

CHAPTER II

AI IMPACT ON CLIMATE CHANGE

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1. Introduction

Climate change refers to a worldwide phenomenon that has a substantial impact on the planet's normal climatic conditions, such as precipitation, wind and temperature, primarily caused by human actions. Many individuals are still unclear about climate change's true effects, and their daily activities considerably increase the risk. In this century, climate change is considered a pressing issue, and rapid action is needed to mitigate its effects (IPCC, 2018). Climate change has been causing widespread environmental, economic and social changes worldwide, especially in the last few decades. These changes include a range of phenomena, such as increased greenhouse gas emissions, rising global temperatures and the degradation of ecosystems. Climate change effects can be seen more clearly in terms of both the frequency and strength of fires, storms, flooding, lack of drains, and dryness (Field et al., 2012).

Humanity depends on agriculture and natural resources, which are a part of the global ecosystem. Global ecosystems are affected by climate change and, as a result, the global resources and agriculture. As determined by IPCC (2018), in the coming 30 years catastrophic results will be seen if the world will not reduce the global greenhouse gas (GHG). Unlikely, the GHG is rising year by year IPCC (2018).

Global warming is the primary cause of climate change resulting from the greenhouse effect. If GHG emissions from normal human activity are not addressed, there will be a continuous rise in global temperature. Industrial revolution and rapid urbanization increased energy production and consumption in the form of fossil fuels, which are major factors contributing to climate change risk. Climate change is posing an increasing threat to earth species, such

as the planet's flora, fauna, and humans. It also has the potential to devastate the economic resources and food chain. The developed countries will have less of an impact in contrast to under-developed and developing countries. As the impacts of climate change become extreme, mitigation and adaptation on the existing possible literature will possibly be useless and ineffective. As a result, it is critical to come up with advanced technologies that monitor, assess, mitigate, and predict the effects of climate change.

Increasing global temperatures make extreme weather events more frequent. Increasing air temperatures increase the severity of droughts, floods and heat waves. The World Meteorological Organization (WMO, 2020) stated that global temperatures have increased by 1.1°C and that this increase increases the frequency of extreme weather events. The melting of glaciers and warming of oceans as a consequence of climate change lead to rising sea levels. This sea level rise poses major threats to coastal areas. The warming of oceans causes the expansion of seawater, which contributes to rising sea levels (Church et al., 2013). Climate change poses serious threats to natural habitats. Increasing temperatures may cause the habitats of some plant and animal species to shrink. Research states that the habitats of animal species living in polar regions are in danger of extinction (Gelpke et al., 2019).

A global fight against climate change can be seen as a need. This fight can be possible with some strategies like reducing GHG emissions, increasing renewable energy sources and encouraging sustainable agricultural methods. Using renewable energy sources as green investments instead of fossil fuels is of great importance. The IEA (International Energy Agency) stated in its 2020 report that investments in renewable energy have increased worldwide and that such energies are effective in reducing GHG (IEA, 2020). Forests are natural resources that store large amounts of carbon dioxide. Therefore, preventing deforestation and reforestation of forests is an important step in combating climate change. Sustainable production methods should be encouraged in agriculture (FAO, 2018). Solutions such as using technologies that will increase energy efficiency in buildings and the widespread use of electric vehicles in transportation play an important role in combating climate change (Stern, 2007).

In the last decades, technological progress has used a lot of tools, and the most robust tool was machine learning (ML) (Dietterich, 2009). ML applications play an important role in many fields including but not limited to intelligent transportation systems (ITS) (Salemdeeb & Erturk, 2020), healthcare, electric fault detection (Elmasry & Wadi, 2022), photovoltaic (PV) system efficiency (Wadi et al., 2024), and energy production estimation (Salemdeeb & Wadi, 2024; Wadi et al., 2024), object detection and recognition (Salemdeeb & Erturk,

2021), smart grids (Jouda et al., 2024), air quality (Jouda & Wadi, 2024), high pressure (Sid Amer et al., 2023), and particularly in mitigating climate change (De-Arteaga et al., 2018).

With the effective use of learning algorithms, sensing devices and data, Artificial Intelligence (AI) is a disruptive paradigm which has the ability to better mitigate, analyze and anticipate climate change danger (Berendt, 2019). Moreover, as a powerful tool of AI (Salemdaab & Erturk, 2021), ML perform classification, estimation, and prediction to help reduce the effects of climate change (Hager et al., 2019).

