CLIMATE CRISIS

Research within the Framework of Disaster Preparednes

Editor
Afşin Ahmet KAYA

Social Sciences

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PREFACE

Unfortunately, the world is in the midst of a profound change. The moment we realize this signifies a time frame in which we may already be too late. With its escalating impacts, this transformation will not only affect nature, living beings, and systems but will also influence the entire future. Disaster management adopts a comprehensive system that begins with planning for events before they occur, extending to the moment of the event and its aftermath. When climate change is examined within this systematic framework, it becomes evident that if intervention is not possible before the event, mitigating the damage and keeping losses under control during and after the event will be extremely challenging. However, the pre-disaster risk reduction phase demonstrates that by reducing the effects of the disaster, emergency levels can be minimized before the event occurs.

This editorial work explores how climate change, occurring on a global scale, is evaluated from the perspective of disaster management. Additionally, it delves into secondary disasters caused by climate change and the methods employed to combat them. As we continue to grapple with the long-term impacts of global climate change, the topics discussed in this work will frequently be the subject of conversation.

In the creation of this work, experts in the field and experienced scientists in disaster management have contributed. I express gratitude to the authors and the working team for their contributions to this work, and I hope it proves beneficial to readers and the academic community.

Assoc. Prof. Dr. Afşin Ahmet KAYA
November-2023

Dünya ne yazık ki uzun bir değişimin içinde. Bunu fark ettiğimiz an bile geç kaldığımız bir zaman dilimini ifade ediyor. Artan etkileri ile bu değişim sadece doğayı canlıları ve sistemleri değil tüm geleceği de etkileyecek. Afet yönetimi olayların öncesini planlamaktan başlayarak olayın gerçekleştiği anı ve sonrasını da kapsayacak bir sistemi benimser. İklim değişikliği bu sistematik içinde incelendiğinde olayın öncesinde müdahale edilemez ise olay anı ve sonrasında sadece zarar azaltma ile kayıpları kontrol altında tutma çok zor olacaktır. Oysaki afet olmadan önceki risk azaltma aşaması, afetin etkilerinin azaltılarak acil durum seviyelerine indirgenebileceğini göstermektedir.

Bu editoryal eser de küresel ölçekte meydana gelen iklim değişikliklerinin afet yönetimi bakış açısı ile nasıl değerlendirildiği anlatılmaktadır. Ayrıca iklim değişikliğinin oluşturduğu ikincil afetler ve bunlar ile mücadele yöntemlerine de değinilmektedir. Etkilerinin uzun vadede görüleceği küresel iklim değişikliği ile mücadele devam ederken ele aldığımız konular bu süreçte sıklıkla konuşulacaktır.

Bu eserin oluşturulmasında alanında uzman ve afet yönetimi konusunda tecrübeli bilim insanları katkı sunmuştur. Bu esere katkı veren yazarlarımıza ve çalışma ekibime teşekkür eder, okuyuculara ve akademi dünyasına yararlı olmasını dilerim.

Doç. Dr. Afşin Ahmet KAYA

Aralık-2023

CONTENT

CHAPTER I

CLIMATE CHANGE AND RENEWABLE ENERGY

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1. Introduction

The earth gets its heat from the sun's rays, which are reflected off the surface of the globe and captured by certain air molecules. As a result, the temperature of our planet reaches a level that is suitable for the continuance of natural life. The greenhouse effect is the name given to this characteristic of the atmosphere, and molecules like carbon dioxide are referred to as greenhouse gases. Photosynthetic plants can change carbon dioxide, which is generated as a byproduct of aerobic combustion, back into oxygen. This cycle develops a sustainable system in the regular harmony of natural existence. But since fossil fuels like coal and oil are used in excess to generate the energy needed for industrial production, carbon dioxide is released into the atmosphere in quantities that cannot be processed by the photosynthetic system. The conversion of carbon dioxide stored in the atmosphere, however, declines towards a critical level in terms of natural life as a result of the quickening destruction of forests and the degradation of the marine ecosystem as a result of pollution. The greenhouse effect has gradually grown to such proportions that it is now responsible for an increase in the global average temperature, devastating storms, excessive precipitation, and drought in some regions. In a few decades, natural life on Earth will be in risk of going extinct if this troubling trend is not rapidly reversed.

2. Climate Change

Climate change, a sort of man-made disaster that threatens the socioeconomic system, natural ecosystems, and the lives of people and all

other living things, is the largest global disaster risk in today's globe. The gases released into the atmosphere as a result of burning fossil fuels and creating the greenhouse effect are the primary driver of climate change. The greenhouse effect is when gases like carbon dioxide, carbon monoxide, nitrous oxide, and methane capture solar heat and reflect it back to space, raising Earth's temperature over time (Figure 1). Rising temperatures result in iceberg melting, an increase in ocean levels, modifications to the Earth's normal climate, and eventually meteorological events that can result in catastrophic disasters like destructive storms, sudden and heavy rains, or large-scale forest fires. According to the World Meteorological Organization's most recent research report, over 2 million people died as a result of 11,778 climatic disasters that took place throughout the world between 1970 and 2021, causing a total economic loss of 4.3 trillion dollars. The most startling finding of the study is that hurricanes and floods have been primarily responsible for increasing the amount of economic damage during the past 51 years, particularly after 2010. (World Meteorological Organization, 2023) Early warnings save lives despite the fact that the financial consequences of weather-related calamities are on the rise.

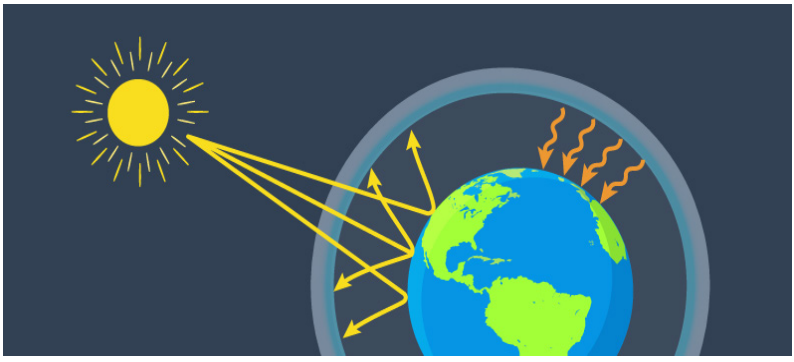

Figure 1. The Atmosphere's Greenhouse Effect

Reflections from the Earth's surface return solar radiation that contains thermal energy. Some molecules in the atmosphere reflect these rays, which warms our atmosphere and naturally the Earth's surface. The gases that generate this atmospheric impact are known as greenhouse gases, and the phenomenon itself is referred to as the greenhouse effect. Our atmosphere currently contains more than 400 ppm of carbon dioxide, which is higher than the typical level of less than 300 ppm.

The usage of fossil fuels like coal and oil expanded along with the industrial revolution as energy demands rose. Prior to the industrial revolution, individuals

could fulfill their fundamental energy demands by using animal power, water, wind, and wood burning. The need for fossil fuels has grown, nevertheless, as a result of the industrial revolution's rising energy needs for production on the one hand and the expanding population's energy needs near the manufacturing facilities on the other. Large-scale industrialisation occurred in the middle of the 19th century, which is when air and environmental pollution first appeared in urban areas. The average temperature values around the globe have risen somewhat more each year as a result of the greenhouse effect brought on by the gases that contribute to air pollution, reaching critical levels that might lead to global climate changes toward the end of the 20th century. The fact that energy consumption has tripled since 1950 is one of the most significant signs of this unfavorable picture. Fossil fuels currently account for more than 70% of the energy needed for transportation, heating, and power production in the globe (Figure 2).

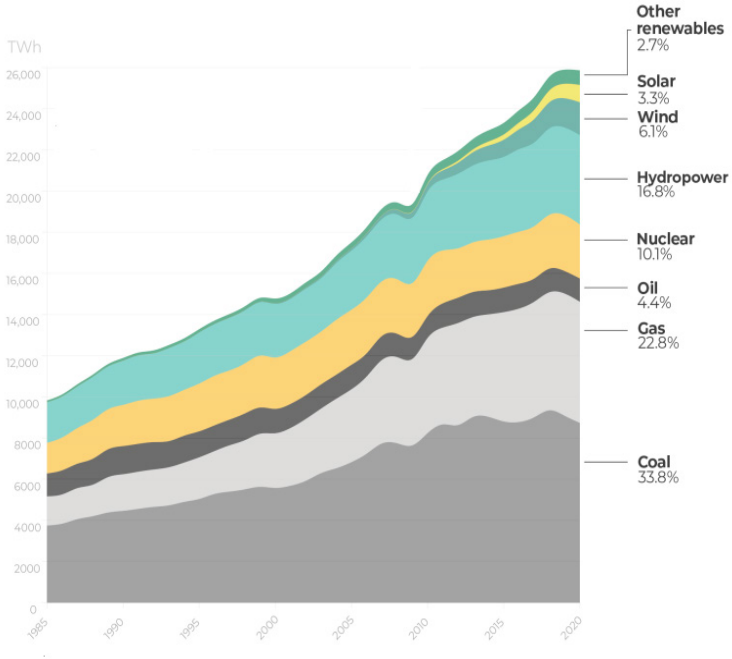

Figure 2: Production of Electricity Worldwide
Source: Woodcock, V.L. 2022.

