

An Application of Artificial Intelligence as a Tool for Climate Change: A Review

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Abstract- Climate change is a significant threat, already damaging urban and natural systems and causing global economic losses exceeding \$500 billion. These problems could be partly addressed with artificial intelligence, which leverages internet resources to offer quick suggestions based on accurate climate predictions. In this study, the applications of AI in reducing the negative effects of climate change, focusing on energy efficiency, carbon sequestration and storage, weather and renewable energy forecasting, grid management, building design, transportation, precision agriculture, industrial processes, reducing deforestation, and building resilient cities was reviewed. It is observed that improving energy efficiency can greatly reduce climate change impacts. Smart manufacturing can cut energy use, waste, and carbon emissions by 30–50%, especially in buildings. About 80% of the global natural gas industry uses AI to improve the accuracy and reliability of weather forecasts. Combining smart grids with AI can optimize power system efficiency, leading to a 5–10% reduction in electricity bills. Intelligent transportation systems can lower CO₂ emissions by around 70%. Consequently, managing natural resources and designing resilient cities with AI can further support sustainability.

Keywords: *Climate Change, Environment, Energy, Artificial Intelligence, Emissions, Greenhouse.*

I. INTRODUCTION

Carbon dioxide emissions from industrial production are driving climate change, which is currently one of humanity's most severe environmental problems. Sea level rise, the increasing frequency of natural disasters, the reduction of crop production capacity, and the loss of biodiversity are closely related to climate change (Shivanna 2022). The widespread use on fossil fuels in manufacturing processes is primarily responsible for these widespread carbon emissions (Yue and Gao 2018). Therefore, improving energy efficiency, developing green energy, and conserving energy are crucial steps to combat climate

change. Transitioning from a society reliant on fossil fuels to one powered by electricity can positively influence ecological protection (Fang et al. 2023; Farghali et al. 2022).

Artificial intelligence can enable automated discovery, distribution, and transmission operations through deep neural networks, significantly lowering energy use (Farghali et al. 2023). As the severity of climate change issues grows, artificial intelligence is often seen as a potential solution to address these challenges. AI technology has the ability to seamlessly integrate expanding opportunities from the internet of things (IoT) and renewable energy within the energy sector. It can play a vital role in energy supply, optimizing decision-making processes, and autonomous software control, making it a key driver in the energy industry. Currently, the review of artificial intelligence and climate change mainly concentrates on the technical aspects of AI, overlooking how artificial intelligence can be applied across various fields affected by climate change. Additionally, the future of artificial intelligence's sustainable development in the context of climate change has also been explored.

As a refuge for modern people, cities house over half of the world's population, offering convenience for human development but also consuming a large amount of energy. Greenhouse gases emitted by cities make up three-quarters of total emissions, making urban areas a key focus for tackling global climate change. The impacts of climate change on cities and the relationship between it and sustainable urban development are complex (Mi et al. 2019). As climate issues become more severe, cities face growing uncertainties and unknown risks. Besides the urgent need to address issues like energy shortages, air pollution, and waste management, people are

increasingly interested in how resilient communities are at handling disasters (Zhu et al. 2019). Resilient cities are a new urban governance concept that has emerged after smart cities, aimed at enhancing a city's ability to withstand disasters and recover quickly in emergencies. Zhu et al. (2020) explored the similarities and differences between smart and resilient cities. Artificial intelligence can be applied to various aspects of waste management, such as waste-to-energy, waste sorting, waste generation models, plastic pyrolysis, logistics, disposal, and resource recovery. It can also help reduce illegal dumping and improve public health. Implementing AI in waste logistics can cut transportation distances by up to 35%, reduce costs by up to 14.5%, and save up to 25.20% of time.

1.1 Climate Change and Artificial Intelligence
Artificial intelligence (AI) acts as a powerful, dual-edged tool for climate change: it accelerates emissions reduction via optimized energy systems and precise climate modeling, while simultaneously increasing energy demand through data center infrastructure. AI improves renewable energy forecasting, enables smart grids, and monitors environmental changes in real-time, but its high water and electricity usage presents a significant environmental footprint

Climate change is a phenomenon that ought to occur naturally. Still, human activities have tripled the amount of greenhouse gases (GHGs) released into the atmosphere, rapidly increasing temperature shifts and weather patterns. The impact of climate change is evident in its footprint on different sectors and human engagements. A significant problem fueling climate change is ignorance, as people are unaware that some of their daily activities increase climate change.

II. ARTIFICIAL INTELLIGENCE'S ROLE IN ADDRESSING CLIMATE CHANGE

Climate change requires a quick global response that includes strategies, tools and laws. AI appears to be especially well-suited to answering issues related to climate change, a field beset by significant data constraints. The expansion of data-driven business models and the use of AI in resource mining, energy consumption and product obsolescence cycles are a

few examples of the material and immaterial ways that AI technologies contribute significantly to extractive industries

GHGs and their sources have been monitored for decades, but filtering, evaluating, and using the data effectively has been challenging. Hence, AI's ability to process vast datasets and extract actionable insights can transform our understanding of climate change and how we mitigate its impacts. Artificial intelligence has tremendous potential for climatic action through optimizing renewable energy, environmental monitoring and protection, advanced climate modelling and prediction, and reducing carbon footprints across industries

The application of artificial intelligence raises ethical and legal issues. AI models can be biased, potentially leading to unequal benefits. The lack of clear policies around AI decision-making can lead to issues in liability when AI models fail especially in critical areas like disaster response or public safety. Therefore, AI governance in climate change should promote transparency, accountability, fairness, ethical AI development and deployment to prevent misuse of data to ensure that AI-driven climate action is equitable and responsible. AI can contribute to climate change mitigation in many ways, in particular through energy optimization, climate modelling, and sustainable agriculture.

