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Use of Artificial Intelligence in Environmental Studies

S. Usha[1], Kavitha Venugopal[2]

[1]Assoc. Professor, Department of Environmental Sciences, Sri Krishna Degree College, ITI Layout, BSK III Stage, Bengaluru-560085.
[2]HOD, Department of English, Sri Krishna Degree College, ITI Layout, BSK III Stage, Bengaluru-560085.

Abstract

Man has caused enormous damage to the environment in the recent years and the implications of his activities have rebound in form of climate change, global warming, biodiversity loss, pollution problems water crisis and desertification, and several others. AI has been impacting man in diverse fields affecting jobs, education, marketing, healthcare, diagnostics, environment and others. The use of Artificial intelligence (AI) in solving environmental issues with deep learning and use of NLP models to assess energy usage, carbon footprint and others have a great potential in the near future. AI has been most efficient in addressing the environmental issues by using data -classification, predictive-analysis and comprehending the data, operational optimization that suggest the course of actions to be implemented, detection of errors and defects in analytical methods. The role of AI in assessment of biodiversity loss, identifying factors, prediction of biodiversity protection, has been reviewed in this paper. The use of AI has been in correlation with data obtained from satellite imagery, camera traps, acoustic and thermal biosensors along with the use of drones, aircraft and other modern gadgets that have enhanced the efficiency of analysis and interpretation hundred folds. AI has been applied in diverse fields of environment aiding in the conservation, protection, and sustainability of the environment combined with preventive measures against pollution.

Keywords: environment, Artificial-intelligence, climate change, global warming predictions, sustainability.

Introduction

Human activities have affected theenvironment tremendously in the last decade which has seen diverse implications on man and other living forms as manifestations of climate change, global warming, loss of species, pollution issues, water crisis and several related problems that seek immediate concern and solutions. Newer concepts that are eco-friendlier and technologically innovative are necessary for addressing these issues. Man has been on the look-out for eco-

friendly solutions for the diverse problems in today's environment.Sustainable green developmental measures have evolved with "changing the energy mix, promoting re-source efficiency, and adopting sustainable practices" (Yi Wang, 2024).

Artificial Intelligence has been defined variously by scientists and writers. One definition by Haugeland, (1989) defines AI as

"The exciting new effort to make computers think ... machines with minds, in the full and literal sense."

Poole et al., (1998) have described AI as "Computational Intelligence is the study of the design of intelligent agents." AI has been impacting man and his activities in diverse fields affecting jobs, education, marketing, healthcare, diagnostics, environment and others.

The impact of the use of Artificial intelligence (AI) in solving environmental issues with deep learning and use of NLP models to assess energy usage, carbon footprint and others have been in the fore (Ligozat et al., 2022). AI has been seen to impact "global productivity, environmental outcomes, both in a positive and negative way affecting sustainability, (Norouzzadeh, et al., 2018; Courtland and Bias, 2018). The use of AI in the detection and solving the environmental issues has come to the fore in recent times and is known to have greater potential in the near future. The use of AI in evaluation of climate change, extent of deforestation, predicting global warming, in monitoring survival of endangered species, analysis of pollution of air, water and soil and other resources, and several other parameters has been of utmost importance. AI has been most efficient in addressing the environmental issues by using the following parameters – "classification of data, prediction and comprehending the data, operational optimization that suggest the course of actions to be implemented, detection of errors and defects in analytical methods, and producing new data based on older information available.

In this article we try to explore the some of the aspects in which AI impacts study of environmental issues globally. AI and its role in assessment of biodiversity loss, identifying factors, prediction of biodiversity protection, climate change, global warming, pollution effects, and observation of earth, deforestation effects, and other related topics.

Figure 1: Use of AI in environmental issues

Review of literature

Ligozat et al., (2022)[4] have observed that the last decade has seen a dramatic emergence of Artificial intelligence as a means to solve issues related to environment especially those connected with emission of green-house gases. They have observed that AI is being used extensively in resolving environmental issues especially related to the emission of green-house gases. In their research paper, the authors have made an effort to "study the possible negative impacts of AI for Green". The researchers have analysed various effects of AI solutions towards the environmental issues and the use different methodologies applied to the study of these effects and the application of the said methods in AI to solve environmental issues.They have opined that study of numerous parameters involves huge amount of data that consumes a lot of energy, which is not environmentally sustainable, thus implying the negative aspects of AI in environmental management.