Burning fossil fuels like coal, gas, and oil produces around 60% of the power used in the globe.

Methane is another significant greenhouse gas in addition to carbon dioxide. This molecule, which makes up the majority of natural gas, is becoming

more prevalent every year in the environment. Measurings show a 150% rise in methane gas concentration in our atmosphere during the previous 250 years. Natural gas that hasn't been burnt is the main contributor of methane gas in the atmosphere. Domestic and environmental solid wastes that have been buried in the soil are a significant source of methane. Methane gas is created during their microbial fermentation. Methane gas is also primarily produced by livestock. Methane gas is released into the atmosphere as a result of microbial activity, particularly in the digestive tracts of cattle. Methane gas is produced as a result of rice growing, which covers a significant area of wetlands.

According to current standards, the greatest risk of a worldwide catastrophe for our planet is the threat posed by climate change. Today's average worldwide temperature has increased by 2 degrees Celsius, which is considered the threshold for global climate change by scientific communities. When this limit is exceeded, water supplies might quickly run out. The melting of the glaciers is predicted to cause the sea level to rise by around 5 m if the average temperature increase reaches 5 °C. It is predicted that massive people migrations would occur as a result of climate change's severe effects if this increase reaches 6 °C. There is a very significant point here that shouldn't be missed. The crucial point was attained over a protracted time beginning in the middle of the 19th century. People may mistakenly believe that "we have more time" as a result of this. However, contrary to popular belief, the critical point did not occur over a lengthy period of time, but rather specifically in the second half of the 20th century, at a period of fast urbanization, significant industrial advancements, quick consumption, and heavy use of forests. Every day use of fossil fuels and environmental contaminants have each risen to extremely high levels, and the critical point has been reached. This bleak picture, which is becoming worse every day, has sped up the logarithmic rise in average temperature values. For this reason, it is stated that if some novel energy consumption strategies are ignored and consumption values keep increasing at the same rate, we will soon face a global climate condition in which all forms of natural life on Earth will vanish completely (Yapraklı and Bayramoğlu, 2017: 19).

Of course, this terrible catastrophic scenario is avoidable. Every person who resides in this earth has a responsibility and obligation. Since the 1980s, when the issue was established as a scientific fact, the United Nations (UN) organization has held special meetings on a regular basis to examine a number of action plans, increase awareness of the issue, and promote scientific investigation into it. The UN Conferences on Environment and Development

helped to draft the Framework Convention on Climate Change, which went into effect in 1994. The nations taking part in the conference and signing the agreement have committed to reducing greenhouse gas emissions and helping to create a sustainable ecosystem within the framework of this treaty. Although the contracted goals haven't been entirely attained globally in the roughly 30-year time that has passed, a glimmer of optimism for the future has appeared as we get closer to the present. The following is a list of the safety measures and actions that should be implemented in this situation:

1. Reducing the energy requirement: Much more energy-efficient devices will be created; Thermal insulation in buildings will be made much more effective and traditional methods of heating and cooling buildings will be discontinued; Energy savings will be achieved by emphasizing the use of recycled materials in manufacturing on the one hand, and by developing innovative production technologies on the other.

2. Reducing daily energy use: Educational programs will be developed to give individual energy consumption the most consideration, and awareness among the public will be increased. As a result, less energy will be utilized for activities such as transportation, food preparation, cleaning, and entertainment that are part of everyday living.

3. Transition to innovative and renewable energy production: It will be made sure that clean, environmentally friendly, and renewable energy sources are used instead of fossil fuels that release greenhouse gases to fulfill industrial and home energy demands. The sooner and simpler the transition to a future powered by renewable energy sources will be, the greater energy savings that may be made.

3. Renewable Energy Systems

In terms of renewable energy sources, electricity produced by solar, wind, and hydraulic power immediately springs to mind. The electrical energy generated by employing the sun, wind, and hydraulic power will be able to totally satisfy this need after the energy required has been converted to electricity (electrification). Electrical energy is extremely clean and leaves no waste if it is produced using renewable energy sources, transported to the consumer with a secure infrastructure, and used with high-tech, energy-efficient equipment (such as heat pumps for heating). In large vehicles like trucks, aircraft, and ships, if the energy generated this way is insufficient, liquid biofuels and biomass (or bioenergy) can be utilized instead of fossil fuels. They can also be used in

industrial operations that call for high heat. Due to the harmful radioactive waste it generates and the fact that it can be active for thousands of years, nuclear energy does not represent the best solution for the future.

3.1. Solar Energy

Photovoltaic panels can transform solar energy into electrical energy. For instance, 7 MWh of power may be generated annually with a 5 kWp photovoltaic system put on the rooftops of homes. Every MWh, a coal plant releases roughly 0.9 tons of carbon dioxide. A household solar system reduces carbon dioxide emissions by around 6 tons every year. Solar power plants that can generate energy at various powers can be built by connecting photovoltaic panels in series with one another (Figures 3 and 4).

Figure 3: A Photovoltaic Cell-Based Solar Power Generation Example

On the roof of a home is a household solar cell system with a 5 kWp capacity.

Figure 4: Installed 5 Mwh Solar Power Plant with Photovoltaic Cells in Antalya-Türkiye

Another method of harnessing solar energy to produce electricity is to use mirrors to concentrate the sun's heat to a specific spot, which is used to boil water, convert it to steam, and then use the steam turbine to produce electricity. As a result, a totally clean and eco-friendly substitute for current coal- or gas-fired thermal power plants might be developed. On this basis, both brand-new solar power plants and thermal power plants that are already in operation might be renovated and turned into solar power plants (Figure 5).

Figure 5: It Shows 5 MW Solar Power Tower in Mersin, Türkiye

To direct sunlight toward the central tower, mirrors (collectors) are positioned all around the power plant. As a result of the heat from the reflected sun rays, the water in the pipes inside the tower boils and is then delivered to the turbines to power the generators there.

After paying for installation, solar energy's main benefit is that it doesn't require any more input for the production of power. On the other hand, installation prices are steadily declining as a result of inventive technical advancements. A solar power plant's installation cost, for instance, dropped from 4731 USD per kW in 2010 to 883 USD in 2020, according to a research released by IRENA in 2021. From 14% to 17%, the production capacity grew by 17%. As a consequence, the cost of power usage per kWh dropped from 0.381 USD to 0.057 USD, an 85% reduction. Figure 6 shows that solar energy is the most cost-effective renewable energy source during a ten-year period, from 2010 to 2020, in terms of both investment and production costs.

	Total installed costs (2020 USD/kW)			Capacity factor (%)			Levelised cost of electricity (2020 USD/kWh)		
	2010	2020	Percent change	2010	2020	Percent change	2010	2020	Percent change
Bioenergy	2 619	2 543	-3%	72	70	-2%	0.076	0.076	0%
Geothermal	2 620	4 468	71%	87	83	-5%	0.049	0.071	45%
Hydropower	1 269	1 870	47%	44	46	4%	0.038	0.044	18%
Solar PV	4 731	883	-81%	14	16	17%	0.381	0.057	-85%
CSP	9 095	4 581	-50%	30	42	40%	0.340	0.108	-68%
Onshore wind	1 971	1 355	-31%	27	36	31%	0.089	0.039	-56%
Offshore wind	4 706	3 185	-32%	38	40	6%	0.162	0.084	-48%

Figure 6: The Table Shows How the Costs of Production and Installation Have Changed for Various Energy Systems Between 2010 and 2020
Source: Renewable Power Generation Costs in 2020: International Renewable Energy Agency, 2021.

Solar power plants may have drawbacks in addition to these advantages. A relatively wide area is required to build a solar power plant, as seen in Figure 4. Particularly among environmentalists, this condition may give rise to the concern that natural life and the ecosystem may be harmed during the construction of such a facility. However, by employing logical techniques, these drawbacks can be removed.

For instance, harsh, uneven ground that receives high sunshine, cannot be used for agriculture, and does not naturally have a lot of flora can be a perfect location for solar power plant installation (Figure 7).

