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The effect of deteriorated ecosystems on the world

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Carbon dioxide emissions caused by the industrial revolution are causing climate change. This is one of the most serious problems humanity is currently facing. Human activities have led to various environmental problems such as global warming, ecosystem degradation, melting glaciers, excessive depletion of natural resources, loss of biodiversity, and air, soil and water pollution. Climate change is a significant change in meteorological elements such as precipitation and temperature. As greenhouse gas emissions in the atmosphere increase, the temperature increases even more due to the warming effect. With the increase in average temperatures, severe climate events such as storms, floods and fires occur more frequently. Frequent changes in weather conditions such as early summers or warm winters disrupt the natural rhythm of life. The consequences of global warming have been clearly seen in recent years. The potential for many coastal cities in India, such as Mumbai, to be submerged is increasing. However, the consequences are not limited to this. This change in climate and natural habitats is changing the population distribution on Earth. The destruction and degradation of natural ecosystems are the main causes of the decrease in biodiversity on Earth. It is now clear that climate change is causing a decrease in biodiversity on both land and water. Since the mid-1990s, the extent of sea ice in the Arctic Ocean has continued to decrease significantly. The doubling of average temperatures in the Arctic is causing the ice to melt. The protection of biodiversity and the transition to renewable energy are necessary to combat climate change. However, the management of renewable energy sources such as solar and wind is a major challenge. Artificial intelligence, which has emerged as a new technological tool in the energy sector, has opened up new prospects for increasing energy efficiency. Artificial intelligence is widely used to search all kinds of data and discover new climate models. Artificial intelligence is already having a significant positive impact on the fight against climate change. Artificial intelligence, especially through deep learning and advanced neural networks, analyzes data such as satellite images, ocean temperatures, weather conditions, carbon emission records, and deforestation and suggests solutions. For example, AI predicts the probability of extreme weather events such as floods, droughts, and hurricanes. This minimizes the damage done.

Keywords: *Azerbaijan, climate change, global warming, Poland, biodiversity*

INTRODUCTION

Climate change is one of the biggest challenges facing the world today. Climate change is a significant change in meteorological elements, such as precipitation and temperature. According to the climate report of the Intergovernmental Panel on Climate Change (IPCC), the Earth is currently warmer than it has been in the last 125,000 years (Tollefson, 2021).

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As the concentration of greenhouse gases in the atmosphere increases, the temperature also increases due to the warming effect. With the increase in average temperatures, extreme weather events such as storms, floods and fires occur more frequently. Frequent changes in weather conditions such as early summers or warm winters disrupt the natural rhythm of life. The consequences of global warming have been clearly seen in recent years. A 10-12% increase in precipitation and a rise in sea level of about 50 cm are leading to the fragmentation of natural habitats and the reduction of the size of intact patches. The potential of many coastal cities in India, such as Mumbai, is increasing. But the consequences are not limited to this. This change in climate and habitat is changing the distribution of populations in the world. According to the IPCC, if the global average temperature increases by 1.5-2.5 degrees Celsius, approximately 20-30% of species could become extinct (Tollefson, 2021; Mammadov et al., 2024).

1. The impact of climate change on genetic diversity

Since the Industrial Revolution, human activities have been destroying ecosystems (WWF, 2020). Rich biodiversity and healthy ecosystems are fundamental to life on our planet. Biodiversity is defined at three main levels: ecosystem, species, and genetic diversity. Ecosystems are communities of living things, including plants, animals, and microorganisms, that interact with each other and their environment (Lipton et al., 2018; Aydin et al., 2024). Species diversity refers to the variety of species within a region. Genetic diversity is the variety among individuals within a species (Verma, 2017) Climate change negatively affects genetic diversity, species richness, and ecosystems (Kumar and Verma, 2017) Biodiversity is under threat: populations are estimated to have decreased by 68% since 1970 (Rands et al., 2010). Over the last 20 years, the average temperature has increased by 0.2 degrees Celsius due to rapid industrialization and population growth, and is expected to increase by another 0.8 degrees Celsius if this process is not stopped (Dar et al., 2016; Hasanova and Aidarkhanova, 2024).