AI can help to create a more visible understanding of the effects of climate change in different geographical places. Models for environmental monitoring and weather forecasting can help in this mission. Particularly, AI can predict severe weather conditions, precipitation, weather events and other socioeconomic consequences of climate change as well as analyze climatic data. Furthermore, it identifies the true source of carbon emissions and makes countless other useful contributions, such as illustrating the effects of extreme weather and improving climate projections. This allows policymakers to be alerted of storms, species extinction, rising sea levels, habitat degradation, temperature changes and natural disasters. Therefore, climate informatics utilizing AI paradigms became the main focus of the specialists and the research community. Further research is required to achieve the full advantage of AI for climate change mitigation.

However, ML as a subfield of AI still needs to be identified to know which are the best ML tools to be used in climate change mitigation and how they can facilitate climate issues detection and change prediction.

This chapter aims to report the positive and negative impacts of AI on climate change, where ML can be applied with high impact in the fight against climate change through either effective engineering or innovative research. The primary contributions of our chapter are comparing the positive and negative impacts of AI on climate change, total AI impact evaluation, and recommendations for minimizing the negative impacts and maximizing the positive impacts.

The chapter structure is as follows:

- Section two gives a background about climate change and AI,
- Section three presents the relationship between AI and GHG,
- Section four explains the positive impacts of AI on climate change,
- Section five explains the negative impacts of AI on climate change,

- Section six provides the total evaluation of AI impacts on climate change and recommendations,
- Section seven summarizes the chapter's conclusions.

2. Climate Change and AI

Climate change is among the most important recent concerns, and it necessitates immediate action from different tools and communities (IPCC, 2018). AI is a tool that has the potential to accelerate climate action. For example, improving building heating/cooling systems, detecting deforestation using satellite data and predicting solar power generation (Rolnick et al., 2019). Moreover, AI has been used in ways that prevent climate action through systemic and direct effects. now, AI is a broad technology with a wide range of applications in society (Dobbe & Whittaker, 2019). According to experts in AI, machine learning (AI technique) can be an effective tool for helping society in adapting to a changing environment and lowering GHG emissions. Machine learning can fill the current gaps related to high-impact challenges determined by disaster management and smart grids. The machine learning community is encouraged to participate in the global effort against climate change (Rolnick et al., 2019).

At the twenty-sixth Conference of the Parties (COP26) climate summit, a new AI ethos was presented and reflected in a report published by the Global Partnership on AI (UNFCCC, 2021). According to activists, researchers and 15 co-authors, AI can still significantly help with mitigation, adaptation and prediction in many ways. On the same day as the COP26 report, visualization platform This Climate Does Not Exist was released. This project, created by a group of dedicated young researchers, reveals how AI may be used to make climate change more emotional, memorable and personal for the general public. For any street address, deepfakes provide comparably realistic pictures of wildfires and floods using a deep learning algorithm that creates hyperrealistic fabricated videos by swapping audio and visual data (Dimock, 2022).

AI can indirectly cause a problem for the environment. Cloud service providers operate large-scale data centres, and with technological progress, these data centres use AI, which may heavily harm the environment. These centres are built from electronic chips housed in boards, which depend on an astonishing amount of grist. For example, 800 kg of raw materials are required to make a two kg computer. Additionally, to operate AI, rare earth elements were needed to produce AI microchips, and these elements are usually extracted in environmentally destructive processes (UNEP and ISC, 2024).

Another problem to be considered is the electronic waste of those data centres, in which some dangerous substances such as lead, and mercury exist in these wastes. On the other hand of this problem, the data centres use water to cool their electrical components during both the construction and operating phases (Li et al., 2025). AI-related infrastructure consumes six times more water than Denmark. This is seen as a problem because already $\frac{1}{4}$ of the world's population is suffering from sanitation and clean water (Li et al., 2025).

Finally, high energy is needed to power the AI electronic devices, which, approximately all the world, burn fossil fuels, and consequently produce GHG that leads to global warming. For more clarification, the Google search consumes ten times less electricity than ChatGPT can consume (IEA, 2024). Furthermore, while the number of data centres in 2012 was half a million centres, in 2024, it was eight million centres. In the earth, the technological demands for data centers are expected to keep growing.

3. AI and GHG Emissions

Capgemini Research Institute (2022) conducted more than 40 industry experts and executives' interviews and a poll of 300 climate change and AI specialists and 800 business executives. There is an 11% increase in power efficiency and a 13% decrease in GHG emissions, which AI-enabled applications have helped organizations achieve in the last two years. Furthermore, there is an 11% to 45% accomplishment of the Paris Agreement's "Economic Emission Intensity" targets, which AI-enabled applications will assist organizations to achieve in 2030, where it varies between sectors on how much they adopt AI. Just 13 per cent out of the 67 per cent of organizations that prioritize climate action have managed to connect their climate strategy with AI skills and scaling solutions (Capgemini Research Institute, 2022).

Generative Pre-trained Transformer 3 (GPT-3) has the ability to output human-like writing by using deep learning-based autoregressive language models (Taddeo et al., 2021). The authors reported that GPT-3 would create 223,920 kg of CO₂ during a single training run. There is approximately 4,600 kg of CO₂ yearly that an average car generates in the United States; thus, in a year, a single GPT-3 training run may produce up to 49 cars. Moreover, 1.4 per cent of global GHG emissions are attributed to communication and information technologies, which AI now accounts for. A range from approximately one megaton to up to 600 megatons of CO₂ emissions, where the carbon footprint of different healthcare systems around the world has been produced (Bloomfield et al., 2021). The carbon footprint of AI will rapidly expand according to current

AI research trends. In order to report and analyze the influence of AI research initiatives on the environment in a systematic way, the AI research field is required to develop metrics and standards. AI has the potential to be a strong tool for developing effective climate emergency responses if utilized correctly. For a sustainable and balanced future, the research community and policymakers must take immediate action to secure these favourable impacts and useful outcomes (Taddeo et al., 2021).

Predicting the system-level effects of AI on GHG emissions and energy usage is a special problem, especially the detrimental effects that could reverse decarbonization efforts. Cross-disciplinary efforts involving social scientists, economists, and engineers will be required to assess system-level effects.

The fact that the AI industry is rapidly growing and there is not enough research on the life-cycle implications of AI will pose issues related to reducing AI's harmful influence on the environment. Due to the continuous evolvments of AI techniques and applications, it would be challenging to create policies to facilitate, regulate and analyze them. Since AI is rapidly evolving, there are not many uses for it in some sectors that have a significant effect on GHG, like agriculture, manufacturing, and energy sectors. Governments must be proactive in creating policies for new technologies, even if they are fast-changing technologies (Zhang et al., 2022).

Figure 1 shows the effect of AI on climate change. In each sector, the green side means positive impact, while the red side means negative impact.

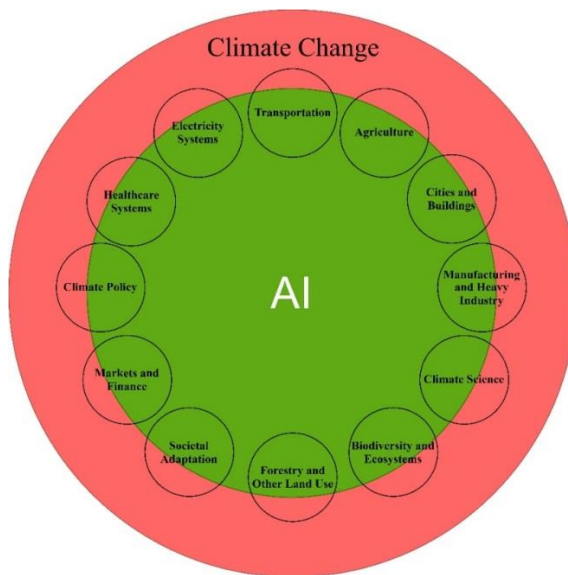


Figure 1. Summary of AI Impacts on Climate Change

4. Positive Impacts of AI on Climate

An overview of some of the specific AI applications' positive impacts on climate will be presented. A lot of these applications have already begun to be implemented, and the majority are in the developing stages (Rolnick et al., 2019).

4.1 Healthcare Systems

AI provides numerous applications that can be deployed to enhance efficiency and quality of influence on climate, energy efficiency and health service delivery. In healthcare, the climate impact of AI is measured by the consumed energy and its carbon dioxide equivalent. AI is implemented in remote monitoring, wearable biosensors, detection of COVID-19, telehealth management of patients, epidemiology, identifying genetic risk factors, forecasting mortality of patients, clinical decision support, development of mammography analysis and drug discovery (Bloomfield et al., 2021).

AI enhances healthcare efficiency by optimizing resource use, reducing unnecessary procedures, and lowering energy consumption (Xu et al., 2022). AI-driven telemedicine minimizes hospital visits and transportation emissions (Liu et al., 2021). Additionally, AI can enable early disease detection and, as a result, reduce the need for resource-intensive treatments (Choi et al., 2021).