Figure 7: The Photograhy Shows the Beşparmak Mountains' South-Facing Skirts

The Island of Cyprus, which lies in the Eastern Mediterranean and has year-round sunshine, has mountains that are well situated for the construction of solar generating facilities.

A significant space for the construction of solar power plants may also be created by bicycle lanes designated for cyclists on roads. For instance, a 32 km stretch of a Korean highway's bicycle-only segment is covered in solar panels. Cycling enthusiasts were able to enjoy a comfortable riding environment that was shielded from the sun while simultaneously producing power (Figure 8).

Figure 8: Path for Bicycles

The solar-covered cycling route that was constructed in the center of a Korean highway not only generates the electricity required to illuminate the road, but it also keeps it warm in the winter, keeping the road from freezing. As a result, it offers a secure and convenient mode of transit for both bicycles and motor vehicle traffic.

Some of the materials used to make solar panels can be harmful to the environment and human health. While not ideal, hazardous materials are occasionally employed to enhance the effectiveness and robustness of solar power systems. For instance, the environment can be harmed by chemicals like cadmium, copper indium gallium selenide (CIGS) used in the creation of thin films, and silicon tetrachloride discharged during the production of silicon solar cells. To stop the discharge of harmful contaminants into the environment,

manufacturers should take action. Solar cells must also be carefully recycled when they have served their purpose.

3.2. Wind Power

Rotating the blades, which are attached to an alternator that produces electricity, converts wind energy into electrical energy. As a result, the wind's kinetic energy transforms first into mechanical energy, then into electrical energy. This may be accomplished with either horizontal or vertical axis wind turbines. Depending on the strength and speed of the utilized alternator, different powers of electricity can be generated. In a personal sense, a modest wind turbine that may be put on the roof of the home in a windy region may be able to fulfill the domestic power requirement (Figure 9).

Figure 9: The Photography Shows the Wind Turbines Installed on a Home's Roof for Personal Electricity Production

There may be enough power to power a small residential area if a much larger alternator is put on a long, sturdy pole and driven by a long-bladed propeller. By connecting these propellers in series in a location with strong winds on average each year, wind power facilities (also known as "wind farms") may be constructed (Figure 10).

Figure 10: The 100 MW Kıyıköy Wind Farm (Kırklareli-Türkiye)

The most significant drawbacks of wind power plants, however, are their expensive installation costs for transportation and assembly as well as the noise they produce thereafter that has a severe impact on the environment. Wind farms can have a negative impact on migratory birds. Bird migratory paths could be altered by a wind farm built in the incorrect place. The region's bird species will undergo significant alteration as a result of the change in migratory paths, which also implies that many of them are ejected from their homes and lost their lives. Turbines must thus be built in a way that prevents interference with bird migration. It is well recognized that wind farms may alter the climate in small ways. These power plants being concentrated in one area may alter the wind patterns and alter the environment. There must be a proportionality between the wind power and the turbines in order to prevent a decline in airflow and wind speed.

3.3. Hydraulic Power

By harnessing the mechanical energy of current, wave, and tide, hydraulic power may be transformed into electrical energy. Hydroelectric power plants, the first of which was used in 1882, are the most well-known of them. Hydroelectric power stations operate similarly to wind power plants. Water from a dam is blown into the turbine at a great height. By turning the alternators attached to the turbine's blades, power is produced in this manner (Figure 11).

Figure 11: The Ilısu Dam and the 1.2 GW Hydroelectric Power Plant Built in Mardin-Türkiye.

Hydroelectric power plants contribute 23% of the electrical energy generated globally. Around 6% of the world's total energy is distributed by hydroelectricity.

Utilizing sea currents is one current alternate approach for converting hydraulic power to electricity. Like wind turbines, water's kinetic energy may be transformed into electrical energy by placing turbines where there is a strong continuous current. Additionally, energy may be produced via tides or wave action. The buoyancy of the water is utilized in this method. The strength, height, and frequency of the wave all play a role in this. First, depending on the type of coast where the power plant will be built, a good location along the shore or toward the open sea is chosen. The parameters of wave or tidal movement are used to construct hydraulic pumps, which are then positioned at the proper depths in the area. The hydraulic pumps rise and fall in response to the flow of the water. In the chamber linked to the pumps, either the high pressure produced by the compressed air or the water being pushed by the pumps can provide electrical energy (Figure 12).

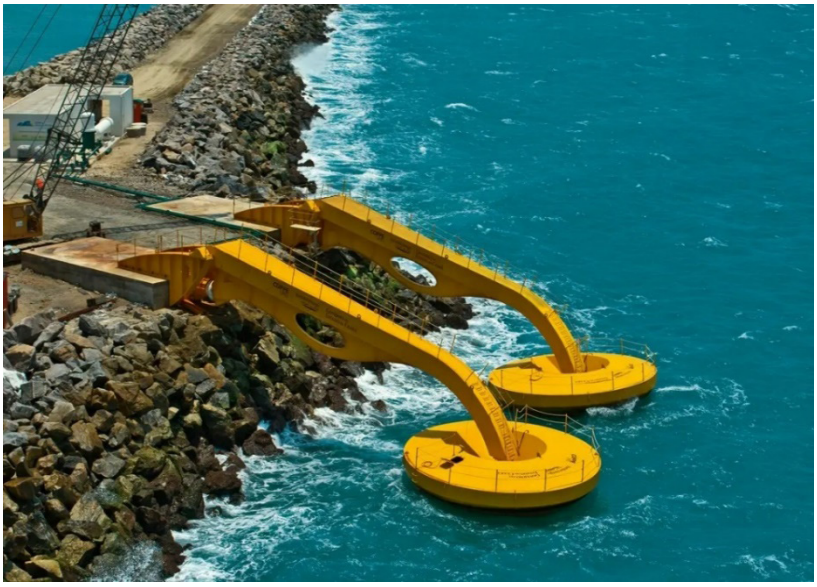

Figure 12: It Shows the Brazilian Power Plant that Produces Electricity Using Wave Action

Two floating tables, each 10 meters in diameter, are linked to a hydraulic pump at the joints of the arms. Hydraulic pumps push water into the turbine as the arms oscillate up and down owing to wave motion, producing electricity.

4. Energy Storage Systems

To provide the electrical energy derived from renewable energy sources for consumption, two significant intermediary systems are required. Transmission lines and voltage regulators are two of them. Future clean energy generation must be widely adopted if consumption is to be entirely linked to electricity. As a result, current transmission lines and transformer systems must be updated and rebuilt.

The storage of the produced power is the other intermediate system. For instance, in time zones when the sun's actual beams are strong, electrical energy derived from solar radiation can be generated. Similar to this, the wind turbine's generation capacity will drop when the wind speed drops below a specified level. In light of this, it makes sense and is acceptable practice to store power when it is generated and then send it to the user for continuous, regular consumption.

Accumulators have traditionally been used to store electricity. The created electrical energy is first transformed into chemical energy and stored thanks to the accumulator. If desired, this chemical energy can later be converted back into electrical energy. The creation of batteries that provide electrical energy in a safe, efficient, environmentally friendly, and long-lasting manner is one of the most significant scientific study fields of the present.

In order to operate power plants more efficiently, mechanical batteries have been designed specifically for this purpose. Pumped storage power plants created for this purpose are constructed with two separate levels of water storage pools. Depending on the topography, the distance between these reservoirs might range from 50 to 500 meters. Inside the tubes that allow water to move between the two reservoirs, there are reversible motor units that can pump and run as generators. The water is pumped from the lower reservoir to the upper reservoir using some of the energy generated by the power plant. When the power plant's output capacity drops, the system is turned around and the water that has accumulated in the upper reservoir is pumped down to the lower reservoir. This ensures that the engines now function as generators and that the energy produced is sent to the grid (Figure 13).