2. Impact of climate change on watersheds

The destruction and degradation of natural ecosystems are the primary causes of the decline in biodiversity on Earth. It is now clear that climate change is causing a decline in biodiversity on both land and water. The oceans are the largest living space on Earth (Moore et al., 2011). Climate change is warming the Arctic faster than any other area, and polar ecosystems are changing rapidly (Lotze et al., 2019). Sea ice is a critical component of the dynamics of Arctic and subarctic marine ecosystems and a major factor affecting the distribution of marine mammals (De La Guardia et al., 2017). The extent of sea ice in the Arctic Ocean has continued to decline significantly since the mid-1990s (Campen et al., 2022). Global sea level has risen by an average of 1.7 mm per year since the 1900s but has increased by 3.3 mm since 1993 (Srinivasu et al., 2017). According to NOAA, over the past 200 years, the world's oceans have absorbed more than 150 billion tons of carbon dioxide from human activities. The increase in carbon dioxide concentrations in the oceans and other water bodies is causing ocean acidification. The oceans act like sponges, absorbing increasing greenhouse gases from the atmosphere. This process is called carbon sinks. Carbon sinks are natural or artificial systems that absorb and store carbon dioxide from the atmosphere. Natural carbon sinks include the oceans, forests, and soil. While this process of change helps regulate the planet’s atmospheric carbon concentration, it comes at a cost to the oceans and the life that lives in them. For many years, the pH of the ocean has remained constant. However, in recent years, about a quarter of the CO_2 produced by the burning of fossil fuels has been absorbed by the oceans. When CO_2 is absorbed by the ocean, it reacts with water to produce carbonic acid. Carbonic acid breaks down into bicarbonate ions and protons, which in turn react with carbon ions. This process causes the ocean’s pH to drop. The decrease in pH is critical for the development of coral reefs, especially some species of sea stars, plankton, and snails, whose shells are composed of calcium carbonate (Kroeker et al., 2013). These ocean-

dwelling organisms form a shell or skeleton made of calcium carbonate ($CaCO_3$). Although these shells are an important part of the ocean ecosystem, ocean acidification is seriously affecting their structure. In 2014, the annual average CO_2 concentration in the atmosphere was 397 ppm. During the Industrial Revolution, the concentration was 280 ppm. This means that the concentration of carbon dioxide in the atmosphere has increased by 40% since 1980. During the same period, the ocean's pH dropped from 8.2 to 8.1 (Gibson et al., 2011; Burge et al., 2013). The Arctic Seas, including the Norwegian Sea and the Greenland Sea, have experienced a decrease in water pH levels of 0.13 and 0.07, respectively, since 1980. Both indicators are higher than the global average (Kirchman, 2010).

