can have a role in controlling environmental degradation, combatting climatic catastrophes and other such nature related issues. Artificial Intelligence has been made in providing a cutting-edge solution for such issues using data and technology (Hamed Taherdoost, 2023, 51), that too at a much faster rate. In the era of self-driven vehicles and tailored medical needs, the advancing lifestyle also calls for caution in dealing with climatic change and its impact on the ecosystem. This is not merely an individual threat but one affecting the entire world map, thus requires a more holistic approach, for which Artificial Intelligence (AI), hence stated as 'AI', has been installed. Several novel methods of computation starting from Machine Learning (ML), hence forth stated as 'ML', Deep Learning (DL) to Big Data, utilizing complex datasets have, by themselves, proven to be more time consuming, thus calling for a swift but effective scheme using these methods. Thus, AI coupled with ML in identifying meteorological quantifications, location and time database and to give automatic warnings, in assisting humans to reach and deal effectively with extreme weather conditions, has been emerging as a latest and better model in not merely combatting these devastations but also in upholding environmental sustainability. (Rakshit Jakhar et al., 2022, 58) Grid system, allowing precise estimation and tracking of storms, clouds, and events of deep convective and the Earth system models (ESM), using sub-grids, for weather forecasting have come to rescue, in not merely forecasting such occurrences, but also in illustrating carbon cycles, atmospheric greenhouse gases and emission levels, their on time diagnosis and treatment and so on. Thus, AI and ML techniques have a major role in not merely in analyzing or protecting environment but also in creating ecological awareness, resilient infrastructures, social systems and its adaptiveness and being ready to tackle crisis situations. (Rakshit Jakhar et al., 2022,59)

Objectives

- To analyze the concept of AI.
- To examine the role of AI in environmental protection.
- To address issues such as data privacy, algorithmic bias, and transparency.
- To investigate the legal frame work of AI in environmental protection.
- To explore future developments in AI for environmental protection.

Artificial Intelligence and its role in environmental sustainability

AI-powered algorithms and technological models serve as a useful tool in enhancing the nations struggle towards attaining Sustainable Development Goals (SDG) as it plays its part in various sectors like food, agriculture, transport, health-care, fuel, maintenance of ecosystem with a view to foster a circular economy an enhance smart city resources. (Duque Acevedo M et al., 2023 50). AI makes its stand-out move by merging smart technology with low carbon emissions, thereby transmitting population needs to varied sectors of which application of AI to environmental issues and settling of the same, has given a newer perspective and has also portrayed the seriousness of environmental problem in the present world. The 'machine learning' in 'Artificial Neural Networks' (ANN) specifies different ecological components that have been outlined like soil, pollution both air and water, waste management, resource conservation, agriculture, land degradation, which incidentally also fall under the broad categories of SDG of the UN on sustaining "Life on land" and "Life below

water", how AI and ML models have contributed and is still contributing to the objectives on eradicating poverty, hunger and most importantly, maintaining an ecological balance and protecting the environment. (Hamed Taherdoost, 2023, 50) Thus, AI contributes much to climate change phenomenon, pollution, their disposal, combatting, cost effective measures and the like and is thus a valuable find for human in the present era.

AI in preserving earth's ecosystem

a. Combating Climate Change

The Intergovernmental Panel on Climate Change in its report has stated: (UN Environment Programme, 2023, 4)

"Global surface temperature was 1.09 (0.95 to 1.20) degree Celsius higher in 2011-2020 than 1850-1900, with larger increases over land (1.59(1.34 to 1.83) degree Celsius) than over the ocean (088 (0.68 to 1.01) degree Celsius). Global surface temperature in the first two decades of the 21st century (2001-2020) was 0.99 (0.84 to 1.10) degree Celsius higher than 1850-1900. Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2000 years (high confidence)." The report shows the severity of climatic crisis.

Thus, arose the use of AI for modelling and predicting climate change so as to mitigate its effects (Paul Brown, 2023), and to optimize power generation and consumption in real-time. (Rakshit Jakhar et al., 2022, 60) The use of grid system to enhance efficiency and predictability of climatic changes, storms, atmospheric conditions etc. along with intelligent meters and sensors, especially within infrastructure was introduced so as to help, not merely in gathering information and data but also in analyzing, monitoring and taking swift action and also optimizing usage of power. This process being unmanageable by humans alone, the ML algorithms in association with AI peruse large database to decode significant patterns in providing 'climate models' accurately. It also helps in connecting 'multiple data points', so as to arrive at data regarding temperature, greenhouse gases and emissions, ocean currents etc. The resultant output helps to a large extent in being prepared for climatic crisis in near future. (Paul Brown, 2023)

b. Conservation of Biodiversity including Wildlife conservation

The prime requirement in conserving biodiversity is minimal intrusion and disturbance by human presence. However, the conservationists also require vast and detailed data set. AI, makes the most significant contributions in conservation of wildlife and biodiversity by collecting data continuously and non-intrusively. Thus, what was earlier impossible to obtain is now made easily available to the conservationists. Moreover, wildlife conservation is of much importance as it not merely includes protecting the animals but also conserving the ecosystem wherein they live, which, at present is deteriorating at an 'alarming rate'.(Paul Brown, 2023). Artificial Intelligence, in association with satellite imagery, AI powered cameras and sensors can easily detect changes on land including forest cover, and any kind of degradation and prevent any prospective natural disaster and can also identify change in vegetation, track and safeguard endangered species. Such predictive software assists in anti-poaching measures as well. (Rakshit Jakhar et al., 2022, 60) Such invaluable data collected supports conservation efforts, based on evidence, thereby helping them to make informed decisions on 'management of land' and 'land-based resources', 'protected area designations',

and 'the implementation of policies' so as to safeguard the earth's biodiversity. The Conservation Area Prioritization Through AI (CAPTAIN) is the AI system used to study and conserve Biodiversity, which works with the object that routine monitoring of biodiversity enhances biodiversity conservation outcomes. (Hamed Taherdoost, 2023, 51)

c. Controlling Air Quality

Technological advancements have introduced various AI-powered tools and methods that can accurately predict the level of pollution, air quality, wind speed etc. by the use of data from high powered radars, sensors and cameras, which cannot merely collect data in this regard but can also facilitate study on emissions and pollutions and can identify ways to mitigate it and thus protect and control air quality. Air pollution emissions have dropped in recent years, especially post Covid-19, but environmental health risk still remains across the globe. This had led to an estimated 238,000 deaths in 2020 alone. Air pollution however, is still a matter of significant concern in the urban areas, where a network of sensors continuously monitors and records pollutants. These pollutants are 'particulate matter', 'nitrogen dioxide', and 'volatile organic compounds'. 'AI' and 'ML' (Machine learning) algorithms processes the data for mitigating pollution by creating 'real-time air quality maps', enabling authorities to issue 'timely warnings' and adjust 'traffic management' and 'industrial operations'. (Paul Brown, 2023) The ANN is the AI system used as a model in providing an alternate strategy for forecasting Nitrous Oxide emission. (Hamed Taherdoost, 2023, 50)

d. Water Usage and its Security

The earth is made up of 97% water, making it the most essential element for sustenance of life on earth. As far as water quality is concerned, it is heavily impacted by various factors like waste effluents, agricultural runoffs, fertilizers, pesticides and other toxic substances disposed off by humans into water bodies, thus depleting water quality, causing algal bloom, eutrophication and thus completely killing aquatic life. Like the Air AI sensors, AI powered sensors are also used to predict and monitor water quality, offering real-time data in protecting and maintaining not merely marine resource but also in entire ecological sustainability. Scientists also use AI to predict usage of water, drought, subsoil and surface water problems, in a particular geographic domain so as to facilitate policies to conserve the same. (Rakshit Jakhar et al., 2022, 60). Similarly, satellite integrated sensors have been used to track quality of water like pH level, the amount of gases and chemicals dissolved in water, detection of any kind of spills or chemical reaction, etc. for not merely making policies but to take immediate steps and response measures in minimizing the effect of such occurrence and mitigate the damage it has caused. The Integrated 'Long Short-Term Memory' network (LSTM), using associated rules and 'cross-correlation' is the AI used in tracking and securing water and its quality. (Hamed Taherdoost, 2023,)

e. Maintaining Good Ocean Health

Global warming and climatic change along with heatwaves, acidification and other such occurrences have been impacting marine ecosystems and causing loss of biodiversity. AI has come out as a powerful weapon to monitor and take steps in preserving marine ecosystem. The 'Autonomous underwater vehicles' (AUVs) integrated with advanced 'AI' technology has been deployed to explore and record the 'health of oceans', facilitating 'crucial conservation' efforts. They conduct surveys in detail on 'marine ecosystem', 'capture high-resolution' pictures and assimilate vast amount of data, above which they are also 'capable of detecting'