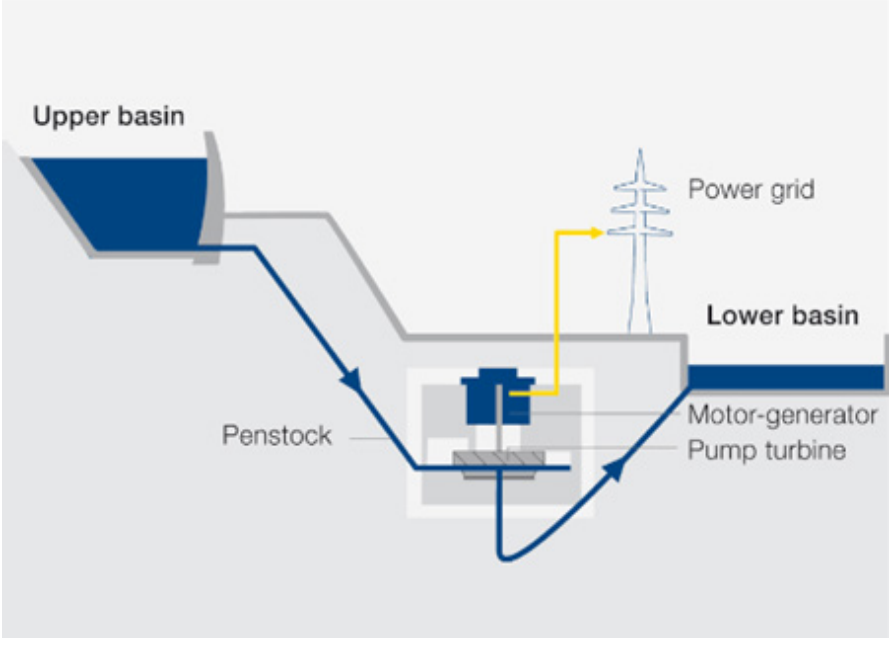

Figure 13: Pumped Storage Power Plant
Source: Çeyrek Mühendis, 2023.

Another technique intended to store energy produced and provide it to the system when production capacity declines is the use of gravity batteries. This mechanical gravity storage-based technique aims to lift a certain weight to a height while allowing the generator axis to spin along the way by releasing it at the proper moment (Figure 14). Electric motors are used to lift special heavy carriages when solar or wind turbines generate a significant quantity of power. The heavy wagons are left down, and this time the motors acting as generators convert the motion energy into electrical energy and return the stored kinetic energy to the grid. This process occurs when the production of energy resources is insufficient to meet the needs of its consumers (for example, at night or when the wind strength decreases).

Figure 14: Gravity Cell Gravitricity Huisman Created the
Source: Edinburgh Chamber of Commerce, 2023.

The prototype version of a four-story apartment height aims to achieve energy savings of about one million pounds. When the engine that hangs a heavy mass on the tower to which it is attached is started, some of the energy created by the sun during its active phase is used to draw the heavy mass upwards. This massive mass steadily descends under the pull of gravity as the sun's rays start to lose their power, converting its kinetic energy back into electrical energy.

5. Results

According to a 2011 report by the World Wildlife Fund titled "WWF Energy Report: 100% Renewable Energy in 2050," all of the world's energy requirements will be satisfied by renewable energy sources by the year 2050. It is anticipated that if WWF's vision can be achieved, catastrophic climate change will be avoided, environmental pollution will be reduced, energy security will grow, and people will have better living circumstances around the world. It could be feasible to accomplish this goal, according to the study findings of one of the most reputable energy consultant businesses in the world. Governments, who are in charge of conducting national affairs and choosing the policies that will be put into effect, hold the key to attaining this. In this direction, WWF offers the people of the globe and all governments ten fundamental advice for utilizing only renewable energy sources.

1. Clean energy: In addition to using the most energy-efficient goods possible, nations are encouraged to develop both new and current renewable energy sources in order to supply clean energy to all people by the year 2050.

2. Networks: Sharing clean energy across nations is advised in order to maximize the utilization of sustainable energy sources across various industries.

3. Access: A quarter of the world's population lacks access to dependable electrical power. For cooking and heating, more than 2.7 billion people rely on conventional bioenergy sources (such wood and coal), which have detrimental effects on the economy, ecology, and human health. Ending energy poverty by giving everyone access to clean power is advised, especially in developing nations, as this will stop home or individual energy production through pollutants that result in carbon dioxide emissions. For this reason, it is believed that providing sustainable practices to their citizens, such as efficient cooking stoves, would be an appropriate option for governments.

4. Money: It is advised that governments spend money on energy-efficient products, buildings, and renewable and clean energy sources.

5. Food: Food waste must be stopped at all costs. Food must be used effectively and responsibly in order to support the environment, sustainable forestry, and the creation of biofuels. Since everyone has a right to a healthy protein diet, wealthier individuals should consume less meat.

6. Materials: Reducing consumption and encouraging recycling are two ways to decrease waste and conserve energy. Producing durable materials is preferable to avoiding pointless materials.

7. Transportation: The use of public transportation has to be promoted and increased. It is important to decrease travel distances for both people and products, and to promote electric transportation systems. It is important to promote research into the use of hydrogen and other alternative fuels in transportation and aircraft.

8. Technology: Action plans at the national, bilateral, or international levels should be created to encourage energy efficiency and renewable energy research and development.

9. Sustainability: It is necessary to design and execute enforceable sustainability standards that guarantee renewable energy is compatible with environmental and development objectives.

10. Agreements: Ambitious climate and energy accords should be promoted to promote international collaboration. To give worldwide direction on renewable energy and efficiency efforts.

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CHAPTER II

LONG-TERM EFFECTS OF THE NATURAL ENVIRONMENTAL CHANGES IN THE EARTH'S CLIMATE: IMPLICATIONS OF PLATE TECTONICS AND UNIVERSAL CYCLES

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1. Introduction

Geographical properties of the earth have changed several times within the period until humans have appeared on the stage of history. Depending on the deterioration of the natural processes in the earth due to different reasons, there exist great variations in the climate of Earth in the specific eras. Therefore, within the time interval between the beginning of human history and the present, the human and natural environments that lived in the glacial and interglacial ages, in which the earth was covered with glaciers, was greatly affected from large-scale changes. At the same time, it is certain that human effects on these long-term changes, which are related to natural factors, have also increased after the middle of the nineteenth century.

Nowadays, nearly all climate scientists working on climate science accepted that there exists a degradation in climate system of the Earth. In addition to long-term effects of the Earth's natural cycle such as plate movements, volcanic eruptions, earthquakes, chaotic events of solar planets

from the universal cycle, it is suggested that if different people activities causing degradation of natural balance continue without taking the necessary precautions, these climate degradations will grow and climate changes from the global warming will be inevitable. Hence, the results of these variations may be very negative. Also, increasing of greenhouse gas accumulations and participles in atmosphere due to human-induced factors, destruction of the natural environment and depletion of the ozone layer will cause a temperature increasing on a global scale.

In the Earth, which as the age of about 4.5 billion years, the natural balance between Earth's elements has been disturbed for different reasons in certain periods, and accordingly, there have been great changes in the climate conditions. The climatic conditions experienced in the northern hemisphere during about the last millennium can be summarized as follows (Ahrens and Henson, 1994):

- A warm but different climate types were effective in the 1200s. Natural disasters such as floods, storms, heavy rains and droughts continued for several centuries.
- Constant climatic conditions were effective from 1400 to 1500. From the middle of the 1550s onwards, a period that lasted for 300 years and called as "Little Ice Age" has been experienced. Mountain glaciers developed and hung towards the valleys in this period. Then, short and rainy summers had been seen despite the harsh and long winters.
- As a result of the unusual climatic changes shown in 1816, Europe experienced a great famine during this period. Also, great numbers of people and animals died of starvation. Significant cold weathers were experienced in the USA and Canada between May and September, and accordingly, 1800 people froze to death in this summer. For this reason, this period is called as the "Year Without a Summer".
- At the end of the 1800s, between 1900 and 1940, the global average temperature increased by 0.5 °C. This increase was followed by a cooling period of 25 years.
- An increasing trend in the global average temperatures was observed in the 1970s, 1980s and 1990s. Then, the hottest eight years after 1878 were experienced in the 1990s.
- 1998 was the hottest year since 1860, when instrumental measurements began in both the northern and southern hemispheres.

Today, in addition to natural factors, it is accepted that there are deteriorations in the climate systems due to the various effects from people. For this reason, climatic changes were defined as "A change in climate as a result of human activities that directly or indirectly degrade the composition of the global atmosphere, in addition to the natural climate change observed over a comparable time period" (United Nations Intergovernmental Panel on Climate Change, IPCC 1995).

2. Brief Description of the Plate Tectonics

The earth has existed for billions of years and the shape of the Earth has changed many times until present-day. Surface of the Earth's crust does not consist of a single whole shell such as in a rubber ball. On the other hand, without changing its spherical shape, it is made up of many parts such as a cracked eggshell. The earth, which revolves around the sun and on its own axis and exhibits a constant movement, is also mobile in its own orbit. Despite the rigid structure of the lithosphere, the asthenosphere moves in its own system at a rate of centimeters per year. These movements of the asthenosphere can be compared to the convection currents of water in a heated vessel and the asthenosphere makes a similar movement due to the heat it receives from the core of Earth. These convection currents in the asthenosphere cause the upper lithosphere to drift in different directions. As a result of the movements of the asthenosphere on the order of centimeters per year, the lithosphere is divided into many large and small parts that move relative to each other. These single, giant or small pieces of lithosphere, which sometimes can cover both oceanic and continental crustal regions and are not stable, are called as plates. The upper layer of the lower mantle moves over the asthenosphere. This science branch that studies plate motion is called as Plate Tectonics.

Plate tectonics theory was firstly proposed as the theory of continental drift by Alfred Wegener in 1915. According to plate tectonics, there exist 15 rigid plates and they move relative to each other with a speed of several cm per year. Plates are rigid and these strong plates are named as the lithosphere and weaker asthenosphere below. The plate tectonics theory states that the lithosphere, which is solid and the outermost layer of the earth, consists of many plates moving on the-semi-solid (plastic) but mobile asthenosphere (Figure 1). The crust of the Earth's surface located on the mantle is in a state

of equilibrium named as isostasy. The buoyancy of the mantle is proportional to the volume of the crust which is subducted in the mantle. Therefore, in the continental region in which the elevations are high, the crustal part reaching into the mantle should be more in proportion to the increasing mass. Due to deep roots of high mountain ranges, Earth's crust is as thick as 70 km in these types of regions. However, the rise of lands is related to their being made of relatively lighter material. As a result, although oceanic crust is thinner, it composed of heavier material and is more subducted into the asthenosphere relative to the continental crust. The lithosphere is formed by the merging of the Earth's crust and mantle and it creates a shifting puzzle table in the form of slowly shifting plate. Convection currents in the asthenosphere supply the required energy for the movement of these plates. Since the plates always touch each other, the intensity and direction of their movements are established from not only by the characteristics of the driving force coming from the depths of the ground, but also by the relations of the plates with each other. As a result, it is stated that plate movements continue in a specific order in the short time and, when the time scale is enlarged, they take place in the imponderable and chaotic manner.

There exist three basic types of plate boundaries: (*i*) spreading centers, (*ii*) subduction zones and (*iii*) transform faults (Figure 1). Spreading centers are the mid-ocean ridges and relative plate motion is away from the boundary in these systems. However, in subduction zones or trenches, subduction plates move toward the boundary. Also, relative motion of the plate in transform faults is parallel to the boundary. Plate tectonics defines the lithosphere behavior and is the principal surface appearance of the heat source. For the evolution of the Earth's ocean and atmosphere, plate tectonics is also important. Also, the processes of plate tectonics largely effect the chemistry of the oceans and the atmosphere and, numerous long-term properties of climate are effected from mountains and the positions of continents. Basically, the plate tectonics theory may clarify how life evolved on earth and it may be great importance for its survival (Stein and Wysession, 2003). Thus, plate tectonics have been studied by many earth scientists for a long time.

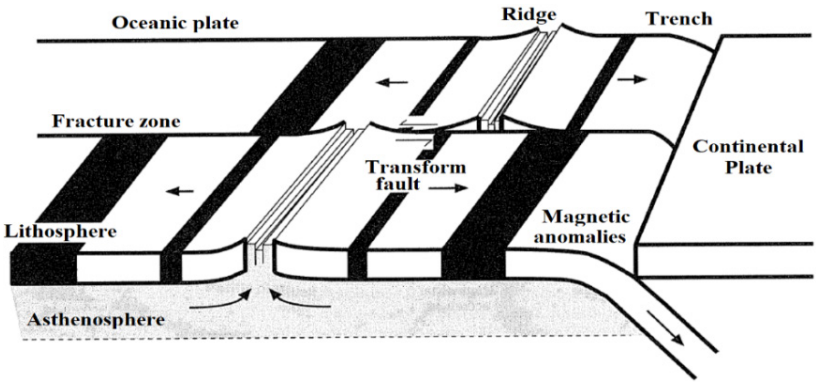

Figure 1. Simplified image of plate tectonics Oceanic lithosphere is relation to subduction zones at trenches and formed at ridges. There exist parallel plate motions to the boundaries at transform systems.
Source: Öztürk, 2016

3. Ecological Changes Related to Plate Tectonics

3.1. Variations in the Level of Sea and Chemistry of Seawater

Marine regressions and transgressions from the changes in the level of sea along the geological time define the sedimentary record in continental regions. Great changes in the level of sea (100 m or more) may be explained during ice ages in relation to high volumes of fresh water. Although any significant glaciations were not observed along the much of geological time, there were great changes in the level of sea. The studies in recent years show that these types of problems can be solved by understanding the issues such as hot spots, sea floor spreading and plumes. According to results of these studies, increased seafloor spreading rates, hot spot and plume events can produce a high ocean floor that will displace water upwards and cause sea level increase. For example, along the Cretaceous period, high sea level standing may be due to exceptionally large sea floor spreading rates and plume events (Kearey et al., 2009).

Variation in the formation rate for the oceanic crust is related to the spreading ratio and/or the total length of spreading ridges. These types of changes are very important for the young and elevated ocean floor, and hence they cause significant changes in the level of sea in the long-term (Figure 2). Also, the changes in the accretion rate affect the sum of hydrothermal and igneous event at spreading centers and hence, these variations have effects on the seawater chemistry. It is thought that the interaction between seawater and hot basaltic

rock at ridge system removes the sodium and magnesium from the seawater and this causes the release of calcium ions from the rock. In addition, sulfate ion may be extracted from the water if it exposed to the oxic situations in and around the see floor (Kearey et al., 2009). It is suggested that these types of changes in the chemistry of seawater are seen in the mineralogy of marine evaporites and carbonate deposits during the Phanerozoic era (Stanley and Hardie, 1999). Thus, the changes in partial pressure of carbon dioxide (pCO_2) in the atmosphere in the geologic epochs are considered to be caused by the outgassing of CO_2 from the volcanic events. Eustatic changes in the sea level are global changes in the level of see related either to variations in the volume of glacial ice on land or to variations in the sea floor shape due to the processes of plate tectonic. For example, variations in the mid-ocean spreading rate will change the sea floor change near the ridges, and this affects sea level. As a remarkable fact that eustatic variations in the level of sea, variations in the chemistry of seawater, and changes in the concentration of CO_2 in the Earth's atmosphere in the past may be in a relation to plume activity and sea floor spreading changes (Hardie, 1996).

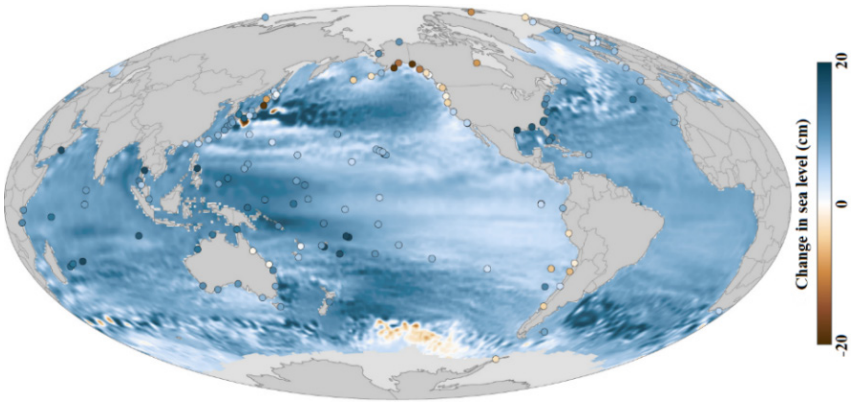

Figure 2. Global Sea Level Changes Between 1993 and 2021
Source: NOAA Climate.gov, Data: UHSLC, taken from https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level

3.2. The Influence of the Oceanic Cycle on the Climate of Earth

It is suggested that there have been intense volcanic activities throughout the Earth's history. Extensive volcanic and igneous activities which affected extraordinary huge amounts of ocean floor have been proposed to be resulted from a super plume (Larson, 1995). There was a worldwide increase in the level

of sea (~ 250m higher than the present day) and this situation may have resulted from the massive emission of carbon dioxide along the volcanic explosions that produced an enlarged greenhouse effect (Larson, 1991). It is stated that one of the most important effects on the climate of Earth is the concentration of greenhouse gases in the atmosphere. In addition, another significant influence can be given as the distribution, extent and bottom topography of the oceans (Kearey et al., 2009). Heat transfer in the oceans is influenced from the shape of the ocean basins. Surface currents and deep-water cycle are the most effective factors in this circulation, and hence, moisture and temperature content of the atmosphere over oceanic regions are affected (Figure 3). A well-known example of the scenario that the temperature gradient is reduced is the Gulf Stream of the western North Atlantic. It warms the air above the ocean in the extreme North Atlantic and hence, affects the climate in Iceland and northwest Europe. Smith and Pickering (2003) stated that opening/closing of the gateways for the circumpolar and equatorial currents is a result of continental drift and this process may have certain effects on the climate of the Earth.

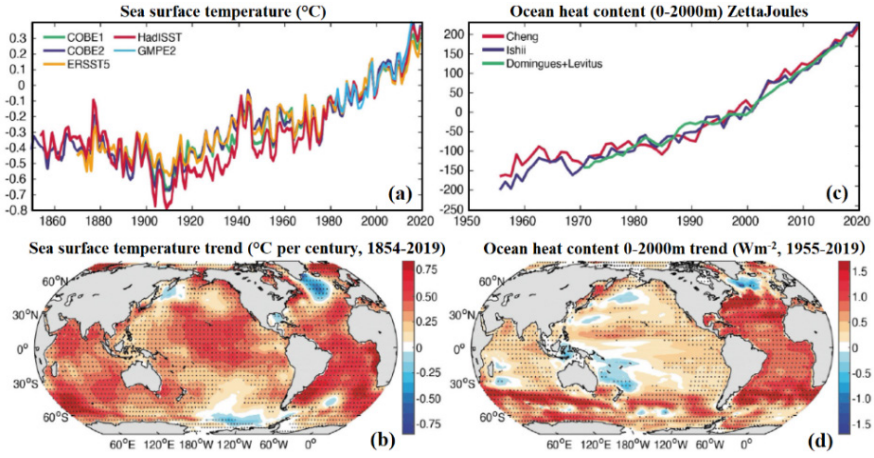

Figure 3. (a) Global temperature of sea surface between 1850 and 2019. (b) Regional variations of long-term sea surface temperature trend between 1854 and 2019. (c) Global changes of oceanic heat content for the upper 2000m. (d) Regional variation of long-term oceanic heat content trend between 0 and 2000m
Source: One can find all details from Garcia-Soto et al., 2021.

During the past 200 Ma, especially by the mid-Cenozoic, an exact southern circumpolar current emerged and it was probably instrumental in triggering the first major build-up of the Antarctic ice cap (Kennet, 1977). About 180 Ma, some tropical waters were heated to a higher temperature before turning northwards

and southwards to warm higher latitudes. Thus, all of the Earth became warmer and heat gradient from the equator to the poles was more reduced (Smith et al., 1994). The first changes in the deep-water cycle resulted from the opening of the gateway and it may explain the anoxic event that produced the widespread black shales in surrounding regions (Poulsen et al., 2001). However, in the late Cretaceous, and even in the early Cenozoic, the circum-equatorial current still existed, and the surface water in the high latitude oceans was still very much warmer than it is today (Kearey et al., 2009). During the continental drift in Cenozoic era, major changes occurred in the near surface oceanic circulation. As a result of following increases in ice volume and changes in level of sea, gave rise to an emergence of land regions and a major reduction in the region of shallow sea waters on continental crust (Smith et al., 1994). Also, extra tectonic movements were required before a complete land bridge formed, about 3 Ma ago; as determined from the interchange of mammals between North and South America (Marshall, 1988). Following a period of warming and deglaciation in the late Oligocene, additional large increases in ice volume on Antarctica, and associated drops in level of sea, are considered to have occurred in the mid-Miocene and at the end of the Miocene (Haug and Tiederman, 1998). The gradual cooling of the Earth's climate throughout the last 50 Ma, especially in higher latitudes, led to a general reduction in precipitation amount, and an increase in aridity. Thus, previous forested regions in high latitudes were turned to tundra, and in temperate latitudes to grassland. As a result of the major cooling about 6 Ma, even some low latitude, tropical forests were converted to savannah. This is considered to have had a strong influence on mammalian, and, finally, human evolution (Kearey et al., 2009).

3.3. Earth's Climate on the Land Regions

The properties of the land regions such as distribution, topography, formation, and extent also influence the Earth's climate. Compared to the sea, land areas cool down and heat up more rapidly. It is well-known that daily cycle of the seas and land breezes in coastal regions is the result of this process. In addition, the monsoonal climate in different parts of the world has a similar affect and it is longer, seasonal period and influences larger geographical regions. Sea regions have a low albedo, whereas land regions have great albedo and depend on the type, or lack, of vegetative cover. However, sea and land regions and their effects on the Earth's albedo and climate are not fully understood. Mountains are covered by seasonal or constant snow and thus, Earth's albedo increases.

Nevertheless, the genesis of the mountain belts changes the weathering rate on the Earth's surface and this process may influence the climate (Kearey et al., 2009).

The elevation of mountains as a consequence of continental drift may increase the physical and chemical weathering processes since they concentrate rainfall on their windward flanks. According to Raymo and Ruddiman (1992), increased weathering of silicate rocks can draw down carbon dioxide content of the atmosphere and it may be possible reason for a global cooling. Greatly increased weathering of silicate rocks in the late Miocene may be responsible from the removing of carbon dioxide from the Earth's atmosphere and this process may account for the pronounced global cooling supplied by the studies on oxygen isotope in the Miocene-Pliocene boundary (about 6 Ma). This may have produced effects that led to the initiation of the Ice Ages approximately 3 Ma ago (Kearey et al., 2009). As a result, the processes of plate tectonic would have affected all major factors that are currently considered to determine the long-term climate changes of the Earth. Hence, the concentration of carbon dioxide in the atmosphere is considered to be determined greatly by the amount of volcanism in this time. Thus, significantly high levels of carbon dioxide related to the "Greenhouse Earth" of the Cretaceous time period are in the relationship with super plume events, and high ratio of sea floor spreading and subduction, all three giving rise to enhanced volcanic activity. On the contrary, regular diminish in plume events, and plate destruction and accretion, may result in global cooling. However, during the past 50 Ma, the periods of pronounced global cooling are not related to decreases in volcanism. Therefore, it seems possible that one needs to invoke the other possible effects of plate tectonics on the climate of Earth, notably changes in oceanic circulation and the results of mountain building, and enhanced weathering, to explain the mid-Cenozoic transition to an "Icehouse Earth," and finally the triggering of the Ice Ages of the past 3 Ma (Larson, 1991).

3.4. Plate Tectonics and Sedimentary Basins

The studies on the plate tectonics suggests that there exists a relation between certain environments and regional changes of deposits (Rona, 1977; Sawkins, 1984; Richards, 2003). These types of approaches allow to classify the economic deposits in accordance with the plate tectonic. Also, the understanding of relationship among the formation of ore deposits, the evolution of great igneous regions and the effects of deep mantle plumes play a significant role for

geologic and tectonic process operating in the early Earth (Ernst et al., 2005). Thus, many attempts have increased to reveal the relationship among the mineral deposits, magmatism in the continental rift environments and Erath's climate.

There exist many types of mineral deposits such as carbonatites, sub-alkaline granites, copper-nickel, zinc-copper-lead sediments, nickel and platinum sulfides, porphyry coppers, carbonaceous mudstones, clastic limestones or quartzites, stratabound copper sulfide deposits, molybdenum, bismuth, and fluorite, gold and silver deposits in different types of plate movements. There are many attempts to show the relation between mineral deposits and magmatism in continental rift environments and hence with rising mantle plumes (Pirajno, 2004). It is well-known that hydrothermal processes depend on the oceanic crust and low/high intensity of hydrothermal activity effect the formation of ocean basin. There is a relation between magma and hydrothermal ores in subduction zones (Hedenquist and Lowenstern, 1994) and, between the large-scale magmatic and tectonic processes in the convergent margins (Richards, 2003). Thus, the mineralization in the backarc basins that from oceanic subduction may be related to exhalative and magmatic volcanic processes. Several studies show that there is a relation among crustal magmatism, break-up of supercontinents, continental rifting zones and mantle plumes. Thus, the relationships between the plate tectonic settings and sedimentary activity and hence mineral deposits have been studied different authors. The results show that different plate tectonic environments and mineral deposits in their content may affect the weather and therefore climate.

3.5. Relation between Deposits and Climate

The formation of sedimentary basins is thought to be related directly or indirectly to plate movements. Climate, quantity of nutrients available and water body geometry are important factors on the plate configuration. Plate tectonics controls the reservoir locations and these reservoirs consist of some formations such as intracratonic basins formed by hotspot activity, basins related to continental rifting, passive continental margin basins, marginal sees, forearc basins, tensional basins, full-apart basins and foreland basins.

Irving et al., (1974) stated that evolution and conservation of hydrocarbon deposits is a result of plate interactions and plate tectonics affects the formation of deposits of the hydrocarbon habitat. Hence, some parts of the Earth have high hydrocarbon reserves. Since great quantities of nutrients from the spreading center were supplied by the extensive, shallow and warm seas, development

of the hydrocarbon source rocks were maximized. Thus, spreading rate of the seaway began to increase in about 100 Ma. To prevent the complete destruction of vegetal matter through biochemical decomposition, very wet conditions are necessary in order to arrest the decomposition by the accumulation of toxic waste products. For example, plate tectonics affects the coal formation and creates the necessary environments to preserve organic matter. The tectonics related to the collisional orogeny supplies an environment whereby coals increase in grade by high-pressure metamorphism. Another example can be given for nickel laterite. This lateritic deposit results from highly weathering of ophiolite ultramafic parts depending on the tropical conditions. The similar deposits such as bauxite, evaporate (commercially significant deposit in the chemical industry which is also significant in the hydrocarbon traps generation). In addition, geothermal energy can be efficiently used for power generation and vertical thermal gradient may produce near surface temperatures. It is stated that this situation is realized at destructive and constructive plate margins in different parts of the earth and, extremely high geothermal gradients also exist in intraplate regions frequently related to granitic plutons (Kearey et al., 2009). Thus, it can be said that climate and latitude, sedimentation conditions, direction of the plate motions and topography controls these conditions and process related to hydrocarbon formation.

4. Environmental Evidences Related to Universal Cycle

4.1. Solar System in Cosmic Cycle

The dynamic processes of the Solar system are controlled by the planets and are thought to affect the activity of Sun and even climates. In the solar system, these phenomena occur in two ways. One of them can be given as the orbital motion of the Sun, called inertia, and the planetary tidal forces affecting the Sun is the second one (Scafetta et al., 2016). It has been observed that the planetary alignment cycle of 11-year (the lineup of Saturn, Mars, Venus and Jupiter) matches with the sunspot cycle. This situation supports the theory that planetary and solar tides affect the solar activity. It is stated that the record of sunspot composed of three main periods with the cycles of 9, 10 and 11 years. These cycles appear to be closely in relation with the tidal periods of Saturn and Jupiter. These three cycles supply major strike periods that can continue 115, 61 and 130 years. In this context, equivalent synchronized records are found between cosmological records and climate records (Scafetta, 2012). The solar

system in the Milky Way galaxy is shown in Figure 4. It has a slope of 60° on this plane. The sun and its elements move in their orbit around the galactic center with periods of 28 million years. We are at the point indicated by the arrow.

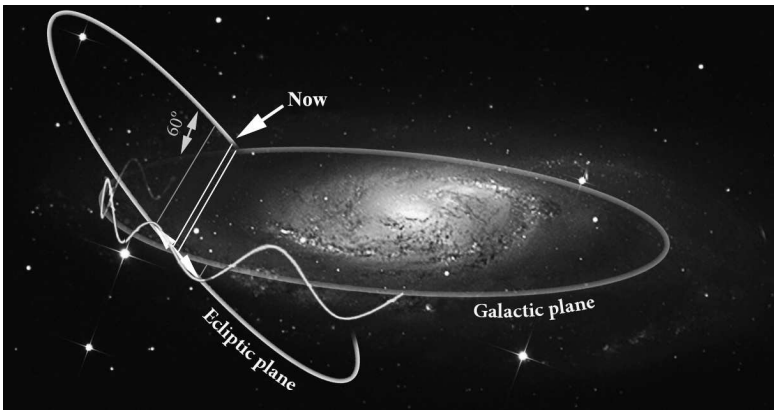

Figure 4: Schematic Image Of Solar System In The Milky Way
Source: Nikolov and Petrov, 2014.

Gravitations between the objects in the solar system cause the Earth's orbit to systematically tilt and stretch over time by affecting the axial rotation graphs of planet (Deitrick et al., 2018). Global and regional changes cyclically continue on time scales greater than 104 years (Laskar et al., 2004). Therewithal, these cyclical changes may have significant outcomes for the life suitability of a planet. Therefore, this processes can affect the biodiversity, evolution and migration of species. In addition, during the Neoproterozoic era, it may even have facilitated the larger climate changes such as the Snowball Earth Transition and the emergence of new life forms (Van Dam et al., 2006).

The universe went through different astronomical processes and took its current form before the world existed. Some of these processes have been continue by creating a cycle at present time and the Earth was formed by being involved in these processes in the universe. Therefore, it has been thought that these astronomical processes and universal cycles have effects on the Earth. The solar system consists of many orbiting celestial objects such as planets, satellites, comets, and asteroids. Based on the different variables, the activity of Sun and aforementioned phenomena show clear cyclicality regarding the climate change. Climate pattern of the Erath changes over the certain time scales. Long-term climate change has been observed primarily by geological processes that can be affect the atmosphere such as plate tectonics and volcanism, and then, periodically by Milankovitch cycles on shorter time scales (Dessler et al., 2018).

Thus, astronomical cycles can affect the solar system, the movements of the planets, and even Earth's climate (Wang et al., 2021; 2022).

4.2. Periodic Processes and Milankovitch Cycles

There exist periodic variations in the rotation axis and orbit of the Earth that have been continued for tens of thousands of years. These periodic variations are called Milankovitch cycles and cause rhythmic climate changes (Meyers and Malinverno, 2018). The geological records of these cycles is a powerful tool for reconstructing the geological time, assessing the history of Solar system, and understanding the ancient climate changes. However, examination of Milankovitch cycles sheds light on the deepest parts of the Earth's billions years of history (Lourens et al., 2010).

Jupiter changes its own orbit and keeps the initial orbits of the other planets constant. This situation causes the sensitive changes in the order of the Solar system and has a significant effect on the changes of the Earth's orbit. Therefore, the amount and distribution of the insolation changes and, Milankovitch cycles are formed. Consequently, this factor causes the Earth's periodic climate change (Horner et al., 2019).

The long time-scale changes (>104 years) of the Earth's climate have been complexly driven by phenomena such as rotation dynamics, orbital evolution, spatial distribution of oceans and continents, biogeochemical phenomena, and formation of the glaciers (Horner et al., 2019). These changes and orientations are defined by researchers as three types of astronomical cycles (Figure 5). They can be given as (*i*) the ellipticity of the Earth's orbit (eccentricity), (*ii*) axial tilt angle of the planets (obliquity) and (*iii*) climatic precession (Zeebe et al., 2017). Climatic precession controls the spatio-temporal distribution of the insolation, which is responsible for the contrast between hemispheres by defining which hemisphere is facing the Sun for a specific season. For example, when it looks towards the Sun at the perihelion in the Northern hemisphere, summers are hot and winters are extremely cold. However, seasonal uniformity decreases in the Southern Hemisphere (Naish et al., 2009).

A precession cycle takes about 23,000 years and this show that the climate of the hemisphere, where the maximum seasonal contrast is experienced, changes every 11,000 years (Laskar et al., 2004). Electricity and precession are perfectly linked with each other in the sense that there is a circular orbit. This situation resulted in both hemispheres receiving equal amounts of light. Therefore, it minimizes the differences between the hemispheres. This eccentricity cycles not

only modulate the climatic precession but also create changes in the amount of insolation the Earth receives (Nie et al., 2008).

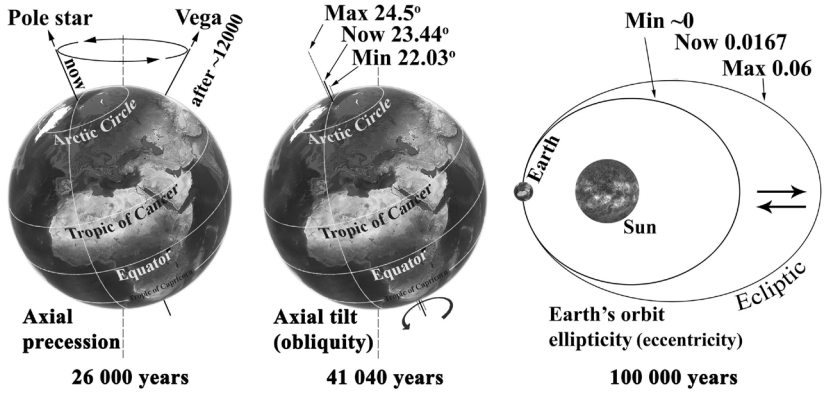

Figure 5. Astronomical Variables Effecting The Earth's Climate
Source: Nikolov and Petrov, 2014.

The axial slope and obliquity of the earth oscillate between 21.5° and 24.5° with an average period of 41,000 years. This mobility not only affects the insolation patterns by widening and narrowing the circles of the poles but also the decrease or increase in the amount of glaciers. In the paleo climate records, 41,000-year cycles show themselves more clearly especially in the Pliocene and Pleistocene times (Kane et al., 2016). In addition, there exist longer periods. It is stated in the literature that these time intervals lasting 400ka, 1300 ka and 2 Ma determine the seasons of the Earth (Nikolov and Petrov, 2014). Consequently, these studies show that Milankovitch cycles are closely related to the climate, icing periods and global warming phenomena on the world due to changes in the Earth orbital parameters.

4.3. Climatic Ages

Astronomical parameters of the Earth such as obliquity, precession and eccentricity cause the changes in the spatial and temporal distribution of the insolation emitted on the surface of earth. Orbital determinations provided that the eccentricity cycles have insignificant power in the seasonal and annual insolation time serious and the studies show that these types of changes control the Earth's climate (Ikeda and Tada, 2013). It is stated that the basic factors that influence the climate in the early history (at the end of Proterozoic) of the planet may be given as astronomical and orbital effects including greenhouse gases (Figure 6).

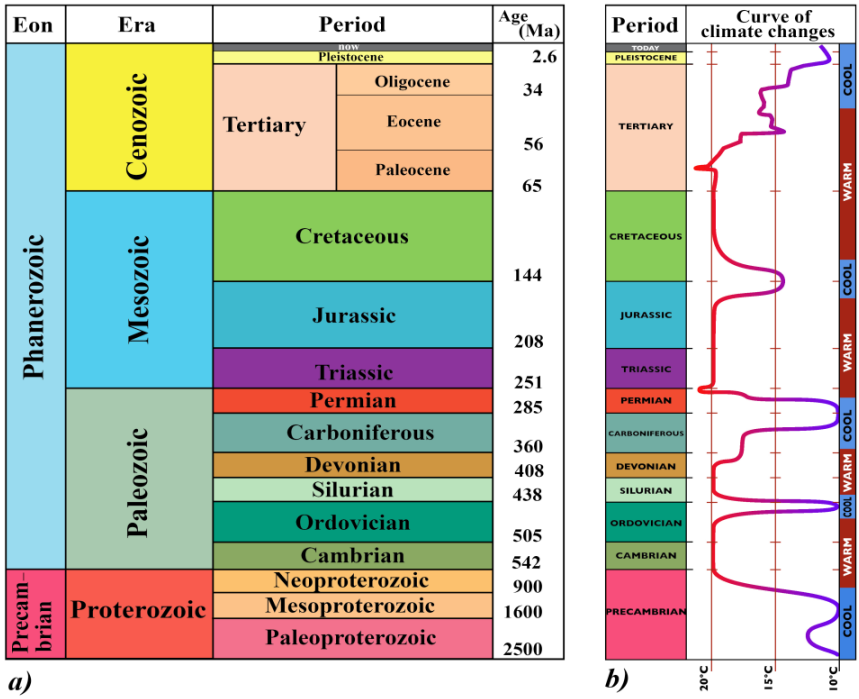

Figure 6: Historical Earth's climate changes: (a) International stratigraphic chart, v. 2013/01, after International Commission on Stratigraphy – www.stratigraphy.org. (b) Global climate variations with time
Source: Nikolov and Petrov, 2014.

Amplitude modulations of the obliquity and eccentricity cycles in the long period such as with periodicities of ~1 and ~2 Myr are becoming more recognized with the increasing in high-resolution records of paleo-climatic and sedimentary periods (Boulila et al., 2012). This fact shows that astronomical cycles have some important effects on the global climate. Literature studies reveal that 2 Myr eccentricity cycle of the Earth may play a significant role in the carbon cycle (Li et al., 2009). It has been suggested that sensitive processes such as biosphere productivity, terrestrial weathering, carbonate precipitation, dissolution, burial and oxidation and organic carbon can be astro-climatically controlled (Huang et al., 2011).

5. Results and Conclusions

Earthquakes and volcanic eruptions arise from tectonic activity and they are the best known natural hazards. On the volcanic islands or at the continental

shelf edge, these two occurrences may trigger slides/slumps from steep slopes and they can directly or indirectly cause tidal waves. The earthquakes in which occurred on faults in and around the ocean floor/trenches and with the subduction of ocean floor can be thought to cause the biggest tidal waves or tsunamis.

Many Global Seismograph Networks in the world have record a large number of earthquakes every year. It is well known that most of the earthquakes occur tectonically and they are related to the vicinity of plate boundaries and other deformation zones. In addition, earthquake occurrences depend on the stresses and strains with plate driving forces and hence these types of earthquakes occur in plate interiors on pre-existing faults. In addition to earthquakes, chemical content of magma affects the nature of volcanic eruptions such that temperature, viscosity and gas content vary from region to region, especially in the island arc volcanoes. These types of occurrences have silica- and volatile magmas (rich or poor) and hence, they bring about changes such as turbulent clouds of superheated gases, topographic depressions, torrential rains or mudflows in large areas of the Earth.

Literature studies show that complex nature of the universe has direct or indirect effects on the atmospheric events. Natural astronomical cycles such as orbital evolution, rotation dynamics, aerosol processes, solar oblateness, tidal dissipation factor, and integration etc. may cause significant changes on the climate of the Earth on the long-term. In addition, Earth's climate regime may be characterized by chaotic dynamics such as the changes in solar radiation due to the dynamic processes of the Sun and variations in the intensity of galactic cosmic rays. Consequently, these changes in the Erath's climate are derived from by the combined effect of these different universal phenomena.

It is widely suggested that tectonic and astronomical parameters of the Earth mentioned above have important effects on the variation of Earth's climate in space and time. These types of changes are a result of the natural cycle of the Earth and thus, they are inevitable results of dynamic process of Earth's interior and Solar planets. It is accepted that environmental impacts from plate tectonics and universal cycle have great effect on the climate of the Earth on the long-term. For future climate changes, better understanding of the regional and temporal effects of the plate tectonics and universal cycle on the long-term climate variation may help to obtain the information about the magnitude of natural climate and environmental variability. Thus, the factors from external cycle (orbital and astronomical), from internal cycle (geophysical and geological) and from anthropogenic cycle are very important on the Earth's climate variations on the long-term.

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CHAPTER III

CLIMATE CHANGE GOVERNANCE

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1. Introduction

Climate change is the most essential and permanent problem that threatens all lives in the world (Barrett & Stavins, 2002; 2003; Birchall and Bonnett, 2021; Howard-Grenville et al., 2014: 615). It develops slowly, but its effects increase in the long term and require all countries to take precautions. It refers to changes in climate systems that result from long-term and sustained changes due to human activities beyond natural variations in the climatic conditions of a region or planet over time. These changes are associated with global warming caused by an increase in the concentration of greenhouse gases in the atmosphere. The long-term effects of global warming and consequent climate change also affect sensitivity to this situation. Based on the idea that consciousness and awareness spread from the individual to the society, awareness of the effects of global warming and the climate crisis society, an awareness of the life of humanity leads to awareness, and increased awareness leads to changes in behavior. The general statement "we are all in the same boat" validates this situation.

According to the IPCC (Intergovernmental Panel on Climate Change) report, "It is unequivocal that human influence has warmed the atmosphere, ocean, and land…… Human-induced climate change is already affecting many weather and climate extremes in every region across the globe" (IPCC, 2021). Also, Le Treut et al. (2007: 96) describe the climate system as "a complex, interactive system consisting of the atmosphere, land surface, snow and ice,

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oceans and other bodies of water, and living things." On the other hand, it is challenging to manage a situation caused by human behavior that affects all life forms on Earth (with 208 countries and a population of nearly 8 billion people).

The leading cause of climate change is the increase in greenhouse gases in the atmosphere due to human- induced caused impacts (Harris, 2007: 195-196). Greenhouse gases are released into the atmosphere due to human activities such as industrial activities, agricultural practices, energy production, and transportation (EPA, UN). These gases trap the sun's rays in the atmosphere, causing the earth's surface to warm up, which is called the greenhouse effect (Birchall & Bonnett, 2021; Gupta, 2014: 5; Muluneh, 2021). The primary greenhouse gases released into the atmosphere by humans are carbon dioxide (CO2), methane (CH4), oxides of nitrogen (NOx), and fluorinated gases (Gupta, 2014: 5; IPCC, 2021; 2022; Oberthür & Ott, 1999: 4; Öztürk & Öztürk, 2019: 528). Human activities such as burning fossil fuels (coal, oil, natural gas), industrial processes, deforestation, agricultural practices, and waste management increase the release of greenhouse gases into the atmosphere, upsetting the natural balance in the atmosphere and contributing to the warming of the planet (Wright & Nyberg, 2017: 1633). This warming is called global warming and leads to changes in climate. According to IPCC (2021) "The likely range of human-induced warming in global-mean surface air temperature (GSAT) in 2010–2019 relative to 1850–1900 is 0.8° C–1.3°C, encompassing the observed warming of 0.9°C–1.2°C, while the change attributable to natural forcings is only −0.1°C to +0.1°C".

The increase in temperature values leads to a decrease in our clean water reