

THE FUTURE OF ARTIFICIAL INTELLIGENCE IN CLIMATE CONTROL AND SUSTAINABLE DEVELOPMENT: AN ASSESSMENT

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Abstract

Artificial Intelligence will help to change the whole world of climate control and sustainable development by optimizing energy systems, enhancing climate modelling, improving resource management, and enabling smarter urban infrastructure. This will be a great help in mitigating climate change impacts through data-driven efficiency and innovation. AI analyses weather patterns and demand to make the best use of renewable energy supply. It ensuring grid stability and lowering the use of fossil fuels. It handles enormous amounts of data to predicting extreme weather, locating ice melt, and comprehending climate shifts. In agriculture, AI is used for the best irrigation/fertilization and in cities care the smart grids and traffic management. AI invents more efficient Carbon Capture & Storage systems and helps in the rapid discovery of new materials for batteries and solar cells. It energizes buildings, industries, and transport through energy-saving measures. Satellites fuelled by AI can constantly keep an eye on deforestation and the general health of the ecosystem. Therefore, there are positive forecasting of artificial intelligence in climate control and sustainable development.

Keywords: Artificial Intelligence, Climate control, Pollution, & Sustainable development.

Introduction

Artificial Intelligence is virtually everywhere from simple things in life to complicated industries. The primary reasons for its usage are automating repetitive tasks, analysing massive data sets, personalizing experiences, improving decision-making, and enabling autonomous systems. All these are done with the intention of making processes faster, more efficient and accurate. It will be the source of personalized treatment and speedy diagnosis in healthcare. It will enable autonomous vehicles be used for traffic management in transportation and used for fraud detection and provision of financial advice by robots in the finance sector respectively. It can employ in customer experience improvement in retail, perfect utilization of manufacturing capacities, cybersecurity, and farming. It will be an indispensable instrument in learning, and will influence the job market (Viljakainen et. al., 2025).

Artificial Intelligence is changing the way humans develop by increasing efficiency, tailoring education/healthcare, and upgrading problem-solving abilities. There is a risk of losing jobs, bias intensification, and the emergence of moral problems that necessitate regulation to achieve growth that benefits everyone. It remains a driving force that speed up the success of worldwide objectives such as Sustainable Development Goals. AI helps climate change by making climate models more accurate by predict extreme weather events and by forecasting long-term climate trends. It helps in controlling the energy demand in smart buildings and increasing the energy efficiency through the prediction of supply and demand. It monitors the sources of greenhouse gases, evaluates the effects of product lifecycles, and makes transportation more efficient (Nagpal and Kumari, 2025).

Literature Review

In their article, Lozo and Onishchenko (2021) address AI in relation to climate change and natural resource management as a potential solution but caution that legal, ethical and political considerations must guide the proper use of AI to mitigate risks associated with its use (ex. environmental; political; ethical). This paper stresses the importance of creating legal systems that provide liability for the use of AI, as well as setting up regulations regarding the proper use of AI to help minimize the potential negative impact on environmental, political and ethical risks while also taking advantage of the benefits of AI for addressing the current environmental crisis (ex. Climate Change).

In his report, Das (2023) found that AI also contributes to enhancing urban sustainability via management of traffic congestion, waste monitoring and reduction, and controlling energy

consumption. This will ultimately reduce the environmental impact of urbanization through the application of AI-based solutions. Furthermore, AI is being used to facilitate renewable energy production through improved prediction of renewables and optimization of smart grid systems as well as balancing energy supply and demand. This will further help in minimizing the need for fossil-based energy sources.

According to Hamdan (2024), AI and ML technologies are revolutionizing how climate science is performed through more advanced predictive modelling for predicting extreme weather events, energy generation systems and ecosystem monitoring. For example, CNN-LSTM and Random Forest models improve our ability to process and analyze large data sets with many dimensions and make more accurate predictions to help reduce the impact of climate change. Artificial Intelligence acts as a major force that will help to reach the Sustainable Development Goals with data driven solutions that will assist with optimizing resources, healthcare, education, and climate action; but also raise ethical risks associated with bias and inequity (Nagpal & Kumari, 2025). Viljakainen et al. (2025) present a conceptual article about a multi-level framework to leverage Artificial Intelligence (AI) to change the world of work from a basic state of satisfaction for workers to a state of human flourishing. The authors recommend a human-centered design philosophy that addresses worker well-being in conjunction with industrial performance to recruit talent and create fulfilling work.