Yadav and Singh (2023) have explored the methods by which "environmental sustainability can be improved using AI". Their study shows the most probable benefits of using AI tools for environmental problems and "qualitative analysis to explore sustainable methods of using AI and effect of AI on the environment." (Yadav and Singh, 2023). Their study, involves looking into "environmental sustainability with respect to the economic and social aspects of sustainability. This study helps the "stakeholders in comprehending global efforts to enhance environmental sustainability through the implementation of AI" and its role as "a catalyst for promoting a "sustainable environment" approach to the advancement of AI technologies and their effect on the environment."

Chaudhary (2023) has observed that the use of Artificial intelligence has spread across many parameters related to environmental issues, like "wildlife protection, natural resource

conservation, clean energy, agriculture, energy management, pollution control, and waste management". He has quoted that "the UN acknowledged that AI could be an enabler in the sustainable development process towards peace, prosperity, and dignified life for humankind and proposed to change attention on the application of AI in providing wholesome efforts on sustainable development to eradicate poverty, hunger and to protect the environment all over the world". He further states that sustainability includes "interrelated agenda of the environment" connected to human society and economic development and quotes the "Brundtland Report," which describes sustainability as a development which caters to the requirements of man without negotiating the needs of the further generations and their capacity to fulfil the same.

Yi Wang (2024)has investigated the role of AI on green economy and its implications of AI in the development of "energy management, environment, cities, transportation, business, innovate and society". His paper debates the role of AI in "data leakage and excessive reliance on data, and the proposed solutions" to the environmental issues.

Rayhan in his article has noted the multiple applications of artificial intelligence in the protection of the environment, and the use of sustainable development. They have assessed the different methods of employment of AI in the field of "remote sensing, wildlife protection, climate change prediction, and others" and implies to gain more information on the use of AI in the conservation of the environment.

GPAI (2022) report says that the use of AI in biodiversity conservation involves the use of modern analytical methods in place of "time-intensive manual data collection and analysis". it says that "AI can support the development of an effective, automated, and globally distributed biodiversity monitoring system that provides verified information on the state of the biosphere in real time." it suggest the use of AI in the assessment of biodiversity loss, and effects of privatizations in the field of "food, industry and fashion", on the biodiversity changes, and assessment of challenges and constraints in AI applications in "AI capacity and awareness, data-related challenges, and funding and investment."

Use of AI in Environmental Studies

A. Use of AI in predicting climate change

Since last few decades one of the most crucial issues facing the world is the change in climate patterns globally impacting several parameters related to geographical, agricultural, ecological manifestations. There have been drastic changesin the occurrence of seasons, rainfall- pattern, extremes of temperature affecting humans, plant and animal life in a huge manner. Environmentally detrimental human activities carried out in the past decades have brought about irreversible changes in the ecosystems worldwide. The end result boomerangs the life on earth and the humans in particular, with societal and economic impacts. AI enables better understanding of the climatic phenomenon and help in more efficient prediction of climatic conditions. Much of the data originates from the satellite imagery of the climatic regions on earth which generates a bulk of data that makes manual analytical techniques impossible. The use of AI and data analytics provides an in-depth study of climatic processes. Data of the past decades using AI algorithm can help project a clearer picture of future climate models, foreseeing natural

disasters, thereby aiding the governments in forming effective policies to tackle them (Rayhan, 2023).

Emergence of non-governmental organizations that are involved in predicting climate disasters have paved the way for better management of disasters globally. One example is on organization "Sipremo" in São Paulo, Brazil, that applies AI in climate disaster predictions. Sipremo applies the information gained from AI in analyzing the effect of climate change on different business ventures and on the society in Brazil, where the occurrence of natural disasters has been continuously occurring in several cities. AI provides "predictive analysis" of climate change that enables effective preventive measures to be implemented during a disaster.

B. AI aids in analyzing deforestation globally

Information about deforestation activities worldwide can be had using AI applications, images from satellite and analysis from experts in Ecology and the effects of this on the climate of the region can be predicted. Information on "changes in vegetation cover, forest density, and land use, and practice of illegal mining, logging, encroachments and faulty agricultural practices" can be traced using the AI (Rayhan, 2023). *Space Intelligence* is an agency operative from Scotland which provides data and mapping information on deforestation activities using AI in around 30 countries globally, with an objective to reduce deforestation and address climate change issues.

Such models can be implemented in other regions for the purpose of study as well as for implementing remediation measures.

C. Prediction of global warming- melting of Icebergs

Ice cover over the Artic and the polar regions are important thermal regulators that help in reflecting back the heat to the space thereby reducing the temperature of earth. The glaciers floating on the seas are thousands of years older and are mirrors to the global warming of the planet, (Boyd, 2024). As a consequence of the industrialization, and increase in the emissions of CO2 and other green-house gases leading to rise in global temperatures on the earth's surface, the glaciers around the world are melting further causing increase in sea -level. This rise in water level further manifests as reduction in ice for polar fauna to global climate changes (WWF, 2024; WOR, 2019). Further rise in sea levels globally resulted in increase in storms and cyclones, flooding, infrastructure damage, and spread of water-borne and mosquito-borne diseases world-wide. The recent developments in AI have enabled faster measurements of changes in icebergs using technology rather than human activity (ESA, 2023; World Economic Forum, 2024). The prediction of melting of icebergs globally can offer timely help to scientists to formulate preventive measures to many of these problems.

D. Use of AI in monitoring the survival and conservation of endangered species.

Endangered species are living plants and animal groups that are on the bring of extinction and required to be conserved and protected by the government and other forest departmental agencies in collaboration with the local population. Endangered species conservation requires a continuous surveillance system to ensure their protection and prevention of their extinction. AI

can aid in the conservation and protection of these species by the various algorithms developed in recent times. The use of Artificial intelligence in monitoring endangered species involves the applications of "camera trap image analysis, acoustic monitoring, and GPS tracking" that can improve the efficiency of wildlife conservation methods.AI helps in identification, assessment of population, surveillance of migration routes, and aids in better management through study of "species behavior, and changes in use of habitat" (Rayhan, 2023).

It has been noted that several scientists and conservationists are trying to use modern methods involving AI in "automated species monitoring" which makes use of information from "optical, acoustic and thermal sensors" employing drones or surveillance posts in the regions, aircraft, and /or images from satellites and AI-algorithms. These methods ensure efficient management of data on species identification and population density studies (GPAI , 2022; Weinstein, 2017).

One of the most widely used applications of AI in species identification is "camera trap imagery" that is used by web-services and facilitates identification of species by image uploads, and assessed by AI algorithms which apply machine and deep learning and "automated species identification" (Kellenberger et al, 2020).

Beery et al (2019) have promoted the use of a detector system named "Microsoft

AI for Earth MegaDetector" which is a Mega detector API interface that helps in the detection of animals, humans and vehicles using camera-trap imagery and allows "batch filtering and cropping of images".

Bioacoustics is a field of computational analysis where acoustic sensors are used for the measuring data on biodiversity. Various applications of these acoustic biosensors are used for "biodiversity monitoring applications". "Conservation NGO Rainforest Connection" is an NGO that uses sound -scape recordings of the animals for automated species identification". they have launched a device named "Arbimon" that helps to upload and analyze vast amount of data on devices and helps in species identification.

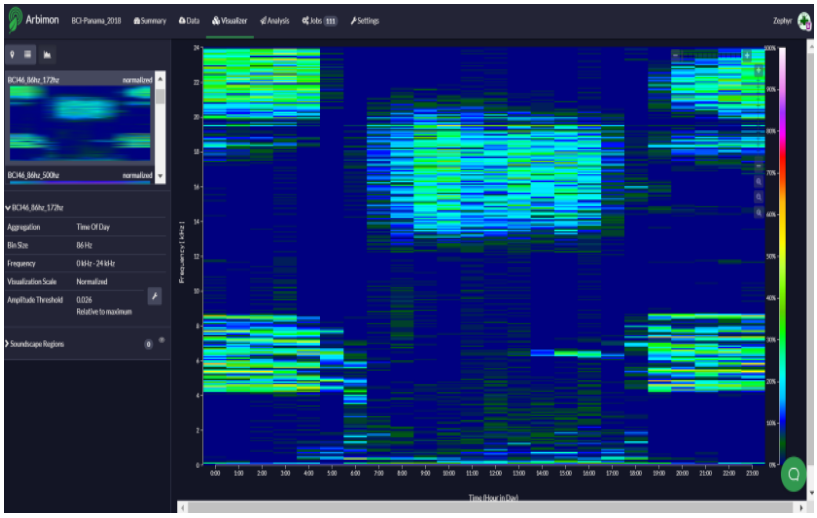

Figure 2: Arbimon- acoustic species analyzer, (Source: Rainforest Connection, 2024)

AI algorithms developed on the usage of "thermal imagery" has been increasingly used in the identification and studies of species. The use of drone carrying thermal sensors has been reported by Corcoran et al. (2019), who have used automated detection systems for studies on koala population in Petrie, Queensland. The authors have detected that the automated system provides greater effectiveness, is sharper and identifies individuals with higher fidelity than the manual methods of analysis by the "RPAS-derived thermal imagery in a comparable amount of time".