4.2 Electricity Systems

AI can estimate electricity demand and supply, locate methane leaks in natural gas pipelines, integrate huge volumes of renewable energy, optimize renewable energy generation operations (reduce dependence on fossil fuels (Lu et al., 2020)), optimize power distribution, minimize waste and losses (Coffrin et al., 2020), and help power networks to reduce emissions (Taddeo et al., 2021; Gottfried et al., 2021).

4.3 Transportation

AI can optimize electric vehicle (EV) charging locations and protocols, help decarbonize transportation, increase utilization of low-carbon options, and optimize freight routing and scheduling. By integrating with public transit and combining the passengers, intelligent autonomous buses could decrease emissions (Taddeo et al., 2021). AI also reduces traffic congestion by optimizing real-time traffic management and lowering idle time, fuel consumption, and

emissions (Liu et al., 2021). It enhances electric and autonomous vehicle efficiency through smarter route planning and energy use, reducing overall transportation emissions (Fagnant & Kockelman, 2015). Additionally, AI improves fleet management by optimizing delivery routes and load distribution, further cutting emissions (Borkowski et al., 2020). AI also balances EV charging demand with renewable energy supply, reducing reliance on fossil fuels (Zhao et al., 2021).

4.4 Agriculture

In agriculture, AI can help with adaptation and mitigation initiatives. AI in automated tools technologies can make agriculture more precise by lowering GHG emissions from land use and agricultural chemicals addition and increasing efficiency (Agarwal et al., 2020). In terms of adaptability, remote sensing methods for yield prediction and crop monitoring can help decrease food shortage in the event of droughts and other harsh weather conditions (Leal Filho et al., 2022). AI improves farming by boosting efficiency, productivity, sustainability and improving food security without harming ecosystems (Kamilaris et al., 2017). Precision farming optimizes pesticides, fertilizers, and water and reduces pollution and emissions (Liakos et al., 2018). AI automation, like autonomous tractors, lowers fuel use and emissions (Vermesan et al., 2019).

4.5 Cities and Buildings

Cities drive economies but also produce high emissions and energy use. As urbanization grows, sustainability is key. AI helps manage infrastructure, boost efficiency, and improve climate resilience. AI has the potential to improve energy efficiency in urban areas and buildings as well as predict energy usage within building properties. Moreover, AI can regulate building lighting and heating to save energy in smart buildings. Furthermore, it can assist communities in reducing methane emissions from wastewater and landfills (Taddeo et al., 2021). AI improves energy usage in buildings by predicting demand, adjusting lighting and HVAC systems, and saving energy (Zhao et al., 2020). Smart grids use AI to enhance electricity distribution, cut energy loss, and integrate renewables. In cities, AI manages resources by optimizing traffic, water, waste, and energy, reducing emissions (Hwang et al., 2020). AI-powered waste management improves collection and recycling, cutting landfill waste and emissions (Tarek et al., 2020; Bertolotto et al., 2020).

4.6 Manufacturing and Heavy Industry

In manufacturing, AI improves efficiency by predicting demand and adjusting real-time equipment. This can cut energy use by up to 25% (De Felice et al., 2020). By applying process of optimization and adaptive control to lower the amount of energy spent by industrial processes. AI can lower the pollutants associated with heavy industry as well as energy requirements of some chemical processes. GHG leakage as methane can be reduced with AI-enabled digital twins and predictive maintenance (Zion Market Research, 2019).

Smart sensors and AI models reduce material waste and carbon emissions by improving production accuracy (Ling et al., 2020). AI also enhances supply chains by predicting demand and optimizing logistics, cutting fuel use and emissions (Zhang et al., 2021). It helps monitor emissions, find inefficiencies, and support carbon capture, especially in high-emission industries like steel and cement (Mizukami et al., 2020).

4.7 Climate Science

Machine learning improves extreme weather predictions and long-term climate trends, aiding adaptation and mitigation (Rolnick et al., 2019). Weather, climate and other Earth systems models can all benefit from AI where it can assist in the data collection through calibrating sensors and inferring properties from satellite imagery. Furthermore, for climate and weather models, AI can make quick approximations to specific physical simulations that would, apart from that, be excessively time-consuming to operate. As a result, more accurate risk forecasts can be made (Zhang et al., 2022). AI also help in renewable energy forecasting of demand, storage, and efficiency (Goh et al., 2020). It enhances carbon capture, tracks emissions in real-time, and supports biodiversity conservation by detecting threats like deforestation early (Hernández et al., 2020; Liu et al., 2020)