Overall conclusion drawn from previous analysis is that AI can accelerate action towards climate change & sustainability through optimizing renewable energy grids and creating models of complex climate change scenarios, as well as enhancing the management of resources. AI-based technologies improve efficiency in agriculture, transport & industry, supporting a low-carbon economy. AI technologies do pose risks; specifically, they consume significant amounts of electricity and have the potential to be used to increase the amount of fossil fuel exploration.

Objectives

- To measure the contribution and role of AI towards achieving sustainability objectives.
- To understand the impact of AI on certain environmental milestones (e.g. taking action against climate change).
- To provide insight into how policymakers and developers can improve environmental oversight in a way that minimizes potential harm.

Methodology

Research in artificial intelligence regarding climate change and sustainability involves mapping applications and assessing their effects. The primary research methods employed in this area of study include literature mapping, expert surveys, and case study analysis. The purpose of these approaches is to balance the predictive, optimized, and automated strengths of AI against its high energy consumption; therefore, existing, peer-reviewed literature will provide the "community of knowledge" regarding AI's role in climate mitigation and adaptation, as well as identify potential gaps in research and/or trend analysis for AI-related applications.

The research relies on secondary data. Sources of secondary data include government reports and evaluation by international organizations. Researchers have utilized both content analysis and evaluation. If researchers compare and contrast findings across sectors, such as renewable energy production or smart agriculture, they may find ways to improve efficiencies. Climate scientists, data scientists, and policy experts helped to evaluate the reliability and sustainability of AI technologies, as well as ensure that the deployment of AI technologies is ethical and does not lead to negative environmental impacts.

Results and Discussion

Role of Artificial Intelligence in Climate Control

One of the major ways artificial intelligence has helped in the fight and management of the effects of climate change is that it has made it easier to understand the implications of climate and weather fluctuations. As such, AI has become an indispensable tool in these efforts as it aids in the refinement of prediction models for anomalous weather patterns, energy usage in buildings and power grids is made more efficient through AI, the integration of renewable energy sources is facilitated by AI, emission being tracked by AI, and eco-friendly city planning is supported by AI. In its interaction with large climate datasets, AI is able to forecast climate changes that are far off. It also enables the efficient management of resources and the development of smart systems for the more efficient use of energy which results in the saving of both money and emissions. It makes the best use of water, agricultural and natural resources and supports the conservation of biodiversity. It enables to build climate-resilient cities, manage waste, and sustainable livable urban environments., AI acts as the mediator between the complex climate data and the rest of the world by providing the data in understandable

format. Thus it is the main driver of efficiency, emission reduction, and societal resilience against climate change.

AI technology is one of the major enablers of a robust disaster management system through features like accurate early warning systems, efficient managing of resources, and better real-time decision-making backed up by the analysis of data. The system is very versatile as it can be utilized in all stages. AI is a main weapon in the arsenal against deforestation. One of its capabilities is that it can detect patterns in satellite images and data from sensors, It helps in immediate supervision of spot areas that might be at risk, and shorten the time of the response in case of illegal logging, fire, and land-use changes. AI tools can provide valuable assistance to governments, NGOs, and conservationists in forest degradation monitoring, advancing policy, and directing reforestation initiatives more efficiently. By using AI, conservation can be done with proper data, thus it is effective in saving forests.

Table 1: Overview of AI's Role in Climate Control

Application Area	Specific Role of AI	Climate Impact
Conservation	Illegal logging, deforestation, and areas of the forest experiencing some issues such as fire can be monitored by satellite technology.	Protecting the Amazon and Indian Forests through real time carbon sink protection.
Transportation	Dynamic timing of traffic signals and route optimization can minimize the time cars are idled.	Reducing urban transport system emissions up to 60%.
Smart Buildings	By controlling HVAC systems with the use of AI and factors such as weather conditions and occupancy, buildings can be maintained at a much more comfortable temperature level.	Reducing energy used in buildings 30 – 50% of current energy usage.
Agriculture	Through irrigation and nutrient management, sensors and satellite data can be utilized to apply a high degree of	Reducing water and fertilizer waste and Increased resilience of the crops by 10 to 50%.

	precision to the amount of water and nutrients provided to crops.	
Weather & Disaster	Warning systems can provide forecasts of weather events, including cyclones, floods, and landslides, at the community level.	Reducing cyclone deaths in certain areas (e.g., India) up to 90%.
Energy Management	Demand for renewable energy sources (wind and solar) can be predicted and optimized so as to reduce reliance on fossil fuel backup power plants.	By 2030, reduce worldwide greenhouse gas emissions up to 15%.