3. The effects of climate change on polar mammals

While some polar mammals have evolved to adapt to these extreme environments, some species have limited ability to adapt to this change. Arctic foxes, walruses, polar bears, seals, polar owls and reindeer are particularly at risk. Polar bears live on ice floes that float along the coast of the Arctic Ocean. An international agreement to protect polar bears was adopted in 1973 to prevent illegal hunting. However, melting ice is currently the main reason why their populations are in danger. According to the IPCC, the average temperature in the Arctic doubled in 2021 (Change, 2013). Marine mammals, especially polar bears, rely on ice as a hunting, feeding and breeding platform. A 2012 study by Stirling and Derocher suggests that prey availability has decreased, energy expenditure has increased and reproductive success has decreased among polar bears (Stirling, 2012). Polar bears' primary food source is seals, especially ringed seals (Pusa hisbida). Polar bears feed on blubber, a fatty layer under the seals' skin, to meet their energy needs (liu, 2023). Fat is not only a source of energy, it also allows polar bears to survive long periods without food and helps them maintain a constant body temperature in cold climates. Polar bears can eat up to 45 kg of fat at a time. However, the retreating ice forces them to travel longer distances and expend more energy. These bears spend 35% of their time active and the rest resting. Despite this, they burn 12,325 calories per day. As the ice cover disappears, they are forced to spend more time on the shore. Unable to forage on land, they starve and lose weight rapidly, further increasing their risk of death (Andrianova, 2022). According to the BBC, researchers have been monitoring the activities of 20 polar bears for three years to see how the loss of ice is affecting this population. In addition to taking blood samples, they monitored the bears with GPS-equipped video cameras. This allowed the scientists to track the animals' movements, activities, and what they were doing during the day (Pagano, 2024). During the summer months, the bears took strategic steps to survive. Some rested more and tried not to waste their energy. Most spent more time on the beach trying to find plants or berries. However, none of these strategic steps were successful. By the end of the study, 19 of the 20 polar bears had experienced a sharp drop in body weight. They were losing an average of one kilogram of body weight every day. One of the interesting findings from the study was that one bear weighed 32 kilograms. According to the Alaska Science Center USA in Alaska, lead author Dr. Anthony Pegano of the USGS said that no matter which strategy they tried, there was no real benefit to either approach. Dr. Pegano also shared another interesting fact with BBC News: A female polar bear, who was not yet fully grown, found a dead beluga whale (a type of whale that lives in the Arctic). Polar bears usually take advantage of this opportunity to eat the whale's flesh to gain energy. However, in this particular case, the bear only bites the whale a few times and mostly uses it as a board to rest when it gets tired of swimming. Dr. Pegano analyzed this behavior and concluded that polar bears have difficulty feeding and swimming at the same time (Pagano, 2024). It was determined that this is because they need ice for support, as they expend a lot of energy while swimming. This also proves that the ice cover is an integral part of the life of this population. According to the best estimates, there are 20,000-30,000 polar bears in 19 different groups and populations, mostly in the United States, Canada, Greenland, Norway and Russia. Four of these are thought to be in decline. Polar bears are particularly well-monitored in the Beaufort Sea region, where their numbers have decreased by 40% in the past year. The World

Wildlife Federation has predicted that polar bear populations in the Arctic will decrease by 30% by 2050 (Pagano, 2024).

4. Forest ecosystem and climate change. The effects of climate change on forests in Azerbaijan and Poland

The second largest ecosystem that acts like a sponge and absorbs carbon dioxide is the forest ecosystem. Forests cover 30% of the Earth's surface. Over the past 8,000 years, up to half of the planet's forests have been destroyed as a result of anthropogenic effects (Ahrends et al., 2017). Since 1850, 30% of the carbon dioxide in the air has been formed as a result of deforestation (Le Quéré et al., 2016). The increase in average temperatures and the concentration of carbon in the atmosphere also negatively affect forest ecosystems. Rising temperatures are an important factor that significantly increases the risk and severity of forest fires (Domke et al., 2023). Although fires can occur quickly, the diversity of wild animal and plant populations, the disruption of the food web, and the occurrence of insect epidemics can take decades (Hayhoe et al., 2018).

Forests are an ecosystem where many plants, animals, and insects can live together. Forests contribute to human health and well-being by providing ecosystem services such as disaster risk reduction and control, soil stabilization and erosion control, water regulation, food, medicine and material supply, air and water purification. Forests are the lungs of the world. In short, forests are essential for human societies and the planet (Gedik et al., 2023). In this study, we compared the forest status of Poland, a European Union country, and Azerbaijan.

4.1. Forests of Azerbaijan

Some decisions have been adopted at the state level on re-learning forest reserves of Azerbaijan, their development and the enrichment of species populations. The Institute of Dendrology of the Ministry of Science and Education of Azerbaijan has set itself the task of conducting research on the influence of climatic factors on some rare tree species in the southern region of Azerbaijan. The main goal here is not only climate change but also to identify the potential of our forests, which were ruthlessly exploited during the 30-year Armenian occupation of the Eastern Zangezur economic region of Azerbaijan, to restore them and make them more productive. Work in this area continues (Mammadov et al. 2025).