2.1 Energy optimization and renewable energy integration.

AI facilitates demand-side management, predictive maintenance, and grid optimization. Machine learning algorithms forecast energy demand and renewable energy output, enhancing the integration of solar and wind resources. Reinforcement learning optimizes energy storage and distribution systems. AI-driven smart grids minimize energy wastage, with studies indicating up to 15 percent reduction in energy efficiency in optimized systems.¹⁴By improving energy efficiency and accelerating the transition to renewables, AI technology can help reduce greenhouse gas emissions and enhance the economic viability of renewable energy through cost-effective load balancing.

2.2 Climate modelling and prediction
 AI deep-learning techniques enhance the resolution and accuracy of climate models. Neural networks process vast datasets from satellites, sensors, and historical records to predict climate trends, extreme weather events, and long-term shifts, helping to reduce economic and human losses. Sophisticated models can compare multiple projections and scenarios and refine the predictive capabilities and granularity of climate models – providing precise projections and enabling early warning systems for extreme weather. For instance, AI-improved models have enhanced hurricane path predictions, decreasing evacuation costs.

2.3 Disaster response and risk assessment
 AI can integrate computer vision and natural language processing to analyse real-time data from drones, social media, and satellite imagery. Predictive models assess risks of floods, wildfires, and droughts, while AI-powered chatbots streamline disaster communication and resource distribution. These applications can reduce vulnerability in high-risk regions, for example through early wildfire-detection systems that achieve up to 90 percent accuracy in identifying ignition points based on explainable machine-learning models. In doing so, AI technologies can help optimise humanitarian aid delivery and support more rapid, resilient recovery.

2.4 Sustainable agriculture and land use
 AI optimizes crop yields through precision agriculture, utilizing IoT sensors and machine learning to monitor soil health, water usage, and pest activity. Computer vision identifies deforestation and land degradation, while predictive analytics guide reforestation efforts. For instance, AI is used to improve forest monitoring and carbon verification, aiding governments in deforestation risk assessment. A case study from Australia showcased the effectiveness of intelligent irrigation systems, which led to a 35% decrease in water losses during rice cultivation through optimized canal management. Thus, AI could promote food security and reduce land-based emissions and enhance adaptive capacity in agriculture-dependent communities.

2.5 Carbon capture and emissions monitoring
 AI optimizes carbon capture and storage processes by modelling geological reservoirs and predicting capture efficiency. Machine learning tracks emissions through satellite data and industrial sensors, identifying leakage and monitoring compliance with emissions regulations in real time. AI-enhanced monitoring systems have detected methane leaks with up to 95 percent accuracy.

Table 1: Summary of AI applications in climate change (Zhang et al, 2024)

Domain	AI techniques	Key applications	Benefits
Energy optimization	Machine learning, reinforcement learning	Smart grids, renewable energy integration, forecasting	Reduces emissions, enhances energy efficiency, supports renewable energy adoption
Climate modelling	Deep Learning, generative adversarial networks	Climate trend prediction, extreme weather forecasting	Informs policy, enables early warnings, optimizes adaptation strategies
Disaster response	Computer vision, natural language processing	Risk assessment, real-time disaster monitoring	Enhances resilience, reduces losses, optimizes aid delivery
Sustainable agriculture	IoT, machine learning, computer vision	Precision agriculture, deforestation monitoring	Promotes food security, reduces emissions, supports sustainable land use
Carbon capture & monitoring	Machine learning, predictive analytics	CCS optimization, emissions tracking	Accelerates decarbonization, ensures regulatory compliance, mitigates greenhouse gases

III. CONCLUSION

This study reviews the application of Artificial Intelligence as a tool for climate change. The integration of Artificial Intelligence into climate action strategies represents a pivotal advancement in fighting against global climate change. As the global economy and population grow, energy demand has skyrocketed. Traditional energy production methods have proven harmful to the environment, releasing excessive emissions of dangerous gases that contribute to global warming and cause extreme weather events such as tornadoes, hail, and thunderstorms, which significantly damage human habitats and threaten lives and property. Artificial intelligence technology is emerging as a new tool in the energy industry, offering a promising approach to combat climate change, address these issues, and lessen their harmful environmental impacts. AI helps mitigate climate change in the energy sector by forecasting energy demand and improving efficiency to reduce pollution. Many countries are using AI to boost energy efficiency and decrease waste.

Furthermore, artificial intelligence has advanced weather prediction technology, allowing for more precise weather forecasting and modeling to better prepare for and respond to extreme weather events through early warning systems. AI also provides a deeper understanding of natural factors such as climate and geography, aiding in the selection of ideal sites for renewable energy. It can forecast renewable energy output, modify grid supply, and ensure a steady electricity flow. Additionally, AI can improve residential architecture by determining the best house orientation and window placement, reducing energy use and improving living conditions. Tackling traffic emissions is also crucial, and AI can enhance bus systems by analyzing large data sets to develop neural networks that optimize routes, vehicle rounds, and passenger flow.

Artificial intelligence is crucial for reducing the environmental impact of agrochemical use. Precision agriculture uses artificial intelligence to gather and analyze environmental data related to crop growth, helping farmers make informed decisions, cut chemical use, and boost yields. In the industrial

sector, traditional hardware sensors often fail to provide decision-makers with relevant information.

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