Source: Composed by author from reports.

From table 1 it can conclude that Artificial intelligence (AI) is a key part when it comes to climate change mitigation as it provides many energy efficient ways of improving climate change controls such as improving renewable energy integration through optimization and supporting implementation of strategies to adapt to climate change. AI acts as a catalyst for climate change action through emission reduction, resource optimization and creation of circular design. There is also potential to reduce emissions from these actions.

AI is essentially revolutionizing the way we deal with pollution. One of the major changes that it brings in is the automation of real-time monitoring, exact forecasting, and regulated control of the pollutants of the air, water, and soil with the help of ultramodern sensors, drones, and machine learning algorithms. As a result, cities planned in smart way, factories getting turned into energy-saving, and emissions being cut in precise manner. It will be useful for ecological balance. AI handle complex environmental data in an excellent manner, identify the sources of pollution, and drastically enhance the decision-making quality.

Artificial Intelligence is changing the waste management scenario by route optimization for collection, computer vision-based automation of sorting, recycling efficiency improvement, and waste generation prediction. It results in cost savings, fewer emissions, less pressure on landfills, and better resource recovery for a circular economy. AI is combining IoT-based sensors, machine learning, and robotics to conceive systems that are driven by data. Artificial Intelligence is drastically changing how animal conservation is done by improving species monitoring, fighting poaching using predictive analytics and real-time alerts, making habitat management more efficient through satellite imagery analysis, and communicating with the

communities by means of easy-to-use apps. It is allowing the implementation of data-driven strategies that are not only proactive but also effective in saving biodiversity from problems like habitat loss and illegal trade.

Artificial intelligence is a major factor in making the human lifestyle possible in extreme climates by refining predictive modelling for natural disasters, managing resources efficiently in harsh conditions, and supporting the creation of resilient infrastructure and habitats. AI changes the huge problem of nature by not only facilitating the prediction but also the response and mitigation/recovery. It employs machine learning, computer vision, and Natural Language Processing on huge datasets to deliver quicker and more accurate forecasts as well as to ease the decision-making process that leads to saving lives and lessening the disaster's side effects (Lozo and Onishchenko, 2021).

Role of Artificial Intelligence in Sustainable development

AI supports a green economy by energy optimization, and environmental monitoring. It helps the implementation of the United Nations' Sustainable Development Goals by data analysis for solving the climate change, poverty and inequality problems, etc. It helps in fight against global warming as it can monitor climate patterns, track carbon emissions, predict natural disasters and monitor deforestation and animal populations. In addition, it is able to enhance smart grids, which are used to keep electricity supply and demand in balance by making renewable energy sources more efficient and by reducing energy consumption. AI technologies are very helpful in environmental protection. It can be used for air pollution monitoring. AI technologies are main drivers of automation. AI technologies bring a lot of benefits to healthcare. Diagnosis, treatment, and drug discovery will be enhanced, public health initiatives will be monitored, and outbreaks will be responded to more quickly and effectively with the help of AI technologies. It can be used for the optimization of traffic flow, buildings energy efficiency improvement and assistance of urban planners to design more resilient cities.

Table 2: table Role of Artificial Intelligence in Sustainable development

Focus Area	Application of AI	SDG Alignment
Energy	Improving energy storage, optimizing industrial energy consumption, and managing smart grids.	SDG 7 (Clean Energy)

Social/Urban	Traffic control in smart cities, personalized learning systems, and bias detection in systems.	SDG 11 (Sustainable Cities), SDG 4 (Education)
Economic	Optimization of Supply Chains, reduction of waste, improvement of efficiency to enable business growth.	SDG 8 (Economic Growth)
Health	Detecting cancer/heart disease, speeding up drug finding, and providing healthcare services to rural areas.	SDG 3 (Good Health)
Agriculture	Predictive analysis of Weather and Pests, Optimizing Irrigation, Increased Crop Yield Management.	SDG 2 (Zero Hunger)
Environmental	Real-time monitoring of Greenhouse Gas emissions, Tracking deforestation, Optimizing Renewable Energy Grids, Managing Water Consumption.	SDG 13 (Climate Action), SDG 6 (Water)

Source: Composed by author from reports.