One of the large forest masses covers the slopes of the Talysh Mountains. Here the forests are spread over the territory of the administrative regions of Astara, Lenkeran, Lerik, Masalli, Yardimli, Jalilabad and partly Bilasuvar. A small part of the forests extends along the banks of the Kura and Araz rivers and occupies a strip-shaped area in the form of a Tugay-type massif (Report, 2015). The total area of forests in the Republic of Azerbaijan is 1,213,700 hectares. The area covered by forests is 1,021,880 hectares, which is 11.8% of the total area. There are approximately 0.12 hectares of forest area per person, which is 4 times less than the global average (0.48 hectares). In Poland, this figure corresponds to 0.24 hectares (Table 1).

Despite the small area of forests of Azerbaijan compared to the total area, it is distinguished by its rich flora and fauna. 4,500 species of higher plants belonging to 125 families and 930 genera are widespread here. Of these, 450 species of trees and shrubs belonging to 48 families and 135 genera grow in the forests of our country. This constitutes 11% of the plant species in the country's flora. The dendroflora of Azerbaijan includes 70 regional endemic species. This is 16% of the total number of tree and shrub species. Such forests are widespread in the lowland and middle mountain areas of the Greater and Lesser Caucasus (85%) and in the Talysh Mountains. Here the forests are spread over the territory of the administrative regions of Astara, Lenkeran, Lerik, Masalli, Yardimli, Jalilabad and partly Bilasuvar. A small part of the forests extends along the banks of the Kura and Araz rivers and occupies a strip-shaped area in the form of a Tugay-type massif (Report, 2015).

As a result of the research, it was determined that approximately 25% of the tree and shrub species in the natural flora of Azerbaijan are relict and rare plants. As a result of active human intervention in the natural vegetation, many valuable species have decreased and the forests in these regions have gradually disappeared. As a

result, anthropogenic steppes have emerged (https://az.wikipedia.org/wiki/azərbaycan_meşələri).

Table 1. Forest assets of Poland and Azerbaijan (Gedik et al., 2023)

Country	Surface area (km²)	Forest area (ha)	Forest area share (%)	Forest area per capita (ha)	The governing organization
Poland	312.677	9.483.000	29.7	0.24	Ministry of Environment and Climate
Azerbaijan	86,6.000	1.213,7.000	11.8	0.12	Ministry of Ecology and Natural Resources

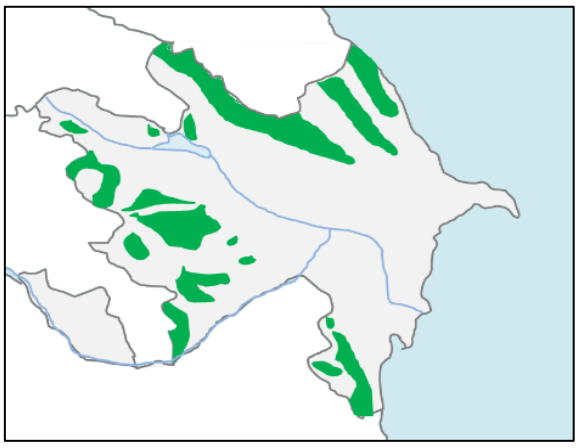

Fig. 1. Forest asset map of Azerbaijan (https://az.wikipedia.org/wiki/azərbaycan_meşələri)

4.2. Forest policy in Poland

Poland is the 5th most populous country in Central Europe. In terms of forest area, Sweden ranks first with 30.3 million ha, Spain ranks second with 28 million ha, and Finland ranks third with 23.2 million ha. Poland ranks ninth with 9,483 million ha (Table 1), (Eurostat, 2020). Although Poland is among the top 10 countries in Europe in terms of forest area, it ranks last in terms of forest area per capita (0.24 ha) (LASY, 2018; Zając et al., 2014.). In addition, a large part of Poland's forests (8,889,000 ha) have been obtained through afforestation, and these forests are considered a natural resource with market value and biological production. The 2020 forest asset map of Poland is given in Figure 2.

