

The role of AI in climate action: Can it be the remedy we need?

Oğuzhan ERDOĞAN¹, Onur KULAÇ²

¹ Department of Management Information Systems, Bucak Zeliha Tolunay Applied Technology and Business Management School, Burdur Mehmet Akif University, Türkiye

² Department of Political Sciences and Public Administration, Faculty of Economics and Administrative Sciences, Pamukkale University, Türkiye

*Correspondence: oordogan@mehmetakif.edu.tr (O.E.); okulac@pau.edu.tr; onurkulac@yahoo.com (O.K.)

Keywords: artificial intelligence; climate change; technology; sustainability

Abstract: Artificial intelligence and climate change are the two biggest topics on the global agenda. While artificial intelligence shapes our lives with technological innovations, climate change threatens our environment and health. While humanity is struggling with the threat of climate change, it is trying to find new and innovative solutions to overcome this existential crisis. In this process, many tools are used to combat climate change. However, none of these tools is as promising as artificial intelligence (AI). With its capacity to analyze large amounts of data and its extraordinary ability to identify patterns and make predictions, artificial intelligence is today a vital tool in the fight against climate change. From predicting weather events to optimizing renewable energy systems, from protecting forests to maintaining biodiversity, AI is revolutionizing the approach to environmental sustainability. With the help of this technology, more effective strategies can be developed to reduce carbon footprint and minimize environmental impacts. In addition, AI-supported solutions can produce innovative solutions that will benefit both humans and nature by enabling faster and more efficient decisions in the fight against climate crisis. From this point of view, in this study, the use of artificial intelligence can be an effective tool in combating climate change and the areas in which artificial intelligence is used in combating climate change are discussed and examples of good practices are analyzed.

1. Introduction

Climate change is one of the most significant problems of our time. The negative effects of climate change lead to significant socio-economic and explosive consequences. The rapid increase in the world population, unplanned industrialization and unconscious consumption habits cause the negative effects of global warming and climate change to be felt earlier and more intensely throughout the world. According to World Health Organization data, approximately 4 billion people in the world live in regions vulnerable to climate change. It is predicted that approximately 250,000 people will die annually between 2030 and 2050 due to malnutrition, malaria, diarrhea and heat stress (Masterson, 2024). These data push scientists to utilize the developing artificial intelligence and data science in combating climate change, one of the most essential topics of discussion on the global agenda. The two most major strategies adopted by the United Nations in combating climate change are: Reducing greenhouse gases and adapting to the current and possible effects of climate change. The use of artificial intelligence offers notable opportunities to policy makers and researchers in terms of improving current understanding and practices in the field of reducing and adapting greenhouse gas emissions and determining different perspectives and strategies (Tuğaç, 2023). While artificial intelligence (AI) offers innovative solutions in many areas that

transform the world, it also plays an influential role in combating climate change. In other words, threats such as global warming, environmental degradation and depletion of natural resources await urgent and sustainable solutions worldwide. Artificial intelligence offers revolutionary technologies in data analysis, energy efficiency, carbon emission reduction and sustainable agricultural practices to address these problems. By processing large datasets, AI enables us to more accurately predict environmental changes, effectively utilize natural resources and develop strategies for a greener, sustainable future.

Experts state that AI can also benefit in solving environmental problems, especially green energy and reducing carbon footprint. In addition, artificial intelligence helps to create a greener environment by detecting reductions in energy emissions and carbon emissions, and accelerates efforts to protect the environment and natural resources by predicting weather and climate events (Dijital Ajanslar, 2024). In this context, artificial intelligence and climate change offer promising solutions for the future of our planet in a critical area where science and technology intersect.

2. Literature Review

In this section of the study, a literature review related to the research area is given. In this context, the concepts of climate change and artificial intelligence are discussed.

2.1. Climate Change

Climate is a concept used to describe the average state of weather events experienced or observed on earth for many years, the variability of weather conditions and atmospheric elements in a certain area and their average values (İklimin, 2024). In another definition, climate is the average of weather conditions that develop in a certain time interval in a part or all of the earth (Turkish Space Agency, 2024). Climate change, on the other hand, refers to the increase in the average surface temperatures of the earth and the changes in the climate as a result of the rapid increase in greenhouse gas emissions released into the atmosphere as a result of human activities such as the use of fossil fuels, land use changes, deforestation and industrial processes, strengthening the natural greenhouse effect (Kreafin, 2024). According to the United Nations Framework Convention on Climate Change climate change is defined as the change in climate as a result of human activities that directly or indirectly disrupt the composition of the global atmosphere, in addition to the natural climate change observed in different time periods (Göksu and Somuncu, 2023). Global warming, which is often confused with climate change in literature, is a different but related phenomenon to climate change. Global warming is defined as the current increase in world temperature (Aksay, et al., 2005). This is only a characteristic of climate change. Climate change is a combination of many different effects of global warming on the climate system, such as rising sea levels, melting glaciers, changing precipitation patterns, changing frequency of weather events, changing lengths of seasons and changing agricultural productivity (İklim Değişikliği Başkanlığı, 2024).

Climate change is one of the most critical global problems affecting all countries today. As mentioned above, the negative effects of climate change, which directly affect sustainable development such as temperature increase, drought, flooding, forest fires, loss of biodiversity, increase in the frequency and severity of extreme weather events, sea level rise, melting of glaciers, food insecurity and increased health risks, are gradually increasing in the world (Republic of Türkiye Ministry of Foreign Affairs, 2024). This situation is also revealed by scientific data. In the reports published by the Intergovernmental Panel on Climate Change (IPCC), it is warned that climate change is a "red alarm" for humanity. According to this report, the most key cause of climate change is the greenhouse gas emissions released into the atmosphere as a result of human activities (Clean Energy, 2021). On the other hand, environmental regulations have been implemented in many countries in recent years within the scope of combating climate

change. Steps have been taken to reduce greenhouse gas emissions in the world with the Paris Climate Agreement, EU Green Deal, and COP 27 Conference. European Union countries aim to reduce carbon emissions by 55% by 2030 with the Green Deal and to become the first carbon neutral continent by 2050 (WWF-Türkiye, 2021). In this framework, within the scope of combating climate change, the global transition to a low-carbon economy envisages a radical transformation that will change people's lifestyles, production and manufacturing methods. Therefore, efforts to combat and adapt to climate change should not be perceived as a mere environmental problem. In reality, this struggle may directly affect the growth strategies, energy policies, health and agricultural programs, use of water resources, food security, transition to a low-carbon economy and sustainable development goals to be pursued by countries and may be decisive in their development (Ministry of Foreign Affairs, 2023).

When the UNFCCC and the Paris Climate Agreement are examined, it is seen that two leading strategies are emphasized in the fight against climate change, which is expressed to be at the crisis level today. These are the reduction of greenhouse gas emissions and adaptation to the effects of climate change (İğci and Çobaoğlu, 2019).