4.8 Biodiversity and Ecosystems

AI can help to maintain biodiversity against changing climate. Sensors are progressively integrating AI techniques that employ auditory and visual data to track species, analyze environmental change using remote sensing technologies, and track wildlife (Leal Filho et al., 2022). AI helps protect biodiversity and ecosystems by processing vast amounts of data. It tracks species, analyzes environmental changes, and monitors wildlife using sensors and remote sensing (Leal Filho et al., 2022). Through satellite data, ML improves the monitoring of

biodiversity systems by assessing ecosystem health, deforestation, and species loss (To et al., 2020). AI models simulate climate change impacts on biodiversity, helping develop proactive adaptation strategies (Gómez et al., 2020). In agriculture, AI optimizes resource use, reduces environmental harm, and promotes sustainable farming (Zhang et al., 2019).

4.9 Forestry and Other Land Use

AI is transforming forest and land management to combat climate change. It helps optimize land use, calculate carbon offsets, and monitor afforestation and deforestation with satellite imagery and drones (Leal Filho et al., 2022). AI detects illegal logging, spots early forest fires, and assesses forest health, reducing emissions and boosting carbon sequestration (Wu et al., 2020). AI also supports reforestation by predicting the best planting locations for restoration efforts (Griffiths et al., 2020). In agriculture, AI-driven precision farming optimizes resources, cuts emissions, and improves soil carbon storage (Liakos et al., 2018). Additionally, AI detects deforestation in real-time, enabling quick responses to illegal logging and protecting carbon-rich forests (Chen et al., 2019).

4.10 Societal Adaptation

AI helps mitigate climate change by improving infrastructure and providing predictive maintenance. It aids in disaster relief by identifying at-risk areas and improving mapping (Leal Filho et al., 2022). In healthcare, AI boosts responses to climate-linked diseases and pandemics. AI strengthens climate prediction models, helping communities prepare for extreme events like floods and heat waves. It supports early warning systems, reducing losses (Madsen et al., 2020). In urban planning, AI optimizes cities for extreme weather and reduces the urban heat island effect. In agriculture, it improves water use, soil health, and crop selection to ensure food security (González et al., 2020). AI also enhances disaster management through real-time data and efficient relief (Cheng et al., 2020)

4.11 Markets and Finance

AI is helping finance support climate action. It estimates carbon stocks, predicts prices, and assesses carbon markets. AI also analyzes climate reports and identifies risks in finance and insurance (Kelly, 2022). AI directs funds to sustainable investments by analyzing ESG data. It predicts long-term

opportunities and company performance related to climate goals, boosting green finance (Sullivan & Mackenzie, 2020).

In finance, AI improves risk assessments by evaluating climate change impacts like extreme weather. It helps manage portfolios better (Feng et al., 2021). AI also supports decarbonization by spotting inefficiencies and promoting low-carbon alternatives (Sullivan & Mackenzie, 2020). It tracks green investments in real-time, reducing greenwashing and ensuring proper fund allocation (Harrison & Mak, 2020).

4.12 Climate Policy

AI helps policymakers make better decisions by providing valuable data. It analyzes the effectiveness of policies, supports causal inference, and evaluates options in models (Kelly, 2022). AI also enhances climate modeling, predicting impacts and refining forecasts. It helps policymakers design effective interventions by processing large datasets and predicting extreme weather events (Rolnick et al., 2022; Chen et al., 2023).

AI optimizes energy systems through smart grids, predicting demand, balancing supply, and integrating renewables (Bacchiega et al., 2021; Henderson et al., 2020). In disaster management, AI improves early warning systems and optimizes evacuation routes, reducing casualties (Silver et al., 2022; Haque & Jamal, 2023). AI also supports policy enforcement by monitoring emissions and ensuring compliance with climate agreements (Wang & Chen, 2021).

Table 1. gives a summary of the most important four positive impacts on climate change in each field.