Forests and other woodlands in continental Europe cover more than 40% of the land area, making them one of the most forested regions in the world. The countries of the European Union share a range of forest-related jurisdictions, including the environment, climate and agriculture. Forests cover approximately 38.5% of Poland's territory, mostly state-owned, and are increasing rapidly by 2035. Poland's forest percentage will be 42–46%. The western and northern parts of Poland, as well as the southernmost Carpathian Mountains, are much more forested than the eastern and central provinces. The most forested administrative regions of the country are: Lubusz Voivodeship (60.2%), Subcarpathian Voivodeship (58.2%) and Pomeranian Voivodeship (50.1%). The least forested are: Łódź Voivodeship (36%), Masovian Voivodeship (34.6%) and Lublin Voivodeship (32.8%) (Gołos and Hilszczański, 2020).

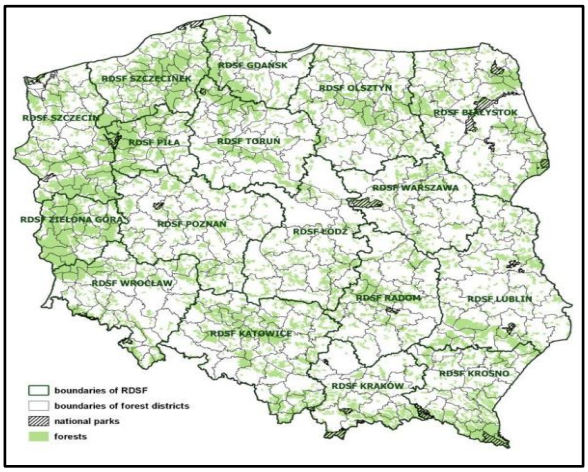

Fig. 2. Poland forest assets map (Gołos and Hilszczański, 2020)

Forests in Poland occupy the poorest soil. Coniferous species make up 54.5% (with absolute dominance of Scots pine - Pinus sylvestris), broad-leaved species make up 45.5% (outside of this, alder and coastal forests make up 3.8%). Over the years, many of the largest Polish forests have shrunk due to the influence of ecology and human factors, and this is reflected in the

structure of forest settlements. A number of forest areas are now protected by the Polish government and in many cases have become tourist attractions (https://en.wikipedia.org/wiki/Forests_of_Poland).

The tree composition of Polish forests is as follows:

Pine – 58.1% (European red pine), Oak – 7.7%, Birch – 7.3%, Spruce – 6.2% (Norway spruce), Beech – 5.9% (European beech), Alder – 5.7%, Other broadleaves – 4.9%, Other conifers – 4.2%. Known for its diverse landscapes, Poland is a treasure trove of natural beauty. From the sandy beaches of the Baltic Sea to the high peaks of the Tatra Mountains, the country's diverse topography is a testament to its rich biodiversity. But perhaps one of the most fascinating aspects of Poland's natural heritage is its forests. Home to 23 national parks, 149 landscape parks and over 1,200 nature reserves, Poland's forests are a haven for a wide variety of native tree species. [wikiped] Covering around 30% of the country, these forests are more than just a collection of trees. They are complex ecosystems that support a variety of flora and fauna and play an important role in preserving the country's biodiversity. They also serve as living proof of Poland's natural history, with some trees dating back hundreds of years (https://www.forestprotection.net/az/bilgiler/avrupa-birligi-ulkelerinde-orman-politikalari/).