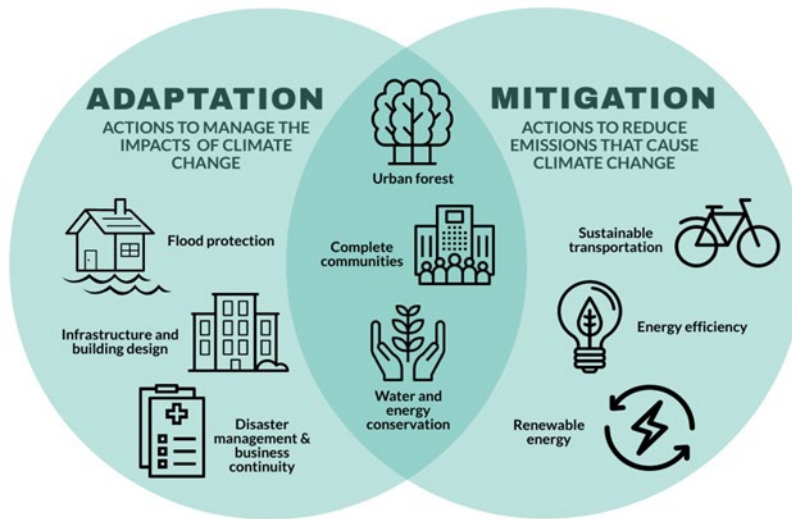


Figure 1. Adaptation and Mitigation in the fight against Climate Change (ICLEI Canada, 2019)

Adaptation is the process of strengthening and implementing strategies and policies in this field in order to combat and manage the impacts of climate change (Doğan and Tüzer, 2011). Adaptation is keeping up with the changing climate, reducing the negative impacts of climate change and turning negative impacts into opportunities as much as possible (Ministry of Environment, Urbanization and Climate Change, 2024). Greenhouse gas is a phenomenon that keeps the planet at the appropriate temperature. However, as a result of human activities, the amount of greenhouse gases in the atmosphere increases, increasing the temperature of the earth and changing climates. Due to the uncontrolled increase of greenhouse gases in the atmosphere, more sunlight is trapped by greenhouse gases and warms the earth (İklimin, 2024). Therefore, studies to prevent the release of human-induced gases that cause greenhouse effect into the atmosphere should be implemented (Görgülü and Görgülü, 2021). According to the World Meteorological Organization, global average temperatures have increased by approximately 1.1°C since 1880 (Çoşgun, 2023). This increase frequently brings along problems such as melting of glaciers, sea level rise, forest fires, floods and drought. Scientists state that it is critical to keep the global temperature increase below 1.5°C (McGrath, 2022). For this reason, the Paris climate agreement stipulates that countries should reduce greenhouse gas emissions, especially carbon dioxide emissions, by 50% by 20230 and zero by 2050 so as to keep global warming at 1.5°C (TÜBİTAK, 2023). In

this framework, many tools are utilized today to reduce greenhouse gas emissions in combating climate change and to adapt to the effects of climate change. One of these tools is artificial intelligence.

2.2. Artificial Intelligence

The concept of artificial intelligence is often used today to develop systems equipped with human intellectual processes such as reasoning, meaning discovery, generalization or learning from past experiences. Artificial intelligence makes our lives easier by performing some tasks that a human can do more quickly with more data. For this reason, artificial intelligence is present in our daily lives with voice assistants, language translations, suggestion systems, navigation, social security, health services, e-commerce and assistant robot applications. It is also used in sector-specific strategic studies such as cyber security and defense industry (Manifesto, 2023).

Although the philosophical foundations and first concrete steps of artificial intelligence, which is very popular today and has found a field of study in almost all disciplines, date back to the 17th century (Çoşkun and Güleroğlu, 2021), the term 'artificial intelligence' was first used in a workshop on artificial intelligence organized by John McCarthy at Dartmouth College in 1956 (Dick, 2019; Anderson, 2024). The first human-like intelligent robot was built in Japan in 1972 under the name WABOT-I (Acar, 2020). In the 1980s, artificial intelligence started to find its place on the world agenda when the UK allocated funds to compete with Japan in artificial intelligence studies (Öztürk and Şahin, 2018). In 1997, the defeat of world chess champion Garry Kasparov in a chess match by the program called "Deep Blue" produced by IBM completely changed the view of artificial intelligence (Çoşkun and Güleroğlu, 2021).

As it is known, while the first industrial revolution enabled the formation of mechanical production systems using water and steam power, the second industrial revolution created mass production systems with the help of electrical power. In the third industrial revolution, the use of digital systems, electronic infrastructures and information technologies made production more functional (Kesayak, 2018). Today, the system called the 4th industrial revolution consists of three structures listed as 'internet of things, internet of services and cyber-physical systems' (Davutoğlu, 2020). In the social transformation in the history of humanity, the industrial and informatics revolutions have merged and a new era, which we call the fourth industrial revolution, is being experienced (Kaya, 2021).

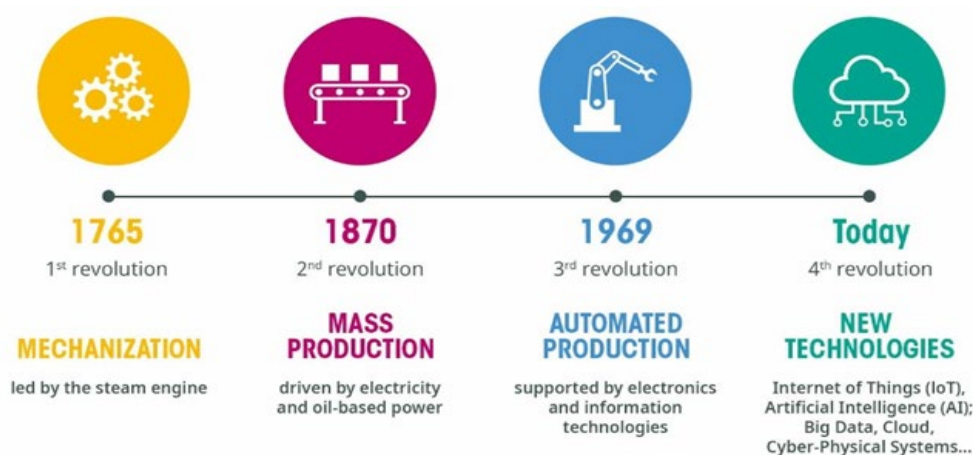


Figure 2. Industrial Revolutions (Visiativ, 2024)

In this period, many skills have been gained by using artificial intelligence methods in the production and service sector. Many tools and equipment in our current life are equipped with artificial intelligence techniques. Thus, artificial intelligence has become an essential part of our lives and has started to play an effective role in the developments of

all countries on a global scale (Türk Bilişim Derneği, 2020). As a result of social transformation in parallel with technological developments, artificial intelligence has also had significant effects on social life. In particular, cloud computing, internet of things, sensors, metaverse, big data systems, 3D printing, robots, 5 and 6G and blockchain applications have led to important social gains by bringing smart city applications in cities. Artificial intelligence has started to be used in all areas of life from transport to health, agriculture to manufacturing, public administration to trade, energy to education. In addition, AI robots, wearable internet, smart city applications that make life easier for people, vision systems that use augmented reality to make real-time decisions, 3D printed manufacturing systems, artificial organs and driverless vehicles, etc. have brought artificial intelligence to a different point in the social field (Öztemel, 2020). While artificial intelligence finds application areas in many fields and seeks solutions to many social problems, one of them is undoubtedly the fight against climate change.

3. Purpose and Methodology

As the problems caused by climate change deepen, the world of science and innovation is looking for new solutions. The aim of this study is precisely at this point to reveal what role artificial intelligence will play in combating climate change. The following research questions are addressed within the scope of the study:

- Can artificial intelligence be a remedy in combating climate change?
- Which artificial intelligence applications are being implemented in the fight against climate change?

In addressing these research questions, the relational research method was used as a working practice. In this context, it is aimed to establish a relationship between the use of artificial intelligence and the fight against climate change. Within the scope of the study, the study was enriched by including different application examples of artificial intelligence used in combating climate change. The contribution of this study to literature is the association of climate change, which is two critical issues of recent years, and artificial intelligence, which is used in every field from industry, technology, transport to health, within the same subject and in this context, artificial intelligence can be applied in the solution of the crisis caused by climate change. On the other hand, it is seen in the literature research that there are not enough studies on the subject, and in most of the studies, artificial intelligence and climate change are handled either on the basis of certain sectors or separately. The study is also functional in terms of addressing these two issues in an integrated manner.