Table 1. Positive Impacts of AI on Climate Change

Field / Impact	First Positive Impact	Second Positive Impact	Third Positive Impact	Fourth Positive Impact
Healthcare Systems	Optimizing Healthcare Operations	Promoting Telemedicine and Remote Health Services	Advancing Predictive Analytics for Early Disease Detection	Intelligent devices and detection services
Electricity Systems	Enhancing Energy Efficiency	Integration of Renewable Energy Sources	Grid Optimization and Load Forecasting	Electric Fault Detection and Protection
Transportation	Optimizing Traffic Flow and Reducing Congestion	Electric and Autonomous Vehicle Integration	AI in Fleet Management for Emission Reduction	Smart Charging Infrastructure for Electric Vehicles
Agriculture	Precision Agriculture for Resource Efficiency	Reduction of Carbon Footprint with AI-powered Automation	AI for Climate-Resilient Crops	Reduction of Waste and Losses through AI-based Supply Chain Management
Cities and Buildings	Energy Efficiency and Reduced Consumption	Smart Cities for Sustainable Urban Development	Climate Resilient Urban Infrastructure	Optimization of Waste Management
Manufacturing and Heavy Industry	Energy Efficiency and Optimization	Improved Resource Management and Waste Reduction	Enhanced Supply Chain and Logistics Efficiency	Carbon Capture and Emissions Monitoring
Climate Science	Enhanced Climate Modeling and Prediction	Optimization of Renewable Energy Systems	Carbon Capture and Emissions Monitoring	Ecosystem and Biodiversity Conservation
Biodiversity and Ecosystems	Improved Monitoring of Biodiversity and Ecosystem Health	Enhancing Conservation Efforts and Species Protection	AI-Driven Climate Change Impact Assessments	Supporting Sustainable Agricultural Practices
Forestry and Other Land Use	Optimized Forest Management	Carbon Sequestration and Forest Restoration	Precision Agriculture and Land Use Efficiency	Real-time Deforestation Detection and Prevention
Societal Adaptation	Enhanced Climate Prediction and Risk Assessment	Smart Urban Planning and Climate Resilient Cities	Agricultural Adaptation and Food Security	Disaster Management and Response
Markets and Finance	Promoting Sustainable Investments	Improved Climate Risk Assessment	Facilitating Low-Carbon Transitions	Enhancing Transparency in Green Finance
Climate Policy	Improved Climate Modeling, Predictions, and Decision-Making	Optimized Energy Consumption and Renewable Integration	Disaster Response and Risk Assessment /Mitigation and Adaptation Strategies	Enhancing Policy Efficiency and Implementation

5. Negative Impacts of AI on The Climate

AI deployment can also have unintended consequences, both environmentally and ethically. The adoption of AI also introduces challenges that could potentially exacerbate climate-related issues, such as energy consumption, biased data management, resource consumption the overuse of synthetic inputs for food, ethical concerns, biases in decision-making, and unintended consequences, inequality, and the potential for exacerbating existing vulnerabilities.

Every AI application has an impact on the climate where it can cause an increase in GHG emissions and negatively impact decarbonization initiatives in three main ways: consequences of AI computation, indirect GHG emissions and social influences.

5.1 Consequences of AI Computation

There are several side consequences of computation. Using, executing, and creating AI algorithms hardware emits its own emissions and consumes energy. These consequences are dependent on the data used, the carbon intensity of the energy used, the specific AI approach and the computing hardware employed. The manufacture of AI technology has also been linked to several other environmental issues.

Increased energy consumption: The deployment of AI, especially deep learning models, requires massive computational resources. Training AI models involves high energy consumption, particularly in data centers. As a result, the growing use of AI could significantly increase the carbon footprint associated with its energy demands (Strubell et al., 2019, Chen & Lin, 2024).

Data privacy and energy use in smart cities: As urban systems become more interconnected, concerns about data privacy and security are growing. If not properly managed, AI applications in smart cities could lead to privacy violations and increase the environmental impact of large-scale data processing (Jiang et al., 2020).

5.2 Indirect GHG Emissions

AI can be used to help with tasks that produce a lot of GHG emissions. In 2025, it is expected that there will be \$425 billion in revenues from the fossil fuel industry that uses AI and other advanced analytics techniques, which are widely employed in gas and oil production and exploration (Zion Market

Research, 2019). As a result, it is possible to see an increase in carbon footprint and power usage.

Rebound effects from increased efficiency: As AI-driven systems enhance efficiency and reduce costs, they can lead to higher usage of transportation services. This increased demand may counteract the emissions reductions achieved through efficiency improvements (Wadud et al., 2019). As a result, transportation emissions could rise despite technological advancements (Sovacool et al., 2021).

AI in fossil fuel industry and policy conflicts: The Atlantic (2024) reports that AI-driven exploration tools are helping fossil fuel companies locate new reserves, which contradicts efforts to mitigate climate change. Policymakers face challenges in ensuring AI is used for sustainability rather than prolonging fossil fuel reliance (GPAI, 2023). According to The Atlantic (2024), major oil companies are using AI to identify profitable drilling locations, effectively extending the lifespan of fossil fuel operations. This raises ethical concerns about AI's unintended role in delaying the transition to clean energy (Chen & Lin, 2024).