differences that occur in 'coral reef', thus monitoring even such minute and fragile things for effective conservation. (Paul Brown, 2023)

f. Role of AI in Disaster Management and Weather Forecast

Global warming and climate change has been impacting various components of the environment thus leading to a surge in natural disasters. Detecting this in advance has been the most challenging issue for so many decades. However, reports of the World Meteorological Organization states that early detection, warning and steps in mitigating natural disasters and handling extreme weather conditions are now possible by way of AI, wherein advanced AI sensors, drones, alongside ML Algorithms have enabled analysis of historical data and its comparison with the real-time data that has been assimilated so as to find ways to control the disaster and not repeat the old mistake. (Paul Brown, 2023) AI, by detecting storms, tremors, floods, risk of fire, windstorms and other natural phenomenon or disasters has facilitated in taking rapid action so as to save peoples' lives to the maximum extent possible. (Rakshit Jakhar et al., 2022,) Timely evacuation of people much before the risk reaches them, in present times is to a large extent accreditable to AI.

Application of AI for various other factors

a. Urban development – Developing residential and commercial infrastructure

AI-powered smart infrastructure leverages data from a 'network of sensors', revolutionizing 'energy efficiency' within such buildings, both 'residential and commercial'. These systems automatically adjust cooling, heating, or rather moderating temperatures, lighting etc. by continuous monitoring of occupancy patterns and environmental conditions, in a way also ensuring optimum utilization of resources. In other words, it reduces energy consumption, controls greenhouse emissions and cuts down heavily on operational cost, thus having a positive impact on economy as well. (Paul Brown, 2023)

b. Managing renewable energy sources

'AI' plays a major role in 'renewing energy' and controlling the natural resources as a whole, thus propelling the towards 'development and transition' for an increased 'sustainable energy production'. Like, energy production which is weather driven, requires accurate prediction of 'weather conditions' for the purpose of enabling 'renewable energy' thereby facilitating to anticipate periods of 'high energy production' and 'plan' accordingly. Various other similar instance call for effective 'grid balancing'. 'AI' technologies are instrumental in 'grid management' and balancing the 'production', 'sustenance', 'supply and demand' of 'renewable energy'. They can also predict fluctuations in energy demand and adjust the supply according to the needs and situation. (Paul Brown, 2023)The "European Centre for Medium-Range Weather Forecasts" (ECMWF) led the "Energy Efficient Scalable Algorithms for Weather Prediction at Exascale" (ESCAPE) project with the object of developing sustainable energy so as to predict more efficiently, 'climate and weather models', in a way to sustain it for future generations also. (Arnault Pachot & Celine Patissier, 2022, 2)

c. Improving efficiency of agriculture

AI in recent times has been supporting the agricultural sector by empowering farmers to take steps based on data assimilated by AI, thus optimizing 'crop management' and increasing 'productivity' and 'sustainability'. The association of 'sensors' in analyzing 'data' for analytical use in farming practices facilitates accurate and efficient approach to 'cultivation'. For instance, sensors placed in fields and powered along with machinery collect

an ‘array of data’, including ‘soil moisture’, ‘temperature’ of both soil and atmosphere around, nutrient levels, crop health including detection of pests for its effective control etc. This real-time data is then processed by ML algorithms, providing farmers a deeper insight and knowledge of the condition of their ‘crops’ and ‘soil’. As a result, farmers are able to maximize crop production and minimize usage of resources. Thus, much of the biodiversity effects are reduced at this stage as well. (Paul Brown, 2023) The agricultural industry is capable of benefiting the ‘environment’ and improve ‘sustainability’ of food production to a great extent. (Arnault Pachot & Celine Patissier, 2022,23)

d. Fuel efficiency and sustainable transportation

‘AI’ is capable even of limiting vehicular pollution and promoting fuel-efficient transport. Companies in automative industry are heading towards ‘innovation’ and ‘sustainable transport’. Manufactures are also looking forward to such smart and ecological transport. This has also been the object of many automobile companies. (Arnault Pachot & Celine Patissier, 2022, 3) Making this a reality for public transport would also contribute much to protecting ecology.

e. Environment friendly Industrialization – including waste management and recycling

AI-powered systems are enabling the transformation of ‘waste management’ for providing more effective solutions. These systems can optimize ‘waste collection’ patterns by analyzing historical data and real-time statistics, like current fill levels in bins. This results in saving the cost significantly, reduced non-renewable resource consumption, and a decrease in harmful ‘emissions’ from collection vehicles. ‘AI’ also helps reduce ‘landfill waste’ by finding means for ‘recycling’ and composting waste. ML algorithms have also been useful in sorting large amounts of data in order to improve the separation of recyclables from non-recyclables, ultimately decreasing the volume of waste sent to landfills. AI also increases ‘recycling rate’ and value of recycled materials.

Struggle between Man and Machine - Limiting the Role of AI in dealing with ‘environmental sustainability’

The increasing use of ‘AI’ in organizational and human processes comes across several obstacles. Despite it being strong and promising in achieving the ‘socio-environmental sustainability’ target, ‘accessibility’, ‘privacy’, ‘liability’, ‘data accountability’ and various other factors are to be considered while using AI. It however, uses a lot of energy and more particularly non-renewable resources and emits CO2 equivalent to 5 car emissions of CO2 during their lifetime. (Arnault Pachot & Celine Patissier, 2022, 6) AI thus has more disadvantages than advantages. Algorithms cannot at any time equal human thinking or ideology. No doubt, in environmental sustainability AI contributes advanced level of initiatives. But this measurement at times gets difficult at times, the results may turn out to be ineffective. (Hamed Taherdoost, 2023.52) The success rate of AI thus depends on integration of analytical and technical outcomes, however, in judgment or decision making, it can never equal a human ideology.

Prospective contributions of AI in combating climatic change issues

AI is and will surely continue to play a vital role in predicting future shortfalls in various phenomenon across the globe, from predicting climate change, to overcoming all such issues associated with the ecosystem. Having a round the clock working potential, AI and ML have been offering promising results despite having certain setbacks. From analyzing floods, or tremors of historical and real-time records and data to analyzing patterns in wildlife, from weather to soil information, in short from pests to pollution prediction, future of AI seems most promising in protecting people, of the current and future generations. 'AI' can thus help prevent prospective dangers and ensure the safe, long-term sustenance goals. (Rakshit Jakhar et al., 2022, 61)

Challenges posed by AI in environmental protection

Despite the advantages of AI, such as reducing the emissions of greenhouse gas, biodiversity conservation, etc., there are risks posed by AI in its utilisation as follows:

- AI system requires substantial energy for its operation which leads to the emission of greenhouse gas.
- The use of AI technology results in electronic waste.
- Due to feeding of biased/ incomplete data, the predictive analysis can perpetuate bias and discrimination resulting in injustice in environmental sustainability.
- Since AI has to rely on personal data, the data are to be secured. Safeguarding privacy and security is essential or else it will overturn the public trust in AI

Regulatory frameworks

AI system should ensure data protection while addressing environmental issues. Therefore, compliance with data privacy regulation is very important. In India, the existing regulatory frameworks in environmental matters such as.... and also, Personal Data Protection Act,2023 do not provide adequate guidance in the use of AI in environmental protection. Therefore, there is a need to have a comprehensive legal framework to regulate the utilisation of AI for effective environmental protection by upholding public trust in it. Furthermore, adequate legal framework is essential for the ethical use of AI. These policies should focus its attention towards ethical standards by giving guidelines to data practices. Hence legal framework should incorporate adequate provisions to regulate collection, analysis and decision -making process in order to safeguard against potential risks and challenges

Future developments in AI

AI technologies are addressing challenges and promote environmental conservation from intelligent monitoring of the ecosystem to analyzing climate data. Presently, AI technologies are advanced from expert systems to deep learning and reinforcement learning thereby expanding its scope in energy management and sustainable practices. There is also a pressing need that it will have to enhance its role in engaging public to create awareness and also to give response to conservation related questions.

CONCLUSION

To conclude, AI plays a significant role not only in processing environmental related data but also for storing and analyzing it, so that it could be utilized for practical implementation for conservation of environment. Thus AI technologies plays a role in

optimizing resource usage, minimizing waste ,track and protect endangered species, predicting analysis for climate change etc. Though AI has emerged as a crucial tool in addressing environmental issues, there are potential risks and challenges linked with it. Since AI plays a pivotal role marching towards a sustainable future , it has to be utilized in a responsible and ethical manner in order to prevent the negative impact of sustainable development.

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