E. Use of AI in pollution studies in relation to biodiversity loss.

Air, water and soil pollution happen to be the key factors that impact the loss of biodiversity and affect the species world-wide. They result in loss of species, and their migration, irreversible impacts on human and animal health causing several types of health hazards. The main causative factors being agricultural run offs, vehicular pollution, industrial effluents and power generation stations. Pollution results in loss of "ecosystems' ability to function, and affects the important ecosystem parameters on which life is dependent".

One of the most pertinent factors in pollution is the water pollution caused by runoff from agricultural fields carrying "fertilizer and pesticide residues", especially the "nitrogen and phosphorus compounds" that enhance eutrophication leading to the increase in "algal blooms and hypoxia", (Chislock et al. 2013). Schindler (2006)have described eutrophication as

"**Eutrophication** is characterized by excessive plant and algal growth due to the increased availability of one or more limiting growth factors needed for **photosynthesis"** (Schindler 2006). The rate and amount of eutrophication has increased tremendously due to pollution from "both point and non-point sources" resulting from addition of nitrogen and phosphorus salts. This has led to "cultural eutrophication" that has led to the contamination of the drinking water sources, affects the living species in water and makes water unusable for recreation purpose (Carpenter *et al*. 1998).

The use of AI has been done in quantitative and qualitative assessment of pollutants in air and water samples, especially, for detection of "ozone concentrations and oil spills". As per reports by AirQo ,the use of AI based software in the analysis of air quality to detect regions with higher localized pollution in Kampala, Uganda.

Keramitsoglou et al. (2006)has observed that "Globally, 80% of wastewater flows back into the ecosystem withoutbeing treated or reused, while soils arepolluted with inorganic and organiccompounds, some organic wastesand so-called "chemicals of emergingconcern". The scientists have made use of an "automated device" that can detect oil spills using satellite imagery on the basis of "AI fuzzy logic". The used of AI has been successfully implemented in the uncovering of "bilge dumps, gas flaring, algal blooms and other forms of pollution from satellite imagery (SkyTruth).

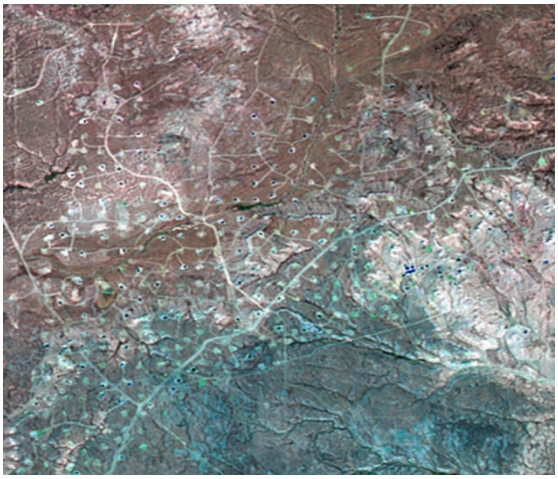

Figure 3: Jonah Gas Field Upper Green River Valley Wyoming 2003. Landsat satellite image (Source: Skytruth)

Conclusion

It can be clearly seen that the use of AI in environmental issues is helpful in the prediction of climate change, global warming, analyzing deforestation, monitoring biodiversity loss, survival of endangered species and in the analysis of pollution and their prevention. AI provides "predictive analysis" of climate change that enables effective preventive measures to be implemented during a disaster. Deforestation activities and the destruction caused can be analysed using AI applications which involve images from satellite and analysis from experts in Ecology. Developments in AI have made possible faster measurements of various environmental phenomenon aiding in better result- oriented solutions in solving environmental issues. AI helps in conservation and protection of wildlife and species by using diverse forms of algorithms in monitoring, better surveillance thus helping in developing better conservation programs. The use of AI in pollution analysis has given us a wider understanding of the problems faced and aids in solving pollution related issues in a more efficient manner. Automated detection systems for population studies have proven to be a boon making it easier and enhancing the efficiency of results than compared to the manual methods.

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