5.3 Ecosystem and Social Influences

AI system-level has the potential to affect civilization, which influences the climate, and they are most difficult to assess, yet they could have a major impact. For instance, autonomous vehicle technology can lead to an increase in the need for individualized transportation because it decreases the barrier to driving even if it improves the driving economy. As a result, it is feasible that autonomous vehicles will raise total transportation-related emissions.

Bias in data and decision-making: AI systems may be trained on limited data that do not holistically represent the full experience. Thus, those systems may fail to detect biodiversity changes in certain regions, and also may neglect threats to species that are not well-represented in the data. These biases can lead to ineffective or even harmful conservation policies (Rahwan et al., 2019). AI also risks excluding indigenous knowledge and local expertise. Both indigenous knowledge and local expertise are crucial for effective biodiversity conservation.

Unequal access to technology: AI technology can be expensive in most applications and systems. Different nations and communities can use AI for biodiversity protection but with imbalance use (Harrison & Sundararajan, 2020). This technological divide could widen existing inequalities resulting in erosion of global efforts to combat climate change and protect biodiversity.

Overreliance on technological solutions: AI can limit communities and disturb the sustainable development of land management plans. Additionally, AI-driven solutions can prioritize short-term land use optimizations instead of giving long-dated ecosystem sustainability. (Harrison & Sundararajan, 2020).

Job displacement and economic disruptions: AI is usually used to automate tasks performed by humans. In developing countries where many people rely on agriculture and manual work, this automation may cause economic and social disruptions (Brynjolfsson & McAfee, 2014).

5.4 Resources Consumption and Pollution

Electronic waste (E-Waste) generation: An increase in e-waste generation has been driven due to the rapid increase in the demand for high-performance computing AI-hardware. Devices like graphical processing units (GPUs) that are commonly used for AI computations contribute to environmental harm when inefficiently recycled or improperly disposed of (Laoufi et al., 2021). Improper disposal and inefficient recycling of hardware can lead to environmental degradation because harmful materials are released into the environment (Jung et al., 2020).

Demand for rare earth substances and resource-intensive infrastructure: In some locations, where rare earth metals are mined for AI hardware, AI implementations can harm the ecosystems. The environmental degradation caused by these mining operations can increase the climate change effects (Graf et al., 2021). The high demand for these materials can lead to habitat destruction, soil erosion, deforestation, and water contamination. Excess reliance on practice decisions may also result in the excessive use of synthetic chemicals (Zhang et al., 2021).

6. Evaluation and Recommendations

6.1 AI Impacts Evaluation

AI's effects on GHG emissions encompass both application-related impacts and compute-related impacts. The source of application-related impacts is from broadly altering social behaviors and hastening activities that are either damaging or helpful to GHG emissions. The source of compute-related impacts is from hardware embodied emissions and computational energy consumption. It is harder to evaluate the impacts of AI deployment compared to impacts of AI's compute-related, yet there is a critical lack of information concerning each of them.

Quantitative assessment of compute-related impacts has frequently centered on the evaluation of AI technology's individual occurrences. This ignores the number of times different AI algorithms are employed, tuned, or trained and the type of energy sources, data and infrastructure. All these factors are necessary for calculating total emissions.

Quantitative assessment of AI-related impacts is limited to domain-specific case studies. Such research has concentrated on the negative and positive effects of GHG emissions. For instance, GHG emissions might decrease or increase based on how self-driving vehicles are used, whereas GHG emissions and world consumption might rise by automatic recommender systems (Wadud et al., 2016). Apps like Netflix, Amazon and Spotify are examples of automatic recommender systems that give suggestions of content according to the user's history.

The Sustainable Development Agenda of 2030 was endorsed in 2015 by the United Nations (UN) as a global strategy for peace and prosperity, as well as; it has 17 Sustainable Development Goals (SDGs) divided into environmental, Economic and Societal groups and has 169 targets. AI may help achieve 134 targets of the 17 UN SDGs however, AI can prevent the achievement of 59 of them. The quick development of AI requires appropriate regulatory knowledge and control for AI-based technology to be viable/sustainable. 38% (31 targets) could be negatively affected by AI within the Society group, whereas 82% (67 targets) might possibly gain from AI-based technologies. AI advantages were recognized in 70% (42 targets) of these SDGs by the Economics group, while 33% (20 targets) reported negative consequences (Vinuesa et al., 2020). Quantifying the negative and positive effects of AI on GHG emissions requires the development of frameworks and effective tools.

In order to determine the recommendations and to estimate the technological priorities, It is necessary to gather holistic and good data on AI's effect on GHG emissions. Understanding the dynamics of using AI effectively in the holistic decarbonization process and the climate impacts that may emerge over time is a must (Kaack et al., 2021).

