

ROLE OF ARTIFICIAL INTELLIGENCE IN MONITORING CLIMATE CHANGE

Abstract

In the era of advance technology and digitalization, every sector has revolutionized rapidly specially, with the introduction of Artificial Intelligence (AI) and Machine Learning (ML), there are various changes that are introduced globally. Focusing on the environment, AI is beneficial in various aspects such as forecasting weather, analysing satellite imagery and many more. AI plays a significant role in monitoring and identifying the issues related to environment and climate change. It helps in predicting the future certainties, for which the appropriate measures can be taken at appropriate time. Undoubtedly, AI has a significant role in managing and identifying the issues pertaining to climate change. It also enables better accuracy in climate modelling, optimizing resource management and improving environmental monitoring. Most importantly, AI may also help in predicting extreme climate and weather conditions so that we, as human beings can take precautions to save ourselves. In addition to this, AI also helps in reducing carbon footprints and enhancing the efficiency of renewable energy systems. This is not the only role of AI in monitoring climate change. This research paper focuses on the benefits of AI in addressing environmental issues and climate change however, the futuristic criticism of AI is also discussed in the present paper. The study is concluded by providing the suggestions based on the current research.

Keywords: Climate Change, Artificial Intelligence, Environmental degradation, Carbon footprint, Weather forecasting

1. Introduction

In the past, weather forecast was not driven by modern technologies and advance techniques. The forecasting was dependent purely on observation and experience. People used to observe animal behaviours, colour of the sky, speed and direction of the wind, to make possible predictions. Also, sometimes local knowledge was the source which passed through the generations. With the passage of time, technology advanced and certain new gadgets and instruments were introduced to ascertain the future weather and climatic conditions. It includes the use of barometers, thermometers and radios to collect data. The information was then transmitted through telegraphs. The ancient and traditional methods of weather predictions were sometimes accurate but not every time. Only some of the clues could be gathered by observing these climatic conditions. Other observations were drawn by observing the animal behaviours as it is believed that they can predict and react according to the bad future predictions and omens. For example, birds fly low when a storm is about to come along with heavy rain. The movement of celestial bodies was also considered as a major aspect for the observing the weather by ancient civilizations like Egyptians. Then, after some technological advancements, an instrument known as 'Barometer' was introduced to measure atmospheric pressure. Another invention was 'Telegraph' which was used to transmit weather data from various locations which helped to forecast and draw a pattern of overall weather. Another invention was of 'Pocket Weather Forecasters' which were used to note the barometric readings and the direction of the wind was also ascertained by this. It became famous in 1900s when the technological advancements were lagging behind. Various other measures were adopted for predicting the weather like meteorologists began using balloons and kites to collect data on the upper atmosphere. So, during the ancient times, the predictions were not totally accurate, it was based on certain myths and traditional knowledge of the people. Slowly and gradually, as we moved from ancient to modern times, the technology began to grow. Various new inventions were introduced in many different sectors. Environment and climate change are the two vital aspects globally which are recognized internationally. Weather and climate change need to be predicted so that the future calamities can be minimized. Although, it is true that these are the natural forces which are not under the control of human beings but still, some mitigating measures can be adopted to minimize the negative impacts of extreme weather conditions and climatic factors. These factors are also addressed in the Conference of Parties (COPs), the latest of which was held in Baku (COP-29) and is a new global

climate finance goal, a renewed focus on adaptation and resilience, and progress on operationalizing carbon markets. So, climate change is not only a nationally known issue, rather it is an internationally recognized issue which needs to be addressed. The environment is deteriorating day-by-day due to rapid industrialization and urbanization. Majority of anthropogenic activities are responsible for climate change and environmental degradation. These activities include burning of fossil fuels, vehicular exhaust, agriculture and livestock, deforestation, industrial waste and many more. We cannot consider these factors as exhaustive as there are various other factors which are deteriorating the environment which results into climate change. One of the major impacts is global warming and increase in overall temperature of the earth, melting of glaciers and polar ice.

2. Technological advancements in addressing the factors affecting climate change

Technology is taking a leap day-by-day. With the introduction of AI, rapid technological changes are taking place globally in almost every sector. While we talk about weather forecast, environmental issues and climate change, AI has its own significance. So, technological advancements are important to address climate change along with providing appropriate solutions for reducing its causes and adapting to its effects. Some of the common technologies which can be used for mitigation are the use of renewable energy sources like solar energy, wind energy, electric automobiles and many more. In addition to this, carbon capture, green hydrogen and digital technologies holds a good position in contributing towards mitigation and adaptation. It is a major challenge for our mother earth, mandating the new approaches to adaptation. A recent report by the World Economic Forum, titled “Innovation and Adaptation in the Climate Crisis,” highlights five key technologies that are pivotal in our fight against climate change among which one is Artificial Intelligence (AI) as it is capable of revolutionizing strategies related to climate adaptation. It can process a massive amount of data at a high speed, AI is capable of predicting the patterns in climate and optimizing resource allocation. The climate models can also be developed with the use of AI. Another technological advancement to check the weather conditions is the use of ‘Drones’. It is also one of the most important inventions which is useful in various ways. It is an excellent tool for climate adaptation efforts. Drones can be used to assess the upcoming disaster so that, an appropriate step can be taking on time. Drones are capable of reaching the remote areas also where human beings cannot reach. We can check the condition in those areas as well.

