

CHAPTER 6

Is Climate Change the Most Important Environmental Problem? The Relationship between Environmental Problems and Climate Change

Emrah HIGDE

Aydın Adnan Menderes University, Türkiye

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Climate

Climate refers to the long-term patterns and averages of weather conditions in a particular region or on Earth as a whole. It encompasses a wide range of atmospheric parameters, including temperature, humidity, precipitation, wind patterns, and more. Climate is distinct from weather, which refers to the short-term atmospheric conditions that can change daily or even hourly (Cartwright et al., 2021).

Climate is influenced by a variety of factors, including latitude, altitude, proximity to oceans or large bodies of water, and prevailing wind patterns. Climate can also change over long periods due to natural factors such as volcanic activity and variations in Earth's orbit, as well as human activities like deforestation and the release of greenhouse gases, which are contributing to modern climate change (Betz, 2019).

Understanding the climate of a particular region is crucial for agriculture, urban planning, and environmental management, as it helps predict long-term weather patterns and informs decision-making related to issues such as water resource management, disaster preparedness, and conservation efforts (Crisman et al., 2023).

Climate Change

Climate change refers to significant and long-term alterations in the Earth's climate

patterns, particularly changes in temperature and weather conditions, which are primarily driven by human activities. While the Earth's climate has naturally varied throughout its history, the term "climate change" is commonly used today to refer to the rapid and unprecedented changes in the Earth's climate system that have occurred since the Industrial Revolution, which began in the late 18th century (Baede et al., 2001).

The primary driver of contemporary climate change is the increase in greenhouse gas concentrations in the Earth's atmosphere, primarily carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). These gases are released into the atmosphere through activities such as the burning of fossil fuels (coal, oil, and natural gas), deforestation, and various industrial processes. Greenhouse gases trap heat from the sun, leading to a gradual warming of the planet, a phenomenon often referred to as global warming (Shukla et al., 2019).

Climate change is not only caused by human activities but also by natural events. There are several natural events that can cause climate change. Volcanic activities, solar radiations, orbital variations and El Niño and La Niña are the main examples of natural events that cause climate change. The release of gases that cause climate change significantly increases climate change. For this reason, the effect of gases released during volcanic activities on climate change has been the subject of research in many studies. When a volcano erupts, it releases a significant amount of greenhouse gases, such as carbon dioxide and sulfur dioxide, into the atmosphere. These gases can have a short-term cooling effect but can also contribute to long-term warming. Variations in the sun's energy output can influence Earth's climate. Changes in solar radiation affect the intensity and distribution of heat on our planet. The warming of the planet due to an increase in solar irradiance probably results in the release of methane and carbon dioxide from stores in the oceans and icecaps, and these greenhouse gases can then produce additional warming (National Academy of Sciences, 2020). Another natural phenomenon that causes climate change orbital variations. Earth's orbit around the sun experiences cyclic variations over long periods of time. These variations, known as Milankovitch cycles, can alter the amount and distribution of sunlight reaching Earth, impacting global climate patterns. Unexpected changes in the currents in our oceans, which maintain the natural balance that allows the world to warm and cool, affect climate change (Curran et al., 2021). El Niño and La Niña: El Niño and La Niña are natural climate phenomena that occur in the Pacific Ocean. These events involve the warming (El Niño) or cooling (La Niña) of the ocean surface, leading to changes in global weather patterns. It's important to note that while natural events contribute to climate change, human activities, such as burning fossil fuels and deforestation, are the primary drivers of the current climate crisis.

Climate change has many negative effects on the environment and living things.

Rising global temperatures are the most important of these effects. Due to the change of climate, the average global temperature has been steadily increasing, leading to warmer temperatures on Earth. This warming is linked to more frequent and severe heatwaves. These rising temperatures cause melting ice and rising sea levels. Higher temperatures are causing glaciers and polar ice caps to melt, contributing to rising sea levels. This poses a threat to coastal communities and ecosystems (IPCC, 2021). Climate change causes not only warming of the air but also changes in precipitation patterns. Climate change can lead to altered rainfall patterns, with some areas experiencing more intense rainfall and flooding, while others may face drought conditions (Cheng et al., 2016). In addition, climate change is associated with an increase in the frequency and intensity of extreme weather events, such as hurricanes, typhoons, wildfires, and heavy storms. In addition, climate change has caused not only the amount of CO₂ in the air to increase, but also the amount of CO₂ in ocean waters. Increased CO₂ levels are absorbed by the oceans, leading to ocean acidification, which can harm marine life, including coral reefs and shellfish (Findlay & Turley, 2021). Such rapid changes in the air and oceans do not allow living things to adapt and survive. That's why most ecosystems are disrupted as a result of climate change induced adverse conditions. Many species are struggling to adapt to rapidly changing conditions, which can lead to shifts in ecosystems and threaten biodiversity. One of the negative consequences of climate change is the adverse impact on agriculture and food security (Kumar et al., 2018). Changes in temperature and precipitation patterns can affect crop yields and food production, potentially leading to food shortages in some regions. While our world is struggling with famine and epidemics in many places, our world is becoming more fragile due to the impact of climate change. Extreme weather conditions caused by climate change pose human health risks for people same as all living things. Heatwaves, vector-borne diseases, and air pollution associated with climate change can pose health risks to human populations.

Efforts to address climate change involve reducing greenhouse gas emissions through measures such as transitioning to renewable energy sources, improving energy efficiency, protecting and restoring forests, and adopting sustainable land-use practices. International agreements like the Paris Agreement aim to bring countries together to set emission reduction targets and limit global temperature increases to well below 2 degrees Celsius above pre-industrial levels, with efforts to limit the increase to 1.5 degrees Celsius. These actions are essential to mitigate the worst impacts of climate change and protect the planet for future generations.