6.2 Recommendations to Balance AI Deployment Impacts on Climate

Several strategies are suggested to harness the benefits of AI with minimum AI's environmental negative effects:

6.2.1 GHG Reduction Related

Promoting the development of efficient energy AI algorithms can help in reducing computational energy demands. Green computing, which is to use

renewable energy sources in data centers, can further mitigate the environmental impact (Wijnhoven & Paccou, 2024). AI may be used to foster shared mobility solutions. This can reduce the total number of vehicles on the road and the overall carbon footprint (Beji et al., 2020). An inclusive dataset that represents all ecosystems and biodiversity should be used in AI models' training processes. This can minimize biases and develop effective conservation plans. Achieving climate goals requires that the regulations must not encourage applying AI in fossil fuel extraction.

6.2.2 Pollution & E-Waste Related

AI e-waste shall be properly disposed of and recycled. This can help in minimizing its impact on the environment. Components reusing as a circular economy principle can be applied to help in treating these concerns (Bandyopadhyay et al., 2022). Promoting sustainable mining practices and investing in the recycling of materials used in AI hardware can help reduce the environmental impact of resource extraction (Bolón-Canedo et al., 2024). AI-powered systems must be regulated to prevent recommendations for using synthetic substances (Huang et al., 2019).

6.2.3 Policy and Regulations

Involving local communities in AI-powered land-use planning makes social and ecological sustainability. Policies in manufacturing should focus on responsible AI, energy efficiency, waste reduction, and emissions monitoring. Climate change combating efforts should prevent job displacement by applying training and green technology. Governments can create frameworks for AI in financial markets, promoting sustainability and transparency.

6.2.4 Degradation of Environment or Communities

Collaboration with local stakeholders and indigenous peoples can make AI solutions culturally appropriate and more effective for climate adaptation. Ensuring equitable access to AI for small-scale and traditional farmers through subsidies or open-source platforms can help protect sustainable farming practices (Duan et al., 2020).

6.2.5 Equitable Resource Distribution

AI must be accessible to all and no one is left behind. Inclusive policies for AI and sustainable finance will support global climate goals. International

cooperation is crucial, especially for developed countries. Governments and urban planners must collaborate to merge AI in sustainability and fair resource distribution (Hwang et al., 2020).

7. Conclusion

AI affect positively and negatively the changing in climate. It can help in systems optimizations, emissions reduction, energy usage, renewable energy adoption support, urban planning, agriculture, and disaster management enhancements. On the other hand, AI consumes energy, delivers e-waste, and requires special resources for its hardware. In agriculture, AI increases efficiency and crop resilience but presents more reliance on synthetic inputs and energy. Renewable energy and sustainable solutions can help balance these impacts. AI enhances efficiency in the manufacturing and city sectors but may disrupt low-carbon technologies. AI improves climate science, carbon capture, and biodiversity monitoring. However, biases and accessibility issues must be treated. AI can also strengthen financial markets by promoting sustainable investments but may contribute to inequalities and market instability. To maximize benefits, AI must adopt energy-efficient models, responsible resource management, and inclusive decision-making. Sustainable AI practices are key to ensure its role in climate change mitigation. AI aids climate policy by improving climate modelling and enhancing disaster preparedness. Policymakers play a crucial role in ensuring that AI is leveraged responsibly to support sustainable development without exacerbating existing environmental challenges.

The impact of AI on climate change will require collaboration across borders since climate change is a global issue that transcends national borders. A good international collaboration between industries and governments can be extremely influential if properly targeted. A more robust estimation of the economic impact of AI needs to be obtained through research that goes beyond case studies to measure the future and current prospective impacts of AI across the economy and in each sector. Stakeholders can provide vital information across a range of fields about how their AI systems could influence GHG emissions and climate change adaptation and mitigation. The entire effects of AI on the climate should be quantified.

In future, it is recommended to incorporate cloud computing in carbon pricing policies and reporting, set reporting criteria for emissions of the life-cycle related to AI usage and development when applicable, keep climate change in mind at all times when promoting the development of AI-enabled technology, and buy AI services from businesses that are committed to a net-

zero goal. Moreover, the use of new AI technologies should be encouraged. These technologies both mitigate climate change and create new jobs and investment opportunities which can be considered as a tradeoff between national income and mitigation/adaptation outcomes. Therefore, the economy will get better and the GHG emissions will be reduced. Therefore, it is better to build international collaboration for the intersection between climate change and AI.

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