Table 2 shown that AI supports sustainable development by using large amounts of data to improve how to use and manage the resources we have, anticipate problems that will happen in the environment and improve how efficiently all different types of industry operate (e.g. Energy, Agriculture, Urban Planning). AI supports the Climate Change agenda (e.g. Climate Action) by monitoring biodiversity (e.g. the health of ecosystems), providing social inclusion efforts (i.e. AI-supported Agriculture), and providing AI-supported healthcare diagnostic assistance (i.e. Healthcare).

Artificial intelligence is the primary engine behind economic growth. It brings significant expansion in productivity and efficiency, quickens innovation, and changes the major sectors like healthcare, finance, and manufacturing. However, its introduction is also associated with some problems such as the replacement of jobs and the need for new skills. AI is a general-purpose technology similar to electricity or the internet, which spreads its effects to industries and makes possible the innovations that are complementary to it. AI-powered automation of repetitive tasks and optimization of processes in manufacturing and services lead to a reduction

costs and waste of resources. Advanced analytics and machine learning algorithms consume huge volumes of data to generate insights that are used to make better decisions in businesses and public policy. AI shortens the research and development durations, thus new products and services can be created and tested at a much faster rate. AI models are capable of analysing real-time, non-traditional data to offer precise and quicker forecasting of economic variables which in turn permits faster reactions to economic shocks.

(1) Sustainable Farming

Artificial Intelligence transforms sustainable agriculture through precision farming, resource optimization, climate adaptation through predictive analytics, task automation, yield increase with minimal environmental harm and support of long-term ecological balance. AI-powered devices such as drones, sensors, and machine learning process the data for the most efficient interventions. AI interprets sensor data to irrigation and fertilization, thus lessening the overuse and runoff.

Computer vision helps to locate the weeds and pests so that the robotic systems can be used to apply the herbicides or pesticides in the exact area, thus drastically cutting the chemical use. Predictive models serve as a guide by forecast of weather, drought, or floods, thus helping the farmers to prepared and implement the early, sustainable solutions. Autonomous tractors and robotic harvesters are help farmers in their heavy work, to make the farm more efficient and to lower the operational costs. Drones and AI together can discover the first symptoms of a disease or shortage of nutrients, thus giving the possibility of a timely, targeted treatment before the issue becomes widespread. Machine learning is able to estimate the yields, thus helping farm management and supply chain planning.

(2) Sustainable Industrial Development

Artificial Intelligence is the key driver of a new era in eco-friendly product development. It facilitates the creation of designs with the least possible impact, quite literally foresees the environmental footprints. It understands consumer sustainability trends. AI goes through a virtually limitless number of design alternatives. It actually performs the product lifecycles simulation to be able to forecast the environmental impacts right from the start. It taps into a huge amount of data to find the best materials and at the same time. It records and assesses the life impact and the availability. AI-driven technologies make the energy side of manufacturing more efficient, and help lower the emissions. It creates less waste by the early stages of defect detection.

Machine learning technologies referred to as Artificial Intelligence are the main contributors to environmentally friendly transportation through their abilities to rationalize the flow of the traffic, make the vehicles self-controlled, maximize the logistics processes and induce the ecologically friendly traveling by revealing the data. So, the emission of carbon dioxide as well as fuel consumptions are being reduced in smart cities and logistics networks. With the help of AI-powered systems, dynamic data could gather for better road management, less congested traffic, faster on the electric vehicle charging process and public transport use could be easier and cheaper solutions. Thus, to a large extent, these systems are 'going green' and are almost self-sustaining. AI is the innovative technology, which is capable of completely transforming transportation from being one of the main sources of pollution to an intelligent and flexible system capable of balancing the environmental and economic needs and thus achieving real sustainable mobility (Hamdan, 2024).