Factors Causing Climate Change

Climate change is primarily driven by human activities and natural processes. There are many human activities that cause climate change. The most well-known and visible human activities that cause climate change are greenhouse gas emissions, deforestation, agriculture, industrial processes, transportation, land use changes, unsustainable energy

use. The primary driver of contemporary climate change is the release of greenhouse gases into the atmosphere. Human activities, such as the burning of fossil fuels (coal, oil, and natural gas) for energy, deforestation, and industrial processes, have significantly increased the concentrations of greenhouse gases, including carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) in the atmosphere (USEPA, 2016). These gases trap heat from the sun, leading to a warming effect known as the enhanced greenhouse effect. Many human activities unconsciously increase greenhouse gas emissions and cause climate change. For example, cutting down forests and clearing land for agriculture and development reduces the Earth's capacity to absorb CO₂ through a process known as carbon sequestration. Deforestation is not only an environmental problem but also a one of the important causes of climate change. Forests act as carbon sinks, removing CO₂ from the atmosphere and storing it in trees and soil. Deforestation, therefore, contributes to higher atmospheric CO₂ levels (Bala et al., 2007). Another cause of human induced climate change is the agriculture practices. Agricultural practices, particularly livestock farming and rice cultivation, produce methane, a potent greenhouse gas. Additionally, the use of synthetic fertilizers in agriculture releases nitrous oxide, another potent greenhouse gas (Ortiz-Bobea, Ault, Carrillo, Chambers & Lobell, 2021). Changes in land use for agriculture can also lead to habitat loss and biodiversity decline, further affecting ecosystems and the climate. In addition to agriculture practices, various industrial processes, such as the production of cement and the use of certain chemicals, release greenhouse gases as byproducts. These emissions contribute to the overall greenhouse effect. Similarly, the transportation sector, including cars, trucks, ships, and airplanes, is a significant source of greenhouse gas emissions, primarily from the burning of fossil fuels for propulsion. In addition to the factors that have a global impact on climate change, there are also human induced factors that have a regional impact. Urbanization, land use changes, and the expansion of agriculture also contribute to local and regional climate changes, known as urban heat islands and land-use effects. Urbanization and land development alter land surfaces, affecting local climates and contributing to the urban heat island effect, where cities are significantly warmer than their surrounding rural areas (Li et al., 2022).

Climate change is also influenced by natural factors, such as volcanic eruptions, which can release large amounts of volcanic aerosols into the atmosphere, temporarily cooling the planet. Additionally, variations in solar radiation and natural climate cycles, like El Niño and La Niña, can influence short-term climate patterns. Climate change can trigger feedback loops that amplify its effects. For example, as the Arctic ice melts due to warming temperatures, it reduces the Earth's albedo (reflectivity), leading to more heat absorption and further warming. Similarly, thawing permafrost releases methane, a potent greenhouse gas, into the atmosphere.

It's important to note that while natural factors and processes can influence

climate, the current rate and extent of global warming are primarily attributed to human activities. Addressing climate change involves reducing greenhouse gas emissions, transitioning to cleaner energy sources, conserving forests, and implementing sustainable land-use practices to mitigate its impacts.

Is Climate Change a Major Environmental Problem?

Many people see climate change as the most important environmental problem for several reasons. It is very difficult to list these reasons in items. However, we can list a few of the most important reasons. Global impact on all regions, urgency due to rapid rate of change, interconnectedness with other environmental problems and critical concerns, magnitude of impact, long-term consequences, scientific consensus, global agreements, media coverage, youth and activism, economic implications are some of the important reasons to see climate change as an important environmental problem (Skogen et al., 2018).

Climate change is a global issue that affects all countries and regions. It doesn't respect national borders, and its impacts are widespread and interconnected. Rising global temperatures, sea-level rise, extreme weather events, and changing precipitation patterns can have far-reaching consequences, making it a top priority for international cooperation. Interplay of climate change-exacerbated rainfall, exposure and vulnerability led to widespread impacts in the Mediterranean region (Zachariah et al., 2023). The latest painful example of global impact of climate change is the flood disaster in Libya. According to the report published by the international "World Weather Attribution" initiative, human-induced climate change has made floods 50 times more likely in Libya. The severe flood disaster that occurred in Spain, Greece, Turkey, Bulgaria and Libya was caused by very heavy rains falling in less than 24 hours in Spain, while it lasted 24 hours in Libya and 4 days in Greece and Turkey. The incident in Libya The magnitude is well beyond that of previously recorded events, and we conclude that for the broad region that includes Greece and parts of Bulgaria and Turkey, human-caused climate change is making these events up to 10 times more likely and up to 40 percent more severe. The change made flooding in Libya up to 50 times more likely and up to 50 percent more severe. Even in this last striking example, many Mediterranean countries were affected (Christidis et al., 2023). Climate change is a common problem not only for a country or the people living in a region, but for the whole world.

Climate change is often perceived as an urgent problem because of the rapid rate of change and its potential to cause irreversible damage to the planet. The longer we delay taking action, the more challenging and costly it becomes to mitigate its effects. Climate change causes average temperatures to rise around the world. This leads to events such as drought, depletion of water resources, fires and extreme heat. Such events pose serious threats to agriculture, water resources, food security and human health. If

precautions are not taken, we may encounter irreversible, unexpected consequences in the near future. As sea levels rise due to melting glaciers, it can seriously affect coastal areas and island countries and lead to the displacement of millions of people. Climate change is a long-term problem that will affect future generations. Precautions not taken today may leave future generations with a more difficult and costly problem (Miles-Novelo & Anderson, 2022).

Climate change is not just an environmental issue; it intersects with various other critical concerns, including public health, food security, water resources, and economic stability. These interconnected challenges amplify the urgency of addressing climate change. Climate change affects natural ecosystems, alters the habitats of plant and animal species, and increases the risk of extinction of some species. This can lead to loss of biodiversity and disruption of food chains. Climate change affects not only the plants and animals living in the natural ecosystem but also the people in that system (Islam & Kieu, 2020). As a result of the degradation of the ecosystem, resources that are critical for human life are also affected. In addition, climate change can affect key sectors such as food production, water resources, energy supply and healthcare. This can disrupt economic stability and social balances, posing a greater threat especially to more vulnerable societies. Besides, climate change increases the frequency and severity of extreme weather events. These include events such as hurricanes, floods, droughts, and extreme rainfall. Such events can cause loss of life and billions of dollars in damage. Focusing only on the known effects of climate change, such as global warming, sea level rise, and extreme weather conditions, does not cover all the effects of climate change. In fact, climate change changes the entire ecosystem of the world and therefore interconnectedness with other environmental problems and has global impact on the world (Cramer et al., 2018).

Climate change has long-term consequences that affect future generations. People are concerned about the kind of world their children and grandchildren will inherit, making it a deeply personal and moral issue for many. In the long term, it may increase the frequency and severity of extreme heat waves. This can lead to consequences such as drought, reduced water resources and reduced agricultural productivity. Irreversible rises in sea level may cause the disappearance of some coastal areas and islands. Destruction of natural ecosystems can lead to the extinction of some species and result in loss of biodiversity. In the long term, these changes in ecosystems can affect people's access to food sources, water resources, and other ecosystem services. When agriculture and food security are affected, it can lead to increased food prices and deepening food insecurity problems in the long run. Considering the social and economic effects of climate change on societies, its long-term effects pose significant risks (Skogen et al., 2018).

There is a strong consensus among climate scientists that climate change is

primarily driven by human activities, particularly the emission of greenhouse gases. This scientific consensus lends credibility to the severity of the issue (Miles-Novelo & Anderson, 2022). Moreover, international agreements, such as the Paris Agreement, highlight the recognition of climate change as a paramount global challenge. The commitment of numerous countries to reduce greenhouse gas emissions underscores its importance on the international stage. Also, the economic consequences of climate change, including damage to infrastructure, agriculture, and insurance costs, have garnered attention from business leaders and policymakers. Climate change is increasingly seen as a financial risk that needs to be managed. Furthermore, climate change often receives significant media attention, raising public awareness and concern. Events like extreme weather disasters, melting glaciers, and rising sea levels are frequently covered in the news, helping to keep the issue in the public eye (Cramer et al., 2018). In addition to scientific consensus, international agreements and media coverage, young activists and movements like Fridays for Future, led by figures like Greta Thunberg, have brought climate change to the forefront of public consciousness. Young people around the world are advocating for immediate climate action, influencing public perception and policy discussions. Studies addressing the results of the Paris Agreement, which has obvious global importance, and awareness of people about environmental projects in the context of environmental education are important steps for climate change (Erten & Atmaca, 2021; Köseoğlu & Erten, 2022).

While climate change is seen as the most important environmental problem by many, it's important to note that other environmental issues, such as habitat loss, biodiversity loss, air and water pollution, and plastic pollution, also pose significant challenges and are interconnected with climate change. Addressing these issues collectively is crucial for ensuring a sustainable and healthy planet.

The Relationship between Climate Change and Other Environmental Problems

Addressing climate change often requires tackling the root causes of other environmental problems, and addressing these issues can, in turn, help mitigate climate change impacts. Integrated and holistic approaches are crucial to finding solutions that effectively address the interconnected challenges posed by these environmental problems. Climate change is intricately connected to various other environmental problems, and these relationships can exacerbate the challenges humanity faces in addressing both climate change and these associated issues (Cramer et al., 2018). Other environmental problems closely associated with climate change are biodiversity loss, water scarcity, land degradation, air pollution, ocean acidification, deforestation, migration and energy use.

Climate change can lead to shifts in habitats and temperature regimes that affect ecosystems and species. Biodiversity loss, in turn, reduces the resilience of ecosystems to climate impacts and disrupts essential ecological processes (Shukla et al., 2019). In addition, changes in precipitation patterns and increased evaporation due to higher

temperatures can lead to water scarcity. Water scarcity, coupled with climate variability, can strain water resources for both human consumption and agricultural use (Gude, 2017). Also, rising temperatures, altered rainfall patterns, and increased frequency of extreme weather events can contribute to land degradation, including soil erosion, desertification, and loss of fertile land. Moreover, some activities that contribute to climate change, such as burning fossil fuels, also release air pollutants. These pollutants can degrade air quality and have adverse health effects on humans and ecosystems. Similarly, the absorption of excess atmospheric carbon dioxide by the oceans leads to ocean acidification, which harms marine ecosystems, particularly coral reefs and shellfish populations. As a solution, forests act as carbon sinks, absorbing atmospheric carbon dioxide. Deforestation contributes to carbon emissions and reduces the planet's capacity to mitigate climate change. Furthermore, the need for increased cooling and heating due to temperature changes can affect energy demand. Energy production itself contributes to greenhouse gas emissions, creating a feedback loop between energy use and climate change (USEPA, 2016). Consequently, climate-related environmental changes can contribute to migration patterns and, in some cases, exacerbate tensions over resource scarcity, potentially leading to conflict. These issues regarding climate change are discussed in more detail below.

Biodiversity Loss

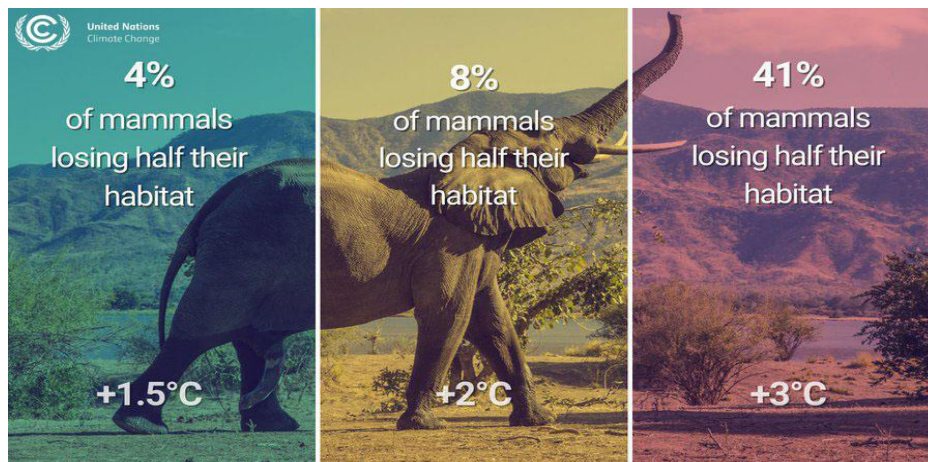
The relationship between climate change and biodiversity loss is complex and intertwined. Climate change directly impacts biodiversity by altering ecosystems, habitats, and species distributions, and at the same time, biodiversity loss can contribute to climate change by disrupting ecosystems' ability to regulate carbon and other environmental processes.

Climate change affects temperature and precipitation patterns, leading to shifts in habitats and ecosystems. Species that are adapted to specific climatic conditions may struggle to survive in altered environments, leading to reduced populations or even local extinctions (Höök et al., 2020). Moreover, many species are already migrating towards higher altitudes or latitudes to find suitable climate conditions. However, if their migration ability is limited or if they encounter barriers, they may not find appropriate habitats, leading to reduced population sizes or declines due to climate change (Weiskopf et al., 2020). Species with small populations or specialized habitat requirements are particularly vulnerable to climate change. Those that cannot adapt quickly enough or find new suitable habitats are at a higher risk of extinction (Trew & Maclean, 2021). Biodiverse ecosystems provide essential services like pollination, soil fertility, and water purification. As biodiversity declines due to climate change, these services may become less reliable or even collapse, impacting human well-being (Nunez et al., 2019). Particularly, climate change will lead to a decrease in the pollination activities of bees. The decrease in pollination activities, which is extremely important for plant

productivity, will bring about plant productivity losses (Eştürk, 2022). Regarding this situation, in a study on the pollination activity of bees due to climate change, Rader et al. (2013) studied watermelon and estimated that bees would cause a 14% decrease in watermelon yield by 2099 through the decrease in bee pollination due to climate change. On land, higher temperatures have forced animals and plants to move to higher elevations or higher latitudes, many moving towards the Earth's poles, with far-reaching consequences for ecosystems. The risk of species extinction increases with every degree of warming (United Nations, 2023).

Figure 1.

Climate Change (United Nations, 2023)



Intact ecosystems, such as forests and wetlands, play a vital role in absorbing and storing carbon dioxide. Biodiversity loss, especially in these ecosystems, reduces their capacity to sequester carbon, contributing to climate change (Miles, 2022). Also, biodiversity loss can amplify climate change through positive feedback loops. For example, the thawing of permafrost in the Arctic releases stored carbon and methane, contributing to greenhouse gas emissions and further warming (Mattox & Duda, 2022). Rising sea temperatures and ocean acidification caused by climate change can harm marine ecosystems, including coral reefs, which are among the most biodiverse habitats on Earth (Kelley et al., 2015). Addressing both climate change and biodiversity loss requires integrated strategies. Conservation efforts that protect and restore ecosystems can enhance their resilience to climate impacts (Malhi et al., 2020). Simultaneously, addressing climate change can help preserve biodiversity by reducing the pressures on ecosystems. Recognizing these interconnected challenges and implementing coordinated solutions is crucial for a sustainable and resilient future.

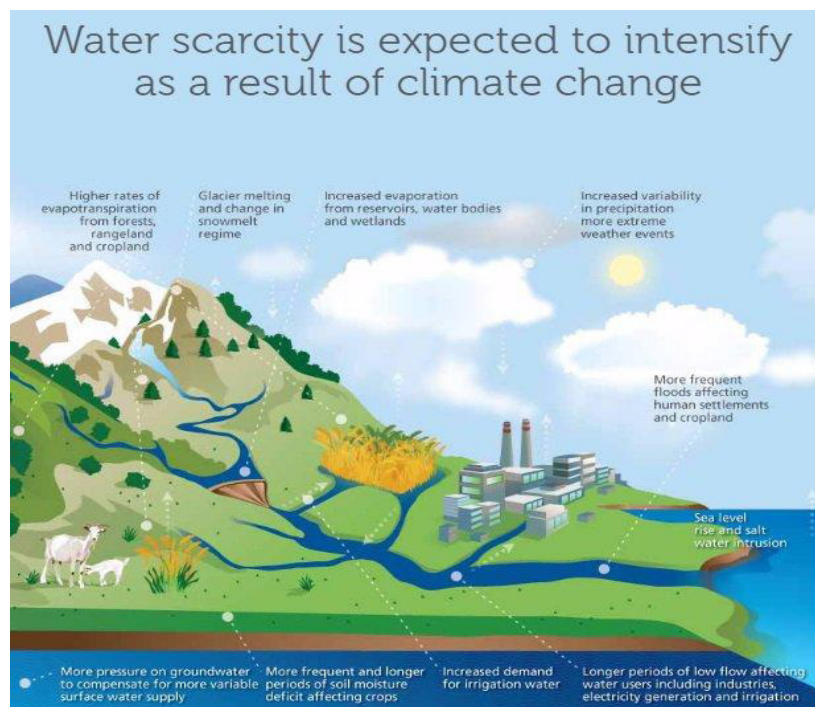
Water Scarcity

The relationship between climate change and water scarcity is significant and multifaceted. Climate change impacts the water cycle by altering precipitation patterns, increasing evaporation rates, and causing more frequent and severe extreme weather events. These changes exacerbate existing water scarcity challenges and create new ones.

Climate change can lead to shifts in rainfall patterns, causing some regions to experience more intense and prolonged droughts while others face heavier rainfall and increased flood risks (Fischer & Knutti, 2015). Altered precipitation patterns can lead to reduced recharge of groundwater reserves, depleting an important source of water in many regions (Scibek & Allen, 2006). As a result, increased demand for water due to population growth and economic development, combined with reduced water availability, intensifies competition for limited water resources. One of the important needs about water is sanitation and hygiene. Climate change induced water scarcity can lead to poor sanitation and hygiene practices, increasing the risk of waterborne diseases and impacting human health (Gude, 2017). Another effect of climate change is agriculture because of major water consumer. Changes in precipitation patterns and increased temperatures can affect crop yields and irrigation needs, leading to increased pressure on water resources. Moreover, higher temperatures caused by climate change result in increased evaporation rates from surface water bodies and soil, reducing water availability for ecosystems and human consumption (Trenberth, 2011). In addition to impact on precipitation and evaporation patterns, rising temperatures cause glaciers and snowpack in mountainous regions to melt at an accelerated rate (Mattox & Duda, 2022). Furthermore, rising sea levels can lead to saltwater intrusion into freshwater aquifers in coastal areas, rendering these sources unfit for human consumption and agricultural use (Figure 2).

Figure 2.

Soil land and Water (Food and Agriculture Organization of the United Nations, 2017)



More frequent and severe droughts, storms, and floods due to climate change can damage water infrastructure, disrupt supply systems, and contaminate water sources,

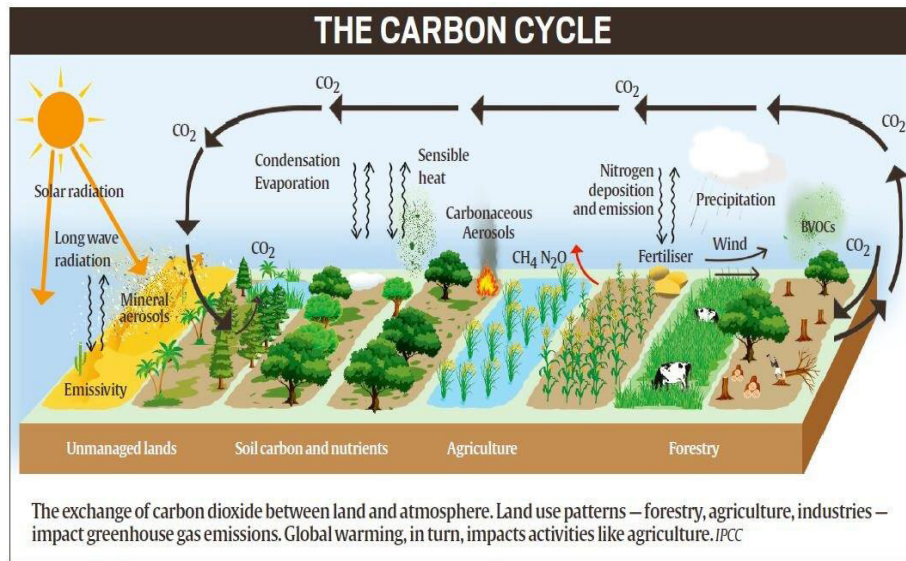
worsening water scarcity. In regions where water scarcity is already a concern, climate change can exacerbate resource competition, leading to migration and even conflict over water resources (Scibek & Allen, 2006). Problems arising from climate change affect not only humans but all living things and the ecological balance in their ecosystem are disrupted. Climate change induced reduced water availability affects freshwater ecosystems, leading to habitat loss and reduced biodiversity (Malhi et al., 2020). Aquatic ecosystems like rivers, lakes, and wetlands are particularly vulnerable.

Addressing water scarcity in the context of climate change requires adaptive strategies that consider the changing hydrological conditions. These may include improving water-use efficiency, investing in water storage and management infrastructure, implementing sustainable agricultural practices, and fostering international cooperation for equitable water sharing. Integrated approaches that consider both climate change and water resource management are essential to ensure water availability and resilience in the face of changing climate conditions.

Land Degradation

The relationship between climate change and land degradation is intertwined and mutually reinforcing. Climate change exacerbates land degradation processes, while land degradation contributes to climate change by releasing stored carbon and reducing the land's ability to sequester carbon. Some of the important relationships between climate change and land degradation are extreme weather events, soil erosion, loss of vegetation cover, desertification, deforestation, vulnerable communities, respectively (Shukla et al., 2019). Firstly, climate change leads to more frequent and intense extreme weather events such as heavy rainfall, droughts, and storms. These events can trigger erosion, soil compaction, and loss of soil structure, accelerating land degradation. Secondly, climate change can alter precipitation patterns and temperature regimes, leading to reduced vegetation cover. Vegetation plays a critical role in preventing soil erosion by stabilizing the soil with its root systems. Then, altered precipitation patterns and increased intensity of rainfall events due to climate change contribute to soil erosion, which is a form of land degradation. Eroded soil can carry nutrients away from agricultural fields and pollute water bodies. Also, higher temperatures and changes in precipitation patterns can exacerbate desertification processes, converting productive land into arid or semi-arid areas with reduced vegetation cover and soil fertility (Shukla et al., 2019). Especially, forests act as carbon sinks, absorbing carbon dioxide from the atmosphere. Deforestation contributes to carbon emissions and reduces the land's capacity to sequester carbon, thus exacerbating climate change. In addition, land degradation releases carbon stored in soil and vegetation, contributing to greenhouse gas emissions. This is particularly relevant in peatlands, wetlands, and degraded forests (Figure 3).

Figure 3.
Land use (IPCC, 2019)



Another important point where climate change and land degradation are related and trigger each other is the degradation of the ecosystem and therefore the vulnerable communities. Land degradation can contribute to positive feedback loops that worsen climate change. For example, degraded soils have reduced water-holding capacity, leading to reduced vegetation growth and further carbon loss (Skogen et al., 2018). Additionally, climate change can affect crop yields due to altered precipitation patterns and temperature extremes, which can contribute to overuse and degradation of agricultural land as farmers attempt to increase production. Significantly, land degradation reduces the ability of ecosystems to provide essential services such as water purification, soil fertility, and habitat for biodiversity, impacting human well-being (Shukla et al., 2019). One of the important consequences of climate change and land degradation is vulnerable communities. Many communities, especially in developing countries, are heavily dependent on natural resources for their livelihoods. Land degradation, worsened by climate change, can lead to reduced agricultural productivity and increased vulnerability.

Addressing both climate change and land degradation requires integrated strategies. Sustainable land management practices can improve soil health, increase vegetation cover, and enhance the land's capacity to sequester carbon (Skogen et al., 2018). These practices contribute to both climate change mitigation and adaptation efforts. Similarly, global climate mitigation efforts can indirectly help combat land degradation by reducing the factors that exacerbate it, such as deforestation and carbon emissions.

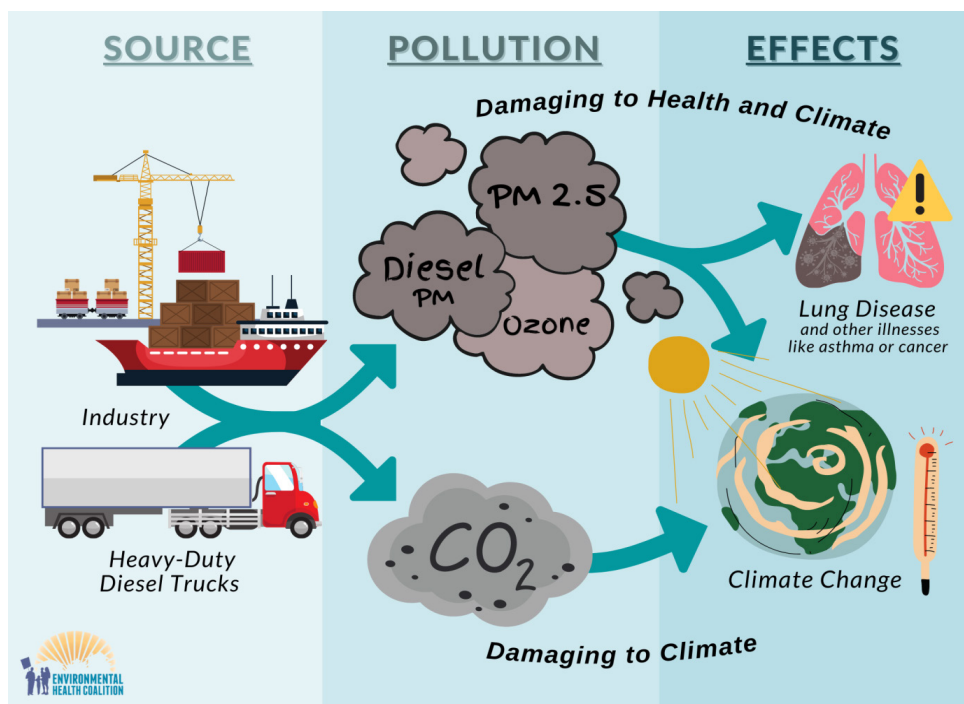
Air Pollution

The relationship between climate change and air pollution is interconnected and complex. While they are distinct issues, they are closely related as certain sources of air pollutants

also emit greenhouse gases that contribute to climate change. Additionally, some climate change mitigation efforts can have co-benefits for reducing air pollution. Essentially, many activities that release air pollutants, such as burning fossil fuels for energy and transportation, also emit greenhouse gases like carbon dioxide (CO₂) and methane (CH₄). This means that some sources of air pollution are also sources of climate-warming gases. Additionally, some air pollutants, like black carbon (a type of particulate matter) and certain aerosols, have both warming and cooling effects on the climate. They can absorb sunlight and heat the atmosphere while also influencing cloud formation and reflectivity. Another interconnection is health impact. Air pollution can have severe health impacts, including respiratory and cardiovascular diseases (Demirbaş & Aydin, 2020). Climate change, by increasing temperatures and altering weather patterns, can worsen air quality and health risks (Figure 4).

Figure 4.

Air pollution and climate change (Environmental Health Coalition, 2022)



Burning fossil fuels for energy is a major source of both air pollutants (like sulfur dioxide, nitrogen oxides, and particulate matter) and greenhouse gas emissions. In order to overcome climate change caused by burning fossil fuels, transitioning to renewable energy sources, such as solar and wind power, can help reduce both greenhouse gas emissions and air pollutants associated with fossil fuel combustion (Tang & Solangi, 2023). In addition, technologies that capture carbon dioxide from industrial processes or power plants can mitigate both climate change and the release of pollutants.

Climate change can increase the frequency and severity of wildfires, releasing large amounts of particulate matter and carbon dioxide. These fires contribute to air pollution and further amplify climate change. Efforts to address climate change, such

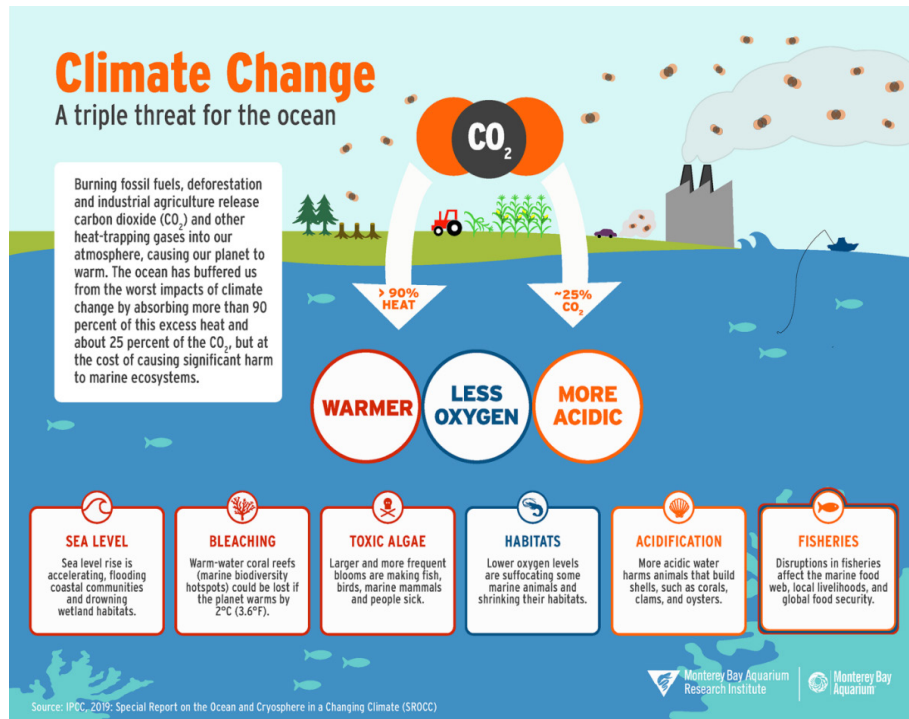
as transitioning to cleaner energy sources, improving energy efficiency, and promoting sustainable transportation, can have co-benefits for air quality by reducing emissions of both greenhouse gases and harmful pollutants (Tang & Solangi, 2023). Simultaneously, addressing air pollution through cleaner technologies and regulations can contribute to climate change mitigation and improve public health.

Ocean Acidification

The relationship between climate change and ocean acidification is closely linked through the absorption of excess carbon dioxide (CO₂) by the world's oceans. Carbon dioxide emissions not only contribute to global warming but also lead to a process known as ocean acidification.

The oceans act as a carbon sink, absorbing about one-third of the CO₂ emitted by human activities, primarily through the burning of fossil fuels. This absorption helps mitigate climate change by reducing the amount of CO₂ in the atmosphere. When CO₂ dissolves in seawater, it reacts with water to form carbonic acid. This process lowers the pH of seawater, making it more acidic. This increase in acidity is known as ocean acidification. Hence, ocean acidification can create a feedback loop with climate change. Impacts on marine ecosystems can affect their ability to sequester carbon and thus influence the global carbon cycle (Allen et al., 2014). Moreover, ocean acidification has negative impacts on marine ecosystems, particularly on organisms that rely on calcium carbonate to build shells and skeletons, such as coral reefs, mollusks, and certain types of plankton. Especially, corals are highly sensitive to changes in pH, and ocean acidification can impede their ability to build and maintain their calcium carbonate structures (Findlay & Turley, 2021). This weakens coral reefs and threatens the biodiversity they support. In addition, ocean acidification affects the availability of calcium carbonate minerals that shellfish, like oysters, mussels, and clams, need to build and maintain their shells (Kelley et al., 2015). This can impact shell growth and overall health. Consequently, changes in the survival and growth rates of key species due to ocean acidification can disrupt marine food webs and ecosystems, affecting fisheries and marine biodiversity (Figure 5).

Figure 5.
Ocean acidification (Pörtner et al., 2019)

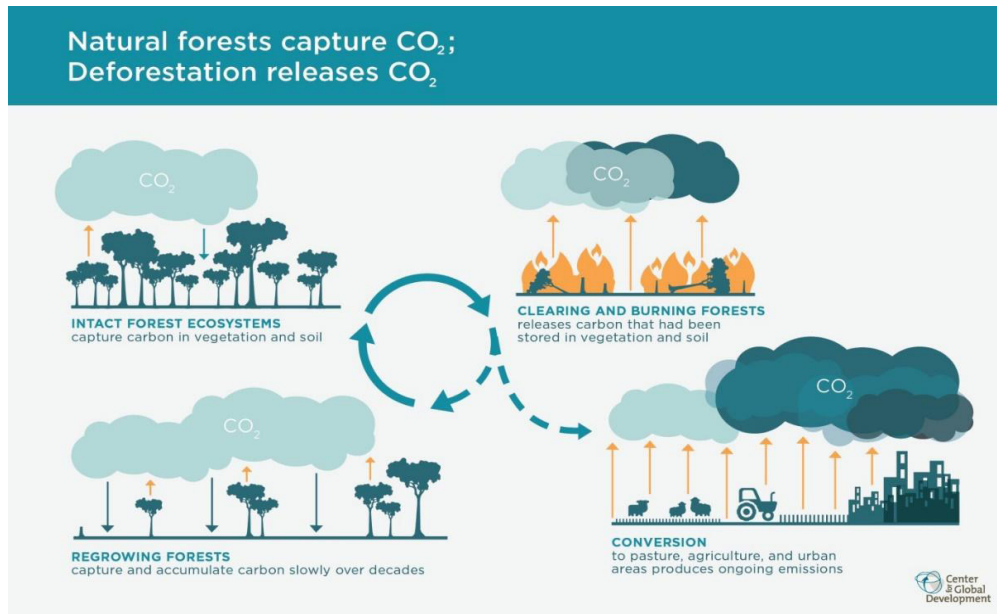


Addressing both climate change and ocean acidification requires coordinated efforts. Reducing carbon emissions is crucial for mitigating both issues. Additionally, measures to protect marine ecosystems, such as creating marine protected areas and implementing sustainable fishing practices, can enhance the resilience of marine life to the impacts of ocean acidification (Curran et al., 2021). Recognizing the interconnections between these challenges is essential for developing comprehensive and effective solutions.

Deforestation

The relationship between climate change and deforestation is closely intertwined, as both issues influence and reinforce each other. Hence, deforestation, the clearing of forests for various purposes, contributes to climate change by releasing stored carbon into the atmosphere, while climate change can impact forests through changing temperature and precipitation patterns. Therefore, forests are important carbon sinks, meaning they absorb and store carbon dioxide from the atmosphere. When forests are cleared or burned, the stored carbon is released back into the air as carbon dioxide, a major greenhouse gas that contributes to climate change. Particularly, deforestation reduces the Earth's capacity to sequester carbon (Figure 6). As forests shrink, their ability to remove carbon dioxide from the atmosphere diminishes, exacerbating the problem of elevated atmospheric carbon levels (Bala et al., 2007).

Figure 6.
Deforestation (Busch & Seymour, 2014)



Climate change can affect forests through altered temperature and precipitation patterns, which may lead to increased vulnerability to pests, diseases, and wildfires. These impacts can further degrade forests, releasing more carbon and contributing to climate change. Especially, some regions, such as the Amazon rainforest, have a hydrological cycle that depends on forests. Deforestation can disrupt this cycle, creating drier conditions that further promote forest degradation and fires. For this reasons, preserving and restoring forests can play a crucial role in mitigating climate change. Forest conservation and reforestation efforts can help absorb carbon dioxide from the atmosphere and enhance carbon storage. Also, indigenous and local communities often depend on forests for their livelihoods. Climate change impacts and deforestation can exacerbate vulnerabilities in these communities (Skogen et al., 2018). Addressing deforestation is an important component of global efforts to mitigate climate change. Efforts to conserve forests, promote sustainable land-use practices, and implement reforestation and afforestation projects can help both reduce carbon emissions and enhance the resilience of ecosystems to changing climatic conditions.

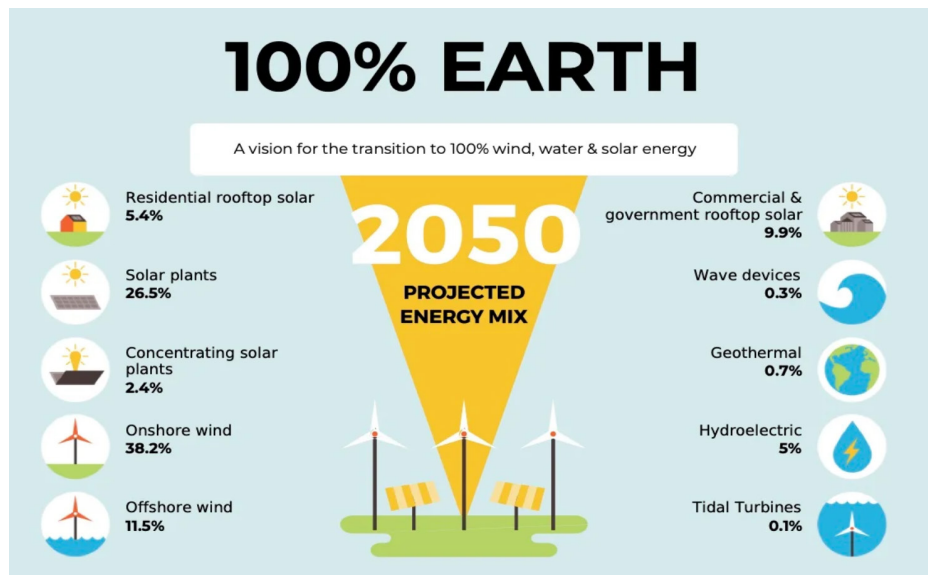
Energy Use

The relationship between climate change and energy use is central to understanding the root causes of climate change and the potential solutions to mitigate its impacts. Energy production and consumption are major contributors to greenhouse gas emissions, the primary drivers of climate change. In addition, the burning of fossil fuels, such as coal, oil, and natural gas, for energy is a major source of carbon dioxide (CO₂) and other greenhouse gas emissions (Miles, 2022). Therefore, these emissions trap heat in the atmosphere and contribute to global warming. For instance, many power plants use

fossil fuels to generate electricity. Transitioning from these carbon-intensive sources to renewable energy sources, such as solar, wind, hydroelectric, and nuclear power, is critical to reducing emissions. Fossil fuels are also the primary energy source for transportation, including cars, trucks, ships, and airplanes. Shifting to electric vehicles and sustainable fuels can significantly reduce emissions from the transportation sector. Furthermore, industries like manufacturing and cement production rely on energy-intensive processes that release significant amounts of CO₂. Implementing energy-efficient technologies and using low-carbon energy sources can help mitigate emissions. Additionally, shifting to renewable energy sources not only reduces emissions but also decreases the reliance on finite fossil fuel reserves, enhances energy security, and creates new economic opportunities (Tang & Solangi, 2023).

Figure 7.

Transition to renewable energy sources (Jacobson, 2019)



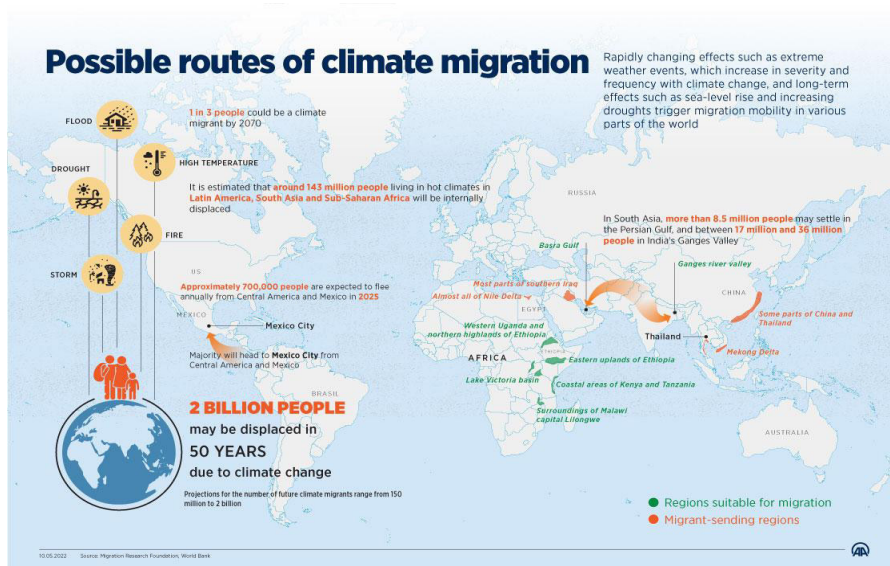
Climate change can influence energy use by increasing the demand for cooling in hotter regions and heating in colder regions. Increased energy demand, often met by burning fossil fuels, can then contribute to more emissions and exacerbate climate change. Therefore, renewable energy can provide a sustainable solution for energy access without increasing emissions (Bala et al., 2007). As the global population grows, ensuring access to clean and affordable energy is essential. Also, addressing energy-related emissions requires international cooperation to share technologies, best practices, and policies for transitioning to cleaner energy sources. Efforts to combat climate change require a fundamental transformation of the global energy system (Figure 7). Transitioning away from fossil fuels, improving energy efficiency, and adopting sustainable energy sources are critical components of mitigating climate change and achieving a more sustainable future.

Migration and Conflict

The relationship between climate change, migration, and conflict is complex and can have wide-ranging social, economic, and political implications. While climate change is not the sole cause of migration and conflict, it can exacerbate existing vulnerabilities and tensions in regions already facing social and political challenges. In fact, those who migrate due to climate change cause more climate change by uncontrolled use of the resources in the regions they migrate to. Therefore, climate change can lead to resource scarcity, such as water and arable land, which can intensify competition among communities. This competition can lead to conflicts over access to limited resources. Especially, environmental changes, such as sea-level rise, droughts, and desertification, can displace communities that rely heavily on agriculture, fishing, or other climate-sensitive livelihoods. This displacement can contribute to both internal and cross-border migration (House, 2007). As a result of climate-related events, such as extreme weather events, can damage infrastructure, disrupt supply chains, and negatively impact economies. These economic shocks can contribute to increased poverty and inequality, which are often associated with migration and conflict risks. Not only economical but also political instability negatively impact of climate change influence all world (Figure 8). Especially, climate change impacts can undermine the ability of governments to provide essential services and protect their populations. This can erode trust in institutions and potentially lead to political instability and conflicts (Nordås & Gleditsch, 2014).

Figure 8.

Mitigation and Climate Change (Migration Research Foundation Report, 2022)



Climate change-induced environmental stresses can lead to the displacement of people within their own countries or across borders. These displaced populations, known as climate refugees, can strain host communities and create tensions (House, 2007). As a result, some individuals and communities may choose migration as an

adaptive response to environmental changes. This movement can lead to the potential for social tensions in host communities. Moreover, climate change-related stresses can amplify existing social and political tensions, creating conditions conducive to conflict escalation. Besides, climate change can exacerbate existing humanitarian crises by increasing the frequency and severity of natural disasters, which require responses from both local and international actors (Bettini, 2017). Consequently, recognizing and addressing the interactions between climate change, migration, and conflict requires a comprehensive approach. This includes efforts to reduce greenhouse gas emissions, strengthen local adaptive capacities, support sustainable development, enhance conflict prevention strategies, and promote international cooperation to address the root causes of vulnerability and instability.

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About The Authors



Emrah HIGDE Assoc. Prof. Dr. of Faculty of Education Department of Mathematics and Science Education at Aydın Adnan Menderes University in Türkiye. He received his doctorate on Science Education in 2018 from Graduate School of Natural and Applied Sciences at Aydın Adnan Menderes University, Türkiye. His research interest relates to environmental education, science education, STEM education and teacher education.

E-mail: emrah.higde@adu.edu.tr

ORCID:  0000-0002-4692-5119