5. Agriculture and climate change

Researchers are seeing the effects of climate change both globally and on European soils. According to a recent report by the European Environment Agency (EEA), soil moisture has decreased significantly in the Mediterranean region since the 1950s, while it has increased in some parts of Northern Europe. The continuous decrease in soil moisture is increasing the need for irrigation in agriculture, leading to lower crop yields and even desertification. Land use change has been the most important cause of biodiversity loss in terrestrial systems over the past few decades. This is primarily due to the conversion of natural ecosystems such as forests and grasslands into agricultural systems. Agriculture is the sector most exposed to the effects of climate change. This is because it is sensitive to the effects of weather and other factors (Mendelsohn, 2009]. Climate change has a serious impact on agriculture, negatively affecting crop production, livestock farming, soil quality and water supply. The misuse of fertilizers and pesticides, as well as the use of irrigation water and agricultural machinery for land use, has caused significant damage to the environment. The world population has been increasing in recent years. Over the last half century, agricultural systems have had to increase their production to meet increasing food demand. This process is mainly achieved through the expansion of arable land (Freedgood, 2024). In the United States, approximately two million farms and more than half of public lands are used for agricultural production (Walsh et al., 2020). Climate change poses a significant threat to global agriculture, disrupting crop production, soil health, water resources, and regional food security. Rising temperatures, changing precipitation and snowmelt patterns, and changing fertilization parameters all have major impacts on crop yields. According to a report by the CCCR-Central Bank on Climate Change, there is considerable evidence and data that the climate in Canada is already changing. Average annual and seasonal temperatures in Canada have increased. Climate change has increased the frequency of extreme weather events, such as fires, floods, hail, and storms across Canada. Although many regions in Canada experience periodic droughts, there has been no long-term change. In the future, droughts and soil moisture are expected to be more intense and widespread in the summer months. More than 100 species of plants important for pollination are grown in the United States. Warmer temperatures and changes in precipitation are causing plants to change the timing of their flowering and pollination (Reeves et al., 2019). If there is a mismatch between plants and pollinators, this will reduce productivity. Climate change cannot be completely eliminated, but it can be slowed down. Ecosystems have long suffered from a lack of structured data (Basole et al., 2011). There is a need for structured ecosystem data (Abdella et al., 2020).

6. Artificial intelligence and ecosystems

Artificial intelligence is already making a significant positive impact on climate change. It is

an important tool for understanding the impact of climate change, combating it, and developing adaptation strategies. Studies have already been conducted to document the potential positive impact of AI on climate change (Abrell et al., 2019; Huntingford et al., 2019). First, despite the basic facts of climate change, many aspects of the environmental crisis remain uncertain. This includes explaining observations of past and present events, predicting future outcomes, etc. The ability of AI to process large amounts of multidimensional data using complex optimization techniques already makes it easier to predict future trends (Farghali et al., 2023). Artificial intelligence can significantly reduce energy consumption through deep neural networks (Yang et al., 2023). Energy-related problems have emerged as one of the major global problems in modern society. The global economy is constantly expanding and the population is constantly increasing. (Cai et al., 2019). Effective measures should be taken to increase energy efficiency and reduce energy waste to meet the increasing energy demand. The transition to renewable energy is necessary to combat climate change. However, managing renewable energy sources such as solar and wind poses major challenges (Jacobides et al., 2021).

Artificial intelligence, which has emerged as a new technology tool in the energy sector, has offered new perspectives for improving energy efficiency (Lee and Yoo, 2021). The application of artificial intelligence in the energy sector can increase the efficiency of energy use by predicting energy demand, optimizing production and consumption. Thus, it can reduce environmental pollution and limit energy costs (Jones, 2017). Studies conducted in Japan and Italy show that the use of artificial intelligence or AI in energy management systems is widespread and yields positive results. Similarly, studies conducted in the UK, although still in its early stages, can conclude that the use of AI has shown good effects. Severe weather events such as hurricanes, hail and storms can cause serious damage to infrastructure and human settlements. As a result, both material damage and human lives are at risk. It is possible to predict extreme situations in advance and minimize damage using AI.