Artificial Intelligence in Service Sector

By automating services, AI basically transforms the service sector to a more customer-focused one, and at the same time, it also raises the overall operational efficiency by using AI-powered tools. These devices simplify customer support, facilitate the running of the business, and also provide detailed data for customer-centric services. AI is an ideal technology for handling the world of routine queries as it provides agents with data and enables self-service, thus resulting in the shift of focus towards complex issues and strategic growth. AI-driven Chatbots and virtual assistants are the ones that take the burden off humans by providing instant, 24/7 support, handling FAQs, and delegating complicated issues, whereas sentiment analysis helps in determining the customer's emotional state. AI plays an important role in fraud detection, credit scoring, risk assessment, and the provision of automated investment advice.

Table 3: Key Roles of AI in the Service Sector

Service Sub-Sector	AI Application Role	Key Benefits & Impact
Marketing	Sentiment Analysis & Data Analytics	Analyzing customer sentiment via social media, targeted advertising, behavioral prediction.
IT Services (ITSM)	Automated Ticket Management	Auto-categorization, self-healing systems, increased agent productivity.

Healthcare Services	AI Diagnostics & Telemedicine	Faster disease detection, AI-powered triage, personalized treatment plans, expanded rural access.
Retail & E-commerce	Recommendation Engines	Personalized product suggestions, demand forecasting, reduced stockouts, optimized inventory.
Banking & Fintech	Robo-advisors & Fraud Detection	Real-time risk analysis, personalized investment plans, automated credit scoring.
Hospitality & Travel	Dynamic Pricing & Service Robots	12% revenue increase (dynamic pricing), 30% reduction in wait times (concierge robots), contactless services.
Customer Service	AI Chatbots & Virtual Assistants (NLP)	24/7 support, handling up to 85% of routine inquiries, reduced wait times, higher satisfaction.

Source: Composed by author from reports.

Table 3 shown that AI is a key tool for creating value within the services industry. Examples of this include using AI to automate repetitive activities, creating customized services for clients as well as assisting in proactive decision-making. One way that AI generally improves efficiency within businesses; however, the addition of AI also contributes to the overall value added when compared to if AI were not present at all, because of the numerous ways that AI increases human performance/willingness to work.

AI changes the tourism and hotel industry in many ways like through Chatbots interactions and customized suggestions, complete automation of reservation tasks, revenue maximization with dynamic pricing, and marketing improvement through data analysis. AI is also making the back of the house operations more efficient in areas like housekeeping and security. It is a game-changer for the telecom industry as it helps in network optimization. These measures lead to a significant enhancement in operations, customer experience, and revenue through the use of real-time analytics and automation (Das, 2023).

Conclusion

Artificial Intelligence is a key element that essentially enables sustainable development as it can make resource use more efficient, speed up the process of energy generation from clean sources, provide better climate forecasting, and increase the aggregate efficiency of different sectors. All these pave the way for achieving the UN Sustainable Development Goals like those of energy that is affordable and clean, water and sanitation, and health/education of quality. Still, the advantages of AI are accompanied by the requirement to resolve problems such as bias and the necessity to secure that there is equitable access in order not to deepen the global divides further. The principal characteristics of AI are the features that set the stage for more intelligent solutions in fields as smart grids, precision agriculture, and early disaster warnings, thus making development more efficient, less wasteful, and more resilient.

Artificial Intelligence is a major factor in making the environment safer. It can check pollution by analysing the data collected through various means. It can forecast natural disasters, and can trace the movement of animals, and also track whether the rules made for the environment are being followed or not by processing large datasets. All this is done with the help of satellite images, sensors, and drones that not only give us the news of a disaster earlier but also allow to manage resources in a well-organized manner. AI scans satellite images and sensor readings to detect in real-time deforestation, illegal dumping, methane leaks, and changes in the habitat. Predictive AI models mapping out the onset of floods, droughts, and hurricanes, thus giving the opportunity for evacuations and saving the necessary resources. AI enables the monitoring of animals through camera traps and drones, the identification of the most important habitats, and supports the return of forests. Machine learning gives the capability to environmental protection agencies to find locations that are more likely to violate the rules so that they direct their inspection efforts there. It is great energy-saving, water-management, and agricultural-efficiency enhancing tool.

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