3.1. Can Artificial Intelligence be a Solution to Climate Change?

Today, with climate change and global warming, there are widespread droughts, floods and extreme temperatures all over the world. Temperatures across the world are far above seasonal norms. Many forest fires occur every day due to the increasingly intense temperatures. The risk of water shortage is increasing in many places, especially in big cities (Dijital Ajanslar, 2024).

It is seen that the problem of urbanization lies at the heart of climate change and global warming, which is a global crisis caused by human activities. Today, 55% of the world's population lives in cities and this rate is expected to increase to 68% by 2050 (Altun and Zencirkiran, 2021). Cities are responsible for a large share of energy consumption and greenhouse gas emissions. For example, 39% of the carbon emissions in the United States of America (USA) originate from residential and commercial buildings and 33% from the transport sector. In other words, in general, about 70% of carbon emissions in cities arise from modern man-made urban infrastructures (Yerküreye Saygı, 2019). At this point, in order to reduce the negative effects of global warming, smart city strategies and artificial intelligence, which is at the center of these strategies, are becoming increasingly significant (Dijital Ajanslar, 2024). Artificial intelligence, which has started to be used in many areas, is of critical importance especially in environmental

issues such as climate change and sustainability. Experts state that artificial intelligence can be of great benefit in solving environmental problems, especially green energy and reducing carbon footprint (Akbulut, 2024). In other words, while artificial intelligence has revolutionized various sectors in recent years, it also plays an important role in solving a major global problem such as climate change (Clutton-Brock et al. 2021). In fact, artificial intelligence supports the fight against climate change in many areas such as data analysis, modelling, mapping, projection, sustainability solutions and resource management. Especially at the point of adaptation to climate change and reduction of greenhouse gases, artificial intelligence applications stand out as systems that are currently used.

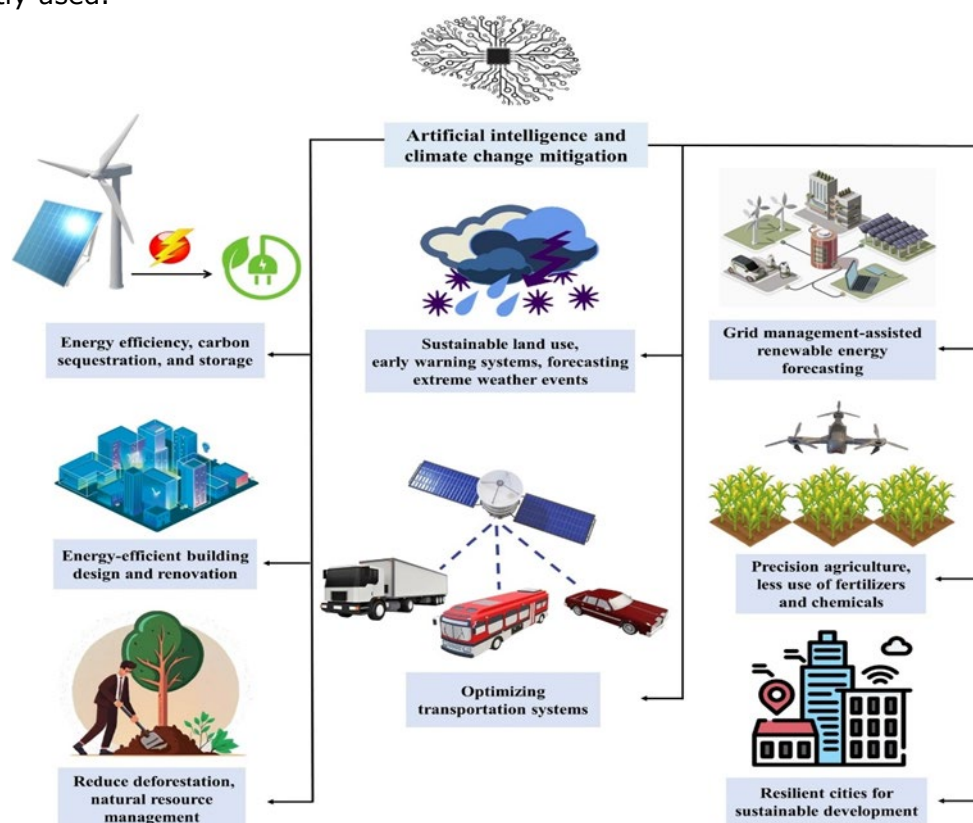


Figure 3. Artificial intelligence-based solutions for climate change (Chen et al., 2023)

On the other hand, studies show that artificial intelligence has a transformative potential that can reduce emissions worldwide by approximately 10% by 2030 by creating scaling opportunities in proven technologies (Lyons, 2024). In addition, one of the most fundamental reasons why artificial intelligence has been used so widely in the fight against climate change in recent years is undoubtedly the unpredictability of climate change. Therefore, artificial intelligence processes large amounts of data together with climate sets and modelling (Tuğaç, 2023). The main areas where artificial intelligence is used in combating climate change are as follows:

Data Analysis and Prediction Models: A large amount of data is required to scientifically understand climate change and predict its future impacts. Data collected from various sources such as weather data, ocean temperatures, atmospheric changes and agricultural activities are too large to be analyzed by traditional methods (Anderson, 2024). Artificial intelligence makes predictable future effects of global warming by analyzing climate models faster and more accurately. Because developing the right policies and strategies in the fight against climate change is of great importance in solving the problem. In this framework, artificial intelligence also helps politicians and scientists to determine their policies by making more accurate and effective decisions (Kyriakopoulou, 2023). In addition, artificial intelligence can also predict which policies

will be most effective in the long run by simulating climate scenarios. A good example of the use of predictive artificial intelligence is related to Lagos, Nigeria. Experts believe that by 2050, rising sea levels could render half of Lagos uninhabitable, leaving 24 million residents with nowhere to go (Rutkowski, 2023).

Prediction of Natural Disasters, Environmental Changes and Climate Change Monitoring: Climate change increases the frequency and severity of natural disasters. Artificial intelligence helps early predictions of disasters such as forest fires, floods and hurricanes by analyzing weather and environmental data obtained through satellite images and sensors (McGovern et al. 2017). Early warning systems are crucial to minimize the damage that disasters can cause. In addition, artificial intelligence can model long-term environmental changes caused by climate change and these models allow better plans to be made in areas such as water resources, agriculture and biodiversity (Maher et al., 2022). In addition, artificial intelligence can measure changes in icebergs 10,000 times faster than a human can. This situation also helps scientists to understand how much water icebergs that melt due to climate change leave in the ocean. Indeed, scientists from the University of Leeds say that artificial intelligence can map large Antarctic icebergs in just 1% of a second (Masterson, 2024).

Energy Efficiency Management, Renewable Energy and Reducing Carbon Emissions: One of the biggest challenges in combating climate change is managing energy consumption. Artificial intelligence creates more efficient models in energy production and consumption processes by optimizing energy use (Farghali et al., 2023). For example, AI-supported smart energy grids monitor energy demand and supply in real time and ensure the most efficient use of resources (Taşdemir, 2024). AI-based systems for homes and commercial buildings optimize energy consumption, enabling systems such as heating, cooling and lighting to operate more efficiently, leading to reduced carbon emissions (Ngarambe et. al. 2020). The report prepared by Pi Labs, a global technology venture capital company, titled 'Sustainable Smart: Artificial Intelligence for a Greener World' prepared by Pi Labs, a global technology venture capital firm, calculates the carbon reduction potential of artificial intelligence to reduce the world's environmental footprint (Yeşil İş Platformu, 2024). In this report, it was stated that with the industry-wide adoption of only four AI use cases, 5.81 to 6.46 gigatons of CO₂-e greenhouse gas emissions could be avoided annually by 2030. This is equivalent to the entire annual carbon footprint of the United States, the world's second largest greenhouse gas emitter according to 2022 figures. According to a report by Google and the Boston Consulting Group, artificial intelligence has the potential to reduce global greenhouse gas emissions by 5 to 10 per cent by 2030.

Today, resources such as wind, solar and hydroelectricity are replacing traditional fossil fuels and the use of artificial intelligence to accelerate this transition is increasing day by day (Fang et al., 2023). Artificial intelligence can predict energy demand, optimize generation processes and manage energy storage systems to make energy generation systems more efficient (Wang and Srinivasan, 2017). For example, artificial intelligence can predict the times and places where solar and wind energy production will be most efficient by analyzing weather data or increase energy efficiency by minimizing production interruptions by predicting the maintenance requirements of wind turbines (Russo, 2021; Sauer, 2024).

Sustainable Agriculture, Food Security and Water Resources Management: Climate change adversely affects the agriculture sector and jeopardizes food security by leading to decreasing water resources, decreasing soil quality and irregular weather events. Artificial intelligence makes food production resistant to climate change by making agricultural processes more sustainable. Artificial intelligence helps farmers to farm more efficiently by monitoring soil fertility and water use with smart agricultural applications (Kyriakopoulou, 2023). With smart irrigation systems and precision agriculture techniques, water can be saved, and agricultural production can be increased. Artificial intelligence can also predict which crops can be more resistant to climate change and optimize agricultural production processes with this information (Sauer, 2024). Thus, it

helps farmers to develop climate-resilient agricultural strategies. In addition, artificial intelligence is also used to establish an effective and sustainable forest management system to reduce deforestation (Raihan, 2023).

Sustainable Smart Cities, Transportation, Infrastructure and Health: Artificial intelligence makes cities more sustainable by optimizing city planning, infrastructure and transportation systems (Kargin, 2021). Smart cities provide efficient employment in areas such as energy, water and waste management, smart traffic management (Fang et al., 2017), autonomous vehicles, energy-saving building management systems and environmentally friendly transportation models make cities greener (Taşdemir, 2024) and “15 minutes” pave the way for the emergence of new city models. The 15-minute city is an urban planning concept that aims to create communities where people can access basic amenities by traveling for no more than 15 minutes on foot or by bike. The concept encourages the development of polycentric cities where offices, shops, restaurants and entertainment are located locally, reducing the need for driving (Çamuşoğlu, 2023). Other climatic conditions also have a significant impact on health. It is seen that the routes of migratory birds change due to extreme temperatures (AIR Institute, 2024). Depending on this situation, new pandemics may emerge. In African countries such as Tanzania, an increase in bite cases is observed due to snakes coming to their distribution areas more frequently due to high temperatures. While combating all these problems and fighting more viruses, artificial intelligence is needed to speed up processes such as producing vaccines and solutions (Lyons, 2024).

As can be seen, artificial intelligence has great potential in combating climate change. However, artificial intelligence also has some risks and ethical issues in its fight against climate change. Excessive energy consumption of artificial intelligence causes the carbon footprint of large data centers to increase. In addition, data privacy, reduction of the human factor in decision-making processes and misuse of artificial intelligence also bring about some problems (Anderson, 2024).

3.2. Good Practice Examples for the Use of Artificial Intelligence in the Field of Climate Change

Studies are being carried out by many different institutions and organizations on the use of artificial intelligence applications in the fight against climate change. The projects, practices and studies carried out by these institutions and organizations and the platforms realized are discussed below within the scope of good practice examples:

3.2.1 DeepMind and Climate Models

Google’s AI research team, DeepMind, uses AI for weather forecasts. A breakthrough has been made in global weather forecasting with GraphCast, developed by Google DeepMind in its artificial intelligence laboratory (Muradoğlu, 2023). In one study, this system gave faster and more accurate results than the High-Resolution Forecast (HRES) system, the gold standard of weather simulations. This artificial intelligence successfully predicted Hurricane Lee to hit Nova Scotia in 2023 nine days in advance (AiTrends, 2023). Because this AI provides shorter-term, more accurate weather forecasts by analyzing large data sets and can predict sudden weather events (for example, storms or excessive rainfall) more effectively. In this way, better planning can be made in weather-dependent areas such as agriculture, energy and transportation sectors (Deepmind, 2024).

3.2.2. ClimateGPT and Climate Ai

ClimateGPT, the first open-source artificial intelligence language model focused on addressing the effects of climate change, supports both scientists and researchers working on the climate crisis by trying to provide accurate information (Thulke et al., 2024). ClimateGPT’s focus is solely on climate change and its scientific and social

impacts. With its database containing more than 200 million academic studies, the model answers the questions asked by citing the articles. To access this artificial intelligence model, which is trained using solar energy and hydroelectric energy and created a data center, it is sufficient to fill out the request form stating the purpose of use (Çevreciyiz, 2024). The main purpose of this artificial intelligence model is to keep up with the pace of climate change by contributing to the studies carried out to enable society to adapt more quickly to a low-carbon lifestyle and, in this context, to address the effects of climate change on society (Şeko, 2024).

Climate Ai, another AI-based platform, guides producers by predicting climate risks in agriculture. The platform helps optimize product planning by predicting changing weather conditions (Climate Ai, 2024).

3.2.3. Microsoft Project Bonsai and Google Carbon Tracker

Project Bonsai aims to optimize the energy consumption of industrial processes by developing AI-supported autonomous systems. For example, by using AI in factory processes, energy consumption is made more efficient, which reduces carbon emissions (Nightingalehq, 2024). On the other hand, Google Carbon Tracker helps companies measure and reduce their carbon footprint by using artificial intelligence to monitor carbon emissions. This system analyzes the energy consumption of companies in their operations and makes recommendations on transitioning to more sustainable methods (Carbontracker, 2024).

3.2.4. Global Forest Watch (GFW) and The Ocean Cleanup

Global Forest Watch is an openly accessible platform that enables all citizens to access information about changes in forests by leveraging satellite data, advanced computer algorithms and cloud computing power (Global Solution Networks, 2013). Thanks to this platform, everyone can see when and where trees were cut by clicking a single button. GFW uses satellite imagery and AI-based analysis to monitor deforestation around the world. It provides governments and NGOs with the opportunity to intervene by detecting deforestation events in real time (UN Environment Program, 2024). This plays an important role in preventing illegal logging, especially in sensitive regions such as the Amazon (Osborne, 2023). More than four million people worldwide have used GFW to date (Word Resources Institute, 2024). On the other hand, Boston Municipality is testing the artificial intelligence-based tree inventory developed by Green City Watch to check the number and health status of trees in the city in order to take the necessary measures to protect green areas (EuroNews, 2020).

Environmental organization The Ocean Cleanup is using artificial intelligence technology to help clean up plastic pollution in the ocean. This artificial intelligence that detects objects helps the organization create detailed maps of ocean debris in remote locations (Masterson, 2024). Ocean debris can then be collected and removed; This is more efficient than previous cleaning methods using trawlers and aircraft. As a matter of fact, plastic pollution causes climate change by emitting greenhouse gases and damaging nature (Let's do it Türkiye, 2024).

3.2.5. Rainforest Connection, One Concern, Copernicus Climate Change Service (C3S) and Copernicus Atmosphere Monitoring Service (CAMS)

Rainforest Connection uses AI and dormant smartphones to protect rainforests (Karahasan, 2021). Sensors placed in rainforests detect illegal logging using sound analysis supported by AI algorithms and send warnings to authorities (RFCx, 2024). These artificial intelligence-based bioacoustics analysis system called RFCx, developed by Rainforest Connection in the USA, is currently used by 16 countries. RFCx alerts authorities to illegal logging by distinguishing human sounds, such as trucks and heavy machinery, from normal rainforest sounds (Minapy, 2024).

One Concern offers a platform that models and simulates the effects of natural disasters using AI. It predicts the effects of disasters such as earthquakes, floods and storms on cities and ensures that preventive measures are taken (One Concern, 2024).

Copernicus Climate Change Service (C3S) and CAMS play an active role in detecting changes in land and vegetation, improving air quality forecasts of cities, and automatically processing satellite images (EuroNews, 2020).

3.2.6. Microsoft Artificial Intelligence Initiative for the Globe

Microsoft's "AI for Earth" initiative is a program that aims to use artificial intelligence (AI) technologies to combat environmental challenges and ensure sustainability. This initiative is part of a broad environmental sustainability program that Microsoft launched in 2017 with \$50 million in resources. AI for Earth focuses on four main areas (Tuğaç, 2023). These; Supporting the monitoring and conservation of biodiversity by analyzing data to help protect ecosystems and species, developing artificial intelligence solutions for more efficient use, management and protection of water resources, helping farmers make better decisions to increase agricultural productivity and reduce environmental impact and reduce carbon emissions. monitoring and mitigating and providing data and AI-based solutions to combat climate change. To support this initiative, Microsoft provides funding, cloud services and artificial intelligence tools to researchers, environmental organizations and governments. It also provides technical support to projects in areas such as data analytics, machine learning and image processing. The goal of this initiative is to broadly use the power of AI to strengthen environmental sustainability and contribute to solving environmental problems around the world (Microsoft, 2024).

3.2.7. Climate Risk Analytics (CRA) and Climate Change AI (CCAI)

CRA is a platform that evaluates the risks of climate change on companies' operations. Thanks to AI, risk maps based on future climate scenarios are created for companies and strategies against these risks are developed (Climateriskanalysis, 2024).

CCAI is a non-governmental organization founded in 2019 that aims to find solutions to climate change problems with artificial intelligence. CCAI develops innovative approaches in areas such as energy efficiency, renewable energy projects and carbon footprint reduction by using machine learning and artificial intelligence in the fight against climate change. For example, thanks to AI algorithms, more accurate climate modeling can be made, systems that optimize energy consumption can be created, and energy load balancing can be achieved during natural disasters (Climate Change AI, 2024).

3.2.8. United Nations (UN) Satellite Based Rapid Mapping Service (UNOSAT)

The UN Satellite-Based Rapid Mapping Service is a service that quickly provides geographic information in events such as natural disasters, humanitarian crises and emergencies. This service helps disaster response teams and relevant authorities make effective decisions by creating fast and reliable maps with satellite images of disaster areas (Tuğaç, 2023). It plays a substantial role in damage assessment and identification of affected areas, especially in events such as earthquakes, floods and forest fires. Such mapping services, supported by artificial intelligence (AI) technology, are also used to predict, analyze and minimize the effects of natural disasters such as floods. Artificial intelligence algorithms can make flood predictions by analyzing large amounts of satellite images, identify areas at risk of flooding, and assist authorities with precautions to be taken in advance. Thus, artificial intelligence-supported flood mapping and analysis systems provide greater preparedness for flood disasters (UNOSAT, 2024). UNOSAT provides its emergency mapping service in 6-7. It was activated after the Kahramanmaraş Earthquakes that occurred in Turkey in February. Thus, it provided

significant support to the relevant authorities in combating this major earthquake in Turkey by providing satellite images (Güleş, 2023). In addition, UNOSAT shared data on floods in Nigeria, Sudan, Pakistan and Nepal with the relevant countries and supported those countries' fight against floods (Clutton-Brock et al., 2021).

3.2.9. Blue River Technology and IBM Watson Agriculture Technology

Blue River Technology, which develops AI-based technologies for agricultural pesticides, reduces unnecessary chemical use by analyzing each plant individually (Blue River Technology, 2024). This draws attention as an environmentally friendly practice and provides cost savings to farmers (Digital Talks, 2017).

IBM Watson's AI system analyzes weather conditions, soil moisture and plant health and guides farmers to apply the right amount of irrigation, fertilization and pesticide application at the right time (Kalkan, 2018). This contributes to more efficient use of water and other resources and sustainability in agricultural production.

3.2.10. Met Office Climate Science Project for Service Partnership

The Met Office is a project run by the United Kingdom Met Office to combat global climate change, advance climate science research and develop solutions in this field by collaborating with governments, research organizations and the private sector. This partnership provides the scientific infrastructure necessary to understand the effects of climate change, conduct climate modeling and create sustainable policies in various sectors (Met Office, 2024). The project aims to develop long-term climate change projections and go beyond short-term weather forecasts to predict annual and seasonal climate events, to help create sustainability strategies for governments and the private sector using climate science data, and to understand how various industries and societies can adapt to the risks brought by climate change. It is aimed to provide guidance on the subject and assisting decision makers in creating more conscious and scientifically based policies at national and international levels. The project was also developed in China and in this context, seasonal precipitation forecasts were made for the Yangtze River Basin in China (Tuğaç, 2023).

3.2.11. Earth Engine, Destination Earth (DestinE) Initiative and Microsoft Azure FarmBeats

Google Earth Engine uses big data and AI to track climate change-related events around the world. It is a significant tool for monitoring environmental changes, from deforestation to melting glaciers, and analyzing this data (Earth Engine, 2024).

Destination Earth (DestinE) is the European Commission's flagship initiative to develop a highly accurate digital model of the Earth on a global scale (ECMWF, 2024). This model monitors, simulates and predicts the interaction between natural events and human activities. As part of the European Commission's Green Deal and Digital Strategy, it contributes to achieving the green and digital twin transition goals (European Commission, 2024).

Microsoft's cloud-based platform, Azure FarmBeats, combines data from sensors, cameras, tractors and UAVs and develops machine learning models based on combined data sets in order to monitor the agricultural sector and support farmers to adapt to climate change. Thus, when producers determine when to plant, irrigate and harvest their crops; It also takes the weather conditions into consideration (EuroNews, 2020). Microsoft Azure helps UK energy producers avoid energy balancing charges imposed by national energy authorities and helps analyze solar producers' data (AWS, 2020).

3.2.12. Re-tina

Re-Tina is an innovative technology developed by Ecording and was created to promote environmental responsibilities and verify individual contributions (Ecording,

2024). Re-Tina offers an active solution to the global climate crisis with real-time data by encouraging and validating users' environmentally friendly behavior. Re-Tina engages in many important activities such as public transportation usage and verification, throwing plastic bottles in the recycling bin, recycling paper materials correctly, avoiding disposable cups, reducing food waste, and energy-saving behaviors. Each of these tasks is verified by Re-Tina through video analysis, and during this verification process, users are provided with feedback to increase their environmental impact levels (Ecording, 2024).

3.2.13. Greyparrot and Eugenie.AI

Greyparrot, a London-based software startup, has developed an artificial intelligence system that analyzes waste processing and recycling facilities, helping them recover and recycle more waste materials. The company tracked 32 billion wastes in 67 waste categories in 2022 and announced that it detected an average of 86 tons of materials that could be recovered but would be sent to the landfill (Masterson, 2024).

Eugenie.ai, based in the US state of California, has developed an emissions monitoring platform that combines satellite imagery with data from machines and processes. AI then analyzes this data to help companies track, monitor and reduce their emissions by 20-30%. Industrial sectors produce approximately 30% of global greenhouse gas emissions (Masterson, 2024).

4. Discussions

As a result of the evaluations made within the scope of the research questions stated in the purpose and method section of this study, the following findings were reached:

- Artificial intelligence analyzes huge volumes of data; By making complex calculations and simulations, it enables effective and rapid decisions to be made, especially in decision-making processes, in the fight against climate change.
- Artificial intelligence undertakes great tasks in combating climate change by making weather forecasts, developing climate models, making simulations and modeling, playing crucial roles in sustainable agriculture, food security and water resources management, creating smart cities and supporting the fight against natural disasters. Within the scope of this struggle, many artificial intelligence applications have been implemented by countries and companies.
- Investments in artificial intelligence technologies have a huge impact on improving the environmental performance of countries. Developed smart systems can reduce waste and energy waste by analyzing data from sensors and satellites.
- While steps such as investing in sustainable energy sources, reducing carbon emissions and using renewable energy sources with artificial intelligence applications can help slow down the climate crisis, protection and restoration of biodiversity and forests, improvement of agriculture and animal husbandry methods or smart agriculture applications, also thanks to artificial intelligence applications. Encouraging options such as environmentally friendly smart transportation and technological recycling also play an important role in the fight against climate change.
- Artificial intelligence enables the implementation of new city models such as the "15-minute city" in the fight against climate change through new strategic methods such as land use planning and site selection.
- In addition, large data centers created with artificial intelligence cause emissions and consume large amounts of water. With the development of artificial intelligence technology, the amount of energy used is expected to increase. In addition, the concept of cyber security, data privacy, reduction of the human factor in decision-making processes and misuse of artificial intelligence, ethics, etc. It continues to create some problems.

5. Conclusions

Climate change is one of the most substantial problems humanities have ever faced. Artificial intelligence, a relatively new technology, is both a powerful tool and a guide in the fight against this global problem that deeply affects societies. Artificial intelligence's capabilities in analyzing environmental data, optimizing energy management and achieving sustainability goals play a critical role in mitigating the effects of climate change. Artificial intelligence contributes to reducing emissions through the systems it develops. Artificial intelligence also provides rapid geographical information in events such as forest protection, weather forecasting, ocean cleaning, waste processing and recycling, forest protection, weather forecasting, ocean cleaning, waste processing and recycling, natural disasters, humanitarian crises and emergencies. It has become an essential actor in the fight against climate change, as well as providing climate modelling, creating risk maps, and developing an open-source language model to address the effects of climate change, combating natural disasters, transportation, infrastructure, health and energy management. On the other hand, artificial intelligence is still not a technology that offers perfect results. There is a great danger in thinking that artificial intelligence will magically solve all problems. Artificial intelligence is a powerful technology; However, it is only one of several tools that can be used in climate change strategies. However, it is worthwhile to remember that artificial intelligence is only a tool to help us overcome the climate change brings. Current AI, with its monetization crackdown, could encourage overconsumption. In this place, it is not artificial intelligence that makes the main decision, but people should ignore the reality.

Funding: This research received no external funding.

Author contributions: Design of the Study Author-1 (60%) – Author-2 (40%), Data Collection Author-1 (60%) – Author-2 (40%), Data Analysis Author-1 (60%) – Author -2 (40%), Writing of the Article Author-1 (50%) – Author-2 (50%), Article Submission and Revision Author-1 (30%) – Author-2 (70%).

References

1. Acar, O. (2020) *Is artificial intelligence an opportunity or a threat?* İstanbul: Kriter Yayınevi.
2. AIR Institute (2024) *The role of AI in bird watching*. Available online: <https://air-institute.com/blog/2024/02/20/role-ai-bird-watching> (accessed on: 10/08/2024).
3. AiTrends (2023) *Google deepmind's artificial intelligence-based weather forecast revolution*. Available online: <https://aitrends.com.tr/google-deepmind-in-yapay-zeka-tabanli-hava-tahmini-devrimi/> (accessed on: 10/08/2024).
4. Akbulut, D. (2024) *Global warming can be prevented with artificial intelligence*. Available online: <https://www.bthaber.com/kuresel-isinma-yapay-zeka-ile-onlenebilir/> (accessed on: 13/08/2024).
5. Aksay, S. C.; Ketenoğlu, O.; Kurt, L. (2005) Global warming and climate change. *Süleyman Demirel University Faculty of Science and Letters Journal*, 25, 29-41.
6. Altun, G.; Zencirkıran, M. (2021) A research on smart campus technologies and applications. *Architecture and Life Journal*, 6(2), 319-336. <https://doi.org/10.26835/my.850103>
7. Anderson, K. (2024) *How can artificial intelligence help tackle climate change?* Available online: <https://greenly.earth/en-us/blog/ecology-news/how-can-artificial-intelligence-help-tackle-climate-change> (accessed on: 10/08/2024).
8. AWS (2020) *Amazon sagemaker customers*. Available online: https://aws.amazon.com/tr/sagemaker/customers/?utm_source=newsletter&utm_medium=email&utm_campaign=newsletter_axiosfutureofwork&stream=future (accessed on: 13/08/2024).

9. Blue River Technology (2024) *Our mission is to create intelligent machinery that solves monumental challenges for our customers.* Available online: <https://bluerivertechnology.com/our-mission/> (accessed on: 13/08/2024).
10. Carbontracker (2024) *Carbon tracker.* Available online: <https://carbontracker.org/> (accessed on: 10/08/2024).
11. Chen, L.; Chen, Z.; Zhang, Y.; Liu, Y.; Osman, A.; Farghal, F.; Hua, J.; Fatesh, A.; Ihara, I.; Rooney, W. D.; Yap, S. P. (2023) Artificial intelligence-based solutions for climate change: a review. *Environmental Chemistry Letters*, 21, 2525–2557. <https://doi.org/10.1007/s10311-023-01617-y>
12. Clean Energy (2021) The amount of carbohydrates in the atmosphere has increased by 43 percent in the last 141 years. Available online: <https://temizenerji.org/2021/01/07/son-141-yilda-atmosferdeki-karbondioksit-orani-yuzde-43-artti/> (accessed on: 10/04/2024).
13. Climatedriskanalysis (2024) *Climate risk analysis.* Available online: <https://www.climate-risk-analysis.com/> (accessed on: 12/09/2024).
14. Climate Ai (2024). Available from: <https://climate.ai/> (accessed on 21/09/2024).
15. Climate Change AI (2024) Available online: <https://www.climatechange.ai/> (accessed on: 12/09/2024).
16. Clutton-Brock, P.; Rlnick, D.; Donti, P.; Kaack, L.H.; Maharaj, T.; Luccioni, A.; Das, H.P. (2021) *Climate change and AI: Recommendations for government action.* Global Partnership on AI Report.
17. Coşgun, Y. A. (2023) *The current status and future of water resources within the framework of climate change in Effects of climate change on Türkiye's water resources and adaptation* (Ed. Mehmet Emin Aydın and Ahmet Duran Şahin). Ankara: Türkiye Bilimler Akademisi Yayınları.
18. Coşkun F.; Güleröğlü, D.H. (2021) Development of artificial intelligence throughout history and its use in education. *Ankara University Faculty of Educational Sciences Journal*, 54(3), 947-966. <https://doi.org/10.30964/auebfd.916220>
19. Çamuşoğlu, N. (2023) *15-minute city concept.* Available online: <https://www.ekoyapidergisi.org/15-dakikalik-sehir-konsepti/> (accessed on: 7/09/2024).
20. Çevreciyiz (2024) A new era in the fight against climate change: ClimateGPT. Available online: <http://www.cevreciyiz.com/haber-detay/6387/iklim-degisikligiyle-mucadelede-yeni-donem-climategpt> (accessed on: 15/08/2024).
21. Davutoğlu, N. A. (2020) Analysis of the fundamental and systematic differences between the third and fourth industrial revolutions with a deterministic approach. *Management and Political Sciences Review*, 2(1), 176-194.
22. DeepMind (2024) *Learn about deepmind.* Available online: <https://deepmind.google/discover/blog/using-ai-to-fight-climate-change/> (accessed on: 7/08/2024).
23. Dick, S. (2019) Artificial intelligence. *Harvard Data Science Review*, 1(1), 1-8. <https://doi.org/10.1162/99608f92.92fe150c>
24. Digital Talks (2017) *John Deere is buying an artificial intelligence startup that will help teach its tractors how to farm.* Available online: <https://www.digitaltalks.org/2017/09/11/john-deere-traktorlerine-ciftciligi-ogretmeye-yardim-edecek-bir-yapay-zeka-startupi-satin-aliyor/> (accessed on: 2/08/2024).
25. Dijital Ajanslar (2024) *We can prevent global warming with artificial intelligence.* Available online: <https://www.dijitalajanslar.com/kuresel-isinmayi-yapay-zek-ile-onleyebiliriz/> (accessed on 2/08/2024).
26. Doğan, S.; Tüzer, M. (2011) Combating global climate change: General approaches and international efforts. *Journal of Sociology Conferences*, (44), 157-194.

27. Earth Engine (2024) *Google earth engine*. Available online: <https://earthengine.google.com/> (accessed on: 15/08/2024).
28. ECMWF (2024) *Destination earth*. Available online: <https://www.ecmwf.int/en/about/what-we-do/environmental-services-and-future-vision/destination-earth> (accessed on: 15/08/2024).
29. Ecoring (2024) *Can artificial intelligence combat the climate crisis: The revolutionary role of retina*. Available online: <https://ecoring.org/retina/#yapay-zeka> (accessed on: 12/09/2024).
30. European Commission (2024) *Destination earth*. Available online: <https://digital-strategy.ec.europa.eu/en/policies/destination-earth> (accessed on: 12/09/2024).
31. EuroNews (2020) *Can we fix our damaged climate with the help of artificial intelligence?* Available online: <https://tr.euronews.com/green/2020/10/12/bozulan-iklimimizi-yapay-zeka-yard-m-yla-duzeltebilir-miyiz> (accessed on: 8/08/2024).
32. Fang, M.; Njangag, H.; Padhan, H.; Simo, C.; Yan, C. (2023) Social media and energy justice: A global evidence. *Energy Economics*, 125, 1-12. <https://doi.org/10.1016/j.eneco.2023.106886>
33. Farghali M.; Osman A.; Mohamed, I.; Chen Z.; Chen L.; Ihara I.; Yap P-S.; Rooney D.W. (2023) Strategies to save energy in the context of the energy crisis: a review. *Environ Chem Lett.* <https://doi.org/10.1007/s10311-023-01591-5>
34. Global Solution Networks (2013) *Global forest watch: A global solution network to protect the world's forests lighthouse case study*. Available online: <https://gsnetworks.org/wp-content/uploads/Global-Forest-Watch.pdf> (accessed on: 6/08/2024).
35. Göksu, E.; Somuncu, M. (2023) The role and importance of city councils in collaborative governance for climate change adaptation. *Ankara University Journal of Environmental Sciences*, 10(2), 1-14.
36. Görgülü, Ç.; ve Görgülü, L., (2021) Eco-morphological approach to climate change: Urban fringe areas. *JENAS Journal of Environmental and Natural Studies*, 3(1), 72-99.
37. Güleş, O. (2023) *Emergency satellite map activated: Critical move from the UN after the Türkiye earthquake!* Available online: <https://www.tgrthaber.com/teknoloji/acil-durum-uydu-haritasi-etkinlestirildi-turkiye-depremi-sonrasi-bmden-kritik-hamle-2873453> (accessed on: 6/08/2024).
38. ICLEI Canada (2019) *Climate change, adaptation and mitigation*. Available online: <https://rdn.bc.ca/climate-change-adaptation-and-mitigation> (accessed on 21/09/2024).
39. İğci, T.; ve Çobanoğlu, N. (2019) Evaluation of climate change and global agreements on climate change in terms of environmental ethics. *Ankara University Journal of Environmental Sciences*, 7(2), 130-146.
40. İklimin (2024) *Guide to your climate*. Available online: <https://www.iklimin.org/ikliminicerrehber.pdf> (accessed on 6 August 2024).
41. İklim Değişikliği Başkanlığı (2024) *Climate change*. Available online: <https://iklim.gov.tr/> (accessed on 6/08/2024).
42. Kalkan, B. (2018). *9 new features from IBM to Watson*. Available online: <https://ioturkiye.com/2018/09/ibmden-watsona-9-yeni-ozellik/> (accessed on: 4/08/2024).
43. Karahasan, F. (2021) *Technology investment is essential for green solutions and protecting the environment*. Available online: <https://www.ekonomim.com/kose-yazisi/yesil-cozumler-ve-cevreyi-korumak-icin-teknoloji-yatirimi-sart/638491> (accessed on: 15/08/2024).

44. Kargin, C.T. (2021) *How can AI power climate change strategy?* Available online: <https://ioturkiye.com/2021/03/yapay-zeka-iklim-degisikligi-stratejisini-nasil-guclendirebilir/> (accessed on: 15 August 2024).
45. Kaya, M. (2021) Artificial intelligence and Türkiye in Industry 4.0. *Firat University Journal of Economics and Administrative Sciences*, 5(2), 63-94.
46. Kesayak, B (2018) *A short journey into industrial history*. Available online: <https://www.endustri40.com/endustri-tarihine-kisa-bir-yolculuk/> (accessed on: 15/08/2024).
47. KreaFin (2024) *Climate risk*. Available online: <https://www.kreaFin.com.tr/i-iklim-riski> (accessed on: 15/08/2024).
48. Kyriakopoulou, D. (2023) *What opportunities and risks does AI present for climate action?* Available online: <https://www.lse.ac.uk/granthaminstitute/explainers/what-opportunities-and-risks-does-ai-present-for-climate-action/> (accessed on: 15/08/2024).
49. Let's do it Türkiye (2024) *9 ways AI is helping fight climate change*. Available online: <https://letsdoitturkey.com/yapay-zekanin-iklim-degisikligiyle-mucadeleye-yardimci-oldugu-9-yol/> (accessed on 15/08/2024).
50. Lyons, R. (2024). *Could artificial intelligence help solve the climate crisis?* Available online: <https://www.thinkwithgoogle.com/intl/tr-tr/pazarlama-stratejileri/otomasyon/yapay-zeka-iklim-degisikligi/> (accessed on 21/09/2024).
51. Maher, H.; Meinecke, H.; Gromier, D.; Garcia-Novelli, M.; Fortmann, R. (2022) *How AI can be a powerful tool in the fight against climate change*. Available from: <https://web-assets.bcg.com/ff/d7/90b70d9f405fa2b67c8498ed39f3/ai-for-the-planet-bcg-report-july-2022.pdf> (accessed on 21/09/2024).
52. Manifesto (2023) *Who is it: Artificial intelligence*. Available online: <https://www.manifestodergi.com/2023/12/09/bilisim-ve-teknoloji-kimdir-o-yapay-zeka-mehmet-akif-ayzit/> (accessed on: 12/09/2024).
53. Masterson, V. (2024) *9 ways AI is helping tackle climate change*. Available online: <https://www.weforum.org/agenda/2024/02/ai-combat-climate-change/> (accessed on: 12/09/2024).
54. Met Office (2024) Available online: <https://www.metoffice.gov.uk/> (accessed on: 12/09/2024).
55. McGrath, M. (2022) *Climate change: Scientists say we are now at a critical point to limit global warming to 1.5 degrees*. Available online: <https://www.bbc.com/turkce/haberler-dunya-60990864> (accessed on 15/08/2024).
56. McGovern, A.; Elmore, L.K.; Gagne, D.; Haupt, E.S.; Karstens, C.; Lagerquist, R.; Smith, T.; Williams, J. (2017) Using artificial intelligence to improve real-time decision making for high-impact weather. *Bull Amer Meteor Soc.* in press. <https://doi.org/10.1175/BAMS-D-16-0123.1>
57. Microsoft (2024) Available from: <https://www.microsoft.com/en-us/sustainability/learning-center/improving-sustainability-with-ai> (accessed on 21/09/2024).
58. Minapy (2024) *Artificial intelligence 2025*. Available online: <https://www.minapy.com.tr/yapay-zeka-2025.html> (accessed on 15/08/2024).
59. Ministry of Foreign Affairs (2023) *The importance of combating climate change*. Available online: <https://www.mfa.gov.tr/iklim-degisikligiyle-mucadelenin-onemi.tr.mfa> (accessed on: 2/08/2024).

60. Muradoğlu, C. (2023) *DeepMind's artificial intelligence-supported weather forecasting program: GraphCast*. Available online: <https://webrazzi.com/2023/11/15/deepmind-yapay-zeka-destekli-hava-durumu-tahmin-programi-graphcast/> (accessed on: 15/08/2024).
61. Ngarambe, J.; Yun, G. Y., Santamouris, M. (2020) The use of artificial intelligence (AI) methods in the prediction of thermal comfort in buildings: energy implications of AI-based thermal comfort controls. *Energy & Buildings*, 211, 1-15. <https://doi.org/10.1016/j.enbuild.2020.109807>
62. Nightingalehq (2024) *What is Microsoft project bonsai*. Available online: <https://nightingalehq.ai/knowledgebase/glossary/what-is-microsoft-project-bonsai/> (accessed on: 11/10/2024).
63. One Concern (2024) *One concern*. Available online: <https://oneconcern.com/en/> (accessed on: 10/10/2024).
64. Osborne, L. (2023) *Amazon deforestation falls as leaders meet for key summit*. Available online: <https://www.dw.com/en/global-forest-watch-report-tropical-forest-loss/a-66034028> (accessed on: 15/08/2024).
65. Öztemel, E. (2020) *Artificial intelligence and the future of humanity*. Available online: https://tuba.gov.tr/files/yayinlar/bilim-ve-dusun/TUBA-978-605-2249-48-2_Ch9.pdf (accessed on 21/09/2024).
66. Öztürk, K.; ve Şahin, M.E. (2018) An overview of artificial neural networks and artificial intelligence. *Takvim-ı Vekayi*, 6(2), 25-36.
67. Raihan, A. (2023) Artificial intelligence and machine learning applications in forest management and biodiversity conservation. *Natural Resources Conservation and Research*, 6(2), 1-16. <https://doi.org/10.24294/nrcr.v6i2.3825>
68. Republic of Türkiye Ministry of Foreign Affairs (2024) *The Importance of fighting climate change*. Available online: <https://www.mfa.gov.tr/iklim-degisikligiyle-mucadelenin-onemi.tr.mfa> (accessed on: 15/08/2024).
69. RFCx (2024) *Rainforest connection*. Available online: <https://rfcx.or> (accessed on: 18/08/2024).
70. Rutkowski (2023) *The role of AI in combating climate change*. Available online: <https://www.informationweek.com/sustainability/the-role-of-ai-in-combating-climate-change#close-modal> (accessed on 18/08/2024).
71. Russo, M. (2021) *How artificial intelligence can combat climate change*. Available online: <https://www.theregreview.org/2021/08/25/russo-artificial-intelligence-combat-climate-change/> (accessed on 13/10/2024).
72. Taşdemir, C. (2024) *AI and the green world of the future: artificial intelligence in search of sustainability*. Available online: <https://robotdreams.com.tr/blog/57-ai-ve-gelecegin-yesil-dunyasi-surdurulebilirlik-arayisinda-yapay-zeka> (accessed on: 13/08/2024).
73. Thulke, D.; Gao, Y.; Pelsner, P.; Brune, R.; Jalota, R.; Fok, F.; Ramos, M.; Wyk, I., Nasir, A.; et al. (2024) ClimateGPT: Towards ai synthesizing interdisciplinary research on climate change. *ArXiv*, 2401.09646v1 [cs.LG], 1-52. <https://doi.org/10.48550/arXiv.2401.09646>
74. Tuğaç, Ç. (2023) Climate change and artificial intelligence: opportunities and challenges. *Hitit Journal of Social Sciences*, 16(1), 74-90. <https://doi.org/10.17218/hititsbd.1240744>
75. Turkish Space Agency (2024) Climate change. Available online: <https://tua.gov.tr/tr/blog/dunya/iklim-degisikligi> (accessed on 15 August 2024).
76. TÜBİTAK (2023) *Green growth technology roadmap: General information and methodology*. Ankara: TÜBİTAK.

77. Türk Bilişim Derneği (2020) Opinions and suggestions for the development of artificial intelligence in Türkiye. Ankara: Türk Bilişim Derneği.
78. Sauer, N. (2024) *Four ways AI could help us respond to climate change – despite how much energy it uses*. Available online: <https://theconversation.com/four-ways-ai-could-help-us-respond-to-climate-change-despite-how-much-energy-it-uses-208135> (accessed on: 15/08/2024).
79. Şeko, A.Y. (2024) *ClimateGPT aims to support the fight against climate change*. Available online: <https://www.aa.com.tr/tr/bilim-teknoloji/climategpt-iklim-degisikligiyle-mucadeleyi-desteklemeyi-hedefliyor/3245317> (accessed on: 15/08/2024).
80. UN Environment Program (2024) *Global forest watch*. Available online: <https://www.unep.org/resources/toolkits-manuals-and-guides/global-forest-watch> (accessed on 23/09/2024).
81. UNOSAT (2024) Available online: <https://unosat.org/products/3734> (accessed on: 23/09/2024).
82. Visiativ (2024) *Industrie 4.0: définition et mise en œuvre vers l'usine de production connectée*. Available online: <https://www.visiativ-industry.ch/industrie-4.0/> (accessed on: 21/09/2024).
83. Wang, Z.; Srinivasan, R.S. (2017) A review of artificial intelligence based building energy use prediction: Contrasting the capabilities of single and ensemble prediction models. *Renewable and Sustainable Energy Reviews*, Elsevier, 75(C), 796-808. <https://doi.org/10.1016/j.rser.2016.10.079>
84. WWF-Türkiye (2021) *Türkiye should see the European Union Green Deal as an opportunity to transition to a low-carbon economy*. Available online: <https://www.wwf.org.tr/?10722/Turkiye-Avrupa-Birligi-Yesil-Mutabakatn-dusuk-karbonlu-ekonomiye-gecis-icin-bir-frsat-olarak-gormeli> (accessed on 21/09/2024).
85. Yerküreye Saygı (2019) Smart city strategies that reduce the effects of global warming and climate change. Available online: <https://yerkureyesaygi.org/yerkureye-saygi/mNqJbqjAzV9/kuresel-isinma-ve-iklim-degisikligi-etkilerini-azaltan-akilli-sehir-stratejileri> (accessed on 21/09/2024).
86. Yeşil İş Platformu (2024) Artificial intelligence can reduce carbon footprint. Available online: <https://www.yesilisplatformu.com/yapay-zeka-karbon-ayak-izini-azaltabilir/> (accessed on 21/09/2024).