Artificial intelligence is widely used to search for all kinds of information and discover new climate models. This makes weather forecasts more accurate (Jones, 2017). According to the UN World Meteorological Organization (WMO), AI-driven technologies offer solid opportunities to process large amounts of data and improve forecast models. More and more experts are focusing on the potential of AI in weather forecasting. The impact of solar activity on climate variability, especially droughts and floods, is significant. Researchers have turned to AI to improve early detection and warning capabilities of solar activity (Pham et al., 2020). In particular, they used three-dimensional recognition techniques to identify meteorological and ecological drought events. Maximum temperature, minimum temperature, wind speed, relative humidity, solar radiation, and other meteorological features were collected (AlDousari et al., 2022).

The use of AI has led to a reduction in forecast uncertainty and an acceleration of forecasting. AI enables smarter and more automated global zoning and decision-making in land classification. In addition, AI has improved land functionality and land use sustainability. Experts deployed artificial neural networks to assess and predict changes in land cover in Kuwait (Wei et al., 2020). Artificial neural networks assessed soil parameters and determined more efficient land use methods. Then, experts used land use maps to examine how changes in land use affect sustainable development using local and global indicators. AI is also developing day by day in the fields of urban planning, transportation, and waste management. Various studies are being conducted to reduce carbon dioxide concentration in the air by increasing autonomous transportation systems using AI. In the Netherlands, an environmental organization called The Ocean Cleanup is using AI and other technologies to clean up plastic pollution in the ocean. Artificial intelligence helps the organization to create detailed maps of ocean waste in remote areas by detecting objects. Later, using these maps, the waste can be easily cleaned from there. In addition, artificial intelligence can also be applied in the field of agriculture.

The use of artificial intelligence makes modern agriculture more profitable and

sustainable (Jones, 2017). Artificial intelligence identifies pests, detects diseases and uses fertilizers and pesticides, plans their use and estimates the yield. Using genomic analysis methods, precision agriculture and artificial intelligence technologies can produce successful products that are beneficial to the soil and maximize crop production (Cai et al., 2019). In recent years, the difficulties of managing natural resources (especially soil, water and forests) have become a hot topic researched worldwide. Therefore, researchers are trying to reduce the risk of natural resource loss using artificial intelligence models. In particular, a neural memory network was used to model statistical data to predict deforestation in the Amazon rainforest (Wei et al., 2020). The results of the prediction of the future level of forest loss are calculated in order to take preventive measures. Therefore, artificial intelligence models are thought to reduce the risk of natural resource loss. Although cooperation between humanity and artificial intelligence in the fight against climate change has only recently begun, very good results have been achieved.

CONCLUSION

As the concentration of greenhouse gases in the atmosphere increases, the temperature rises even more due to the warming effect. With the increase in average temperatures, extreme climatic events such as storms, floods and fires occur more frequently. Frequent changes in weather conditions, such as early summers or warm winters, disrupt the natural rhythm of life. The consequences of global warming have been clearly seen in recent years. Although it is not possible to completely eliminate the problems caused by climate change, it is possible to slow down the pace of this process. As the global economy and population expand, energy demand has increased exponentially. It has been proven that traditional energy production methods are harmful to the environment. Artificial intelligence technology is emerging as a new tool in the energy sector. It offers a promising direction to solve these problems and combat climate change. Climate change is a serious challenge for agriculture. To overcome these challenges, the application of artificial intelligence requires government support and continuous experimentation. In particular, the per capita rate of forest land in Azerbaijan is very low. This is 4 times less than world standards. The destruction in the Shergi Zangezur region is obvious. The protection of our forests and the release of new forests are important tasks facing the state. In this way, it is possible to meet the food needs of the growing population and ensure food security. The AI and climate change review currently focuses primarily on the technical aspects of AI and takes into account the perspective of how AI can be applied in various areas affected by climate change.

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