The technologies like supercomputers and cloud computing are also playing a significant role in ascertaining complex climate scenarios.

3. Role of Artificial Intelligence in monitoring climate change

There are various technological advancements and internet technologies which are playing their role significantly in every sector. Focussing on climate change and the environment, AI has its own pivotal role and significance. AI is not an invention, rather it is a revolution introduced to the world. In one of the studies published in the year 2023, showed how AI weather forecasting tools, developed by Huawei Cloud, could predict weather with more accuracy than the industry gold-standard weather simulation system – the High-Resolution Forecast (HRES), produced by the European Centre for Medium-Range Weather Forecasts (ECMWF). Artificial Intelligence and its subset, machine learning, have introduced new methodologies for improving weather prediction. Unlike traditional models that rely solely on physical equations, AI models can identify patterns and correlations in data that might be overlooked by human analysts. Another technique used for weather forecasting is neural networks, which are made in such a way that they can copy the human brain's ability to catch details from the data. Its more advanced form is deep learning which can analyse many layers of data, which makes it effective to predict complex tasks including weather predictions. AI processes huge amount of meteorological data fast as compared to human predictions. Most of the times, this analyses is accurate. Example of this is, AI models which can analyse satellite imagery, sensor data and weather patterns to make more accurate weather forecasts.¹

4. Role of AI in Climate Change Mitigation

AI is playing a pivotal role in almost every sector making it very popular and advance day-by-day. One of the major sources of greenhouse emissions which results into global warming and climate change is energy sector. The climate change mitigation is necessary with respect to this sector. Real-time data from smart grids may be used to optimise energy distribution, reduce waste, and increase the share of renewable energy sources in the energy mix using advanced algorithms. Furthermore, predictive maintenance powered by AI can enhance the reliability of wind turbines and solar panels, ensuring consistent energy production and minimal downtime.²

¹ International Renewable Energy Agency, *Innovation Landscape Brief: Artificial Intelligence and Renewable Energy* (IRENA 2019).

² Mia Lucas, *The Role of AI in Climate Change Mitigation and Environmental Monitoring*, ResearchGate (2023), <https://www.researchgate.net/>

Another important role played by AI is reducing carbon emissions. There are some Machine learning models helps to interpret the data from different sources which includes industrial sensors to keep a check on various activities such as deforestation, transportation and industrial sensors.

AI plays a pivotal role in monitoring and reducing carbon emissions. Machine learning models can analyze data from various sources, including satellite imagery and industrial sensors, to track emissions from deforestation, transportation, and industrial facilities. These insights enable policymakers to formulate effective emission reduction strategies. Additionally, AI-driven carbon capture technologies hold promises for sequestering and utilizing carbon dioxide, contributing to a circular carbon economy.

One of the most important sector where AI contributes to mitigation is in the energy sector. The transition from fossil fuels to renewable energy sources such as solar and wind is central to climate action. However, renewable energy systems are inherently variable due to changing weather conditions. AI helps address this variability by forecasting energy production and demand with high precision. Machine learning algorithms analyze historical weather data, consumption patterns, and grid performance to optimize energy distribution. AI-powered smart grids can automatically balance supply and demand, reduce transmission losses, and prevent blackouts. This improves the reliability of renewable energy systems and accelerates the transition toward low-carbon energy infrastructures.

5. Conclusion and Suggestions

Artificial Intelligence (AI) has emerged as one of the most transformative tools in addressing the complex and urgent challenge of climate change. As climate change accelerates and its impacts become increasingly evident through rising global temperatures, melting glaciers, extreme weather events, biodiversity loss, and sea-level rise, the need for accurate monitoring, prediction, and timely intervention has never been greater. Traditional climate monitoring approaches, while useful, are frequently constrained by data size, analytical speed, and forecast capacity. AI has dramatically improved the capacity to monitor climate change by allowing for quick processing of massive quantities of environmental data, pattern recognition, forecasting accuracy, and evidence-based policy choices. AI has revolutionized climate monitoring from a reactive to a proactive approach by combining machine learning, deep learning, satellite imagery analysis, and predictive modeling. This shift is critical for governments, researchers,

and organizations to effectively adapt to environmental changes and reduce their long-term effects.

One of the most significant role of AI lies in its ability to analyze large volumes of climate data collected from satellites, sensors, weather stations, and ocean monitoring systems. These datasets are often too complex and extensive for traditional analytical methods. AI systems can efficiently process this data to detect trends such as temperature changes, deforestation rates, glacier retreat, and ocean warming. For example, AI-powered satellite image analysis allows scientists to monitor deforestation in real time, identify illegal logging activities, and assess environmental degradation. Similarly, AI models help track polar ice melt, changes in vegetation cover, and shifts in atmospheric conditions. This enhanced monitoring capability provides accurate and timely information, which is essential for understanding the progression of climate change and taking corrective action. In addition to monitoring, AI plays a critical role in climate prediction and early warning systems. Climate systems are inherently complex and influenced by numerous interacting variables. AI models can analyse historical and real-time data to predict future climate patterns, including extreme weather events such as hurricanes, floods, droughts, and heatwaves. These predictive capabilities enable early warnings, which help governments and communities prepare in advance, reduce loss of life, and minimize economic damage. AI-driven forecasting also improves disaster management and resilience planning by providing more accurate and localized predictions. This demonstrates that AI is not only a monitoring tool but also a preventive and protective mechanism in climate governance. AI also contributes significantly to improving environmental efficiency and sustainability. It supports monitoring of greenhouse gas emissions, optimization of energy consumption, and enhancement of renewable energy systems. For instance, AI can monitor emissions from industries, identify inefficiencies, and suggest corrective measures. It also improves the efficiency of renewable energy sources such as solar and wind by predicting weather conditions and optimizing energy generation and distribution. Smart grids powered by AI can balance energy demand and supply, reducing waste and promoting sustainable energy use. These applications demonstrate how AI supports both climate monitoring and climate mitigation. Despite its immense potential, the use of AI in climate monitoring also presents certain challenges and limitations. One major concern is the availability and quality of data. AI systems rely heavily on accurate, comprehensive, and unbiased data. In many developing countries, climate monitoring infrastructure is limited, resulting in data gaps that reduce the effectiveness of AI models. Another concern is the high

energy consumption associated with training large AI models, which may contribute to carbon emissions if not powered by renewable energy sources. Additionally, there are issues related to technological inequality, as developed countries have greater access to AI infrastructure and expertise, while developing countries may lack the necessary resources. This disparity can widen the global gap in climate monitoring and response capabilities. Ethical concerns also arise regarding transparency, accountability, and the reliability of AI predictions, especially when used for policy decisions.

In conclusion, AI has revolutionized the monitoring and management of climate change by providing faster, more accurate, and predictive insights into environmental conditions. It enhances data analysis, improves forecasting, supports sustainable resource management, and strengthens climate resilience. AI enables policymakers, scientists, and organizations to make informed decisions and implement effective climate mitigation and adaptation strategies. However, its effectiveness depends on the availability of quality data, technological infrastructure, and responsible implementation. Therefore, while AI is not a standalone solution, it is an indispensable tool that complements human expertise and scientific research in addressing climate change.

To maximize the benefits of AI in climate monitoring, several suggestions must be considered. First, governments and international organizations should invest in strengthening climate data infrastructure, particularly in developing countries. This includes expanding satellite monitoring systems, installing environmental sensors, and improving data collection networks. Reliable data is essential for training accurate AI models. Second, there should be increased collaboration between governments, research institutions, private technology companies, and environmental organizations. Such collaboration can facilitate data sharing, technological innovation, and capacity building. Third, efforts should be made to ensure that AI systems used for climate monitoring are transparent, accountable, and ethically designed. Clear standards and regulatory frameworks should be established to ensure responsible use of AI.³

Fourth, sustainable AI practices should be promoted to minimize the environmental impact of AI itself. This includes using energy-efficient algorithms, optimizing computing resources, and powering AI systems with renewable energy sources. Fifth, capacity-building initiatives should

³ United Nations Environment Programme, *Artificial Intelligence and Climate Change: Opportunities and Challenges* (UNEP 2021).

be implemented to train researchers, policymakers, and environmental professionals in the use of AI tools. Education and training will help ensure that AI technologies are used effectively and responsibly. Sixth, governments should integrate AI-based climate monitoring into national climate policies and action plans. AI-driven insights should be used to support evidence-based policymaking and long-term climate planning.

Furthermore, AI should be used to enhance public awareness and community engagement. AI-powered platforms can provide accessible information about climate risks, enabling individuals and communities to take preventive measures. Public participation is essential for effective climate action. Finally, international cooperation is crucial in ensuring equitable access to AI technologies for climate monitoring. Climate change is a global problem that requires collective action. Developed countries should support developing nations through funding, technology transfer, and knowledge sharing.

In summary, AI offers unprecedented opportunities to improve climate monitoring, prediction, and response. Its ability to analyze complex data, provide accurate forecasts, and support sustainable practices makes it a powerful tool in combating climate change. However, its successful implementation requires investment, collaboration, ethical governance, and global cooperation. By adopting responsible and inclusive AI strategies, the international community can strengthen climate monitoring systems and enhance efforts to protect the environment for present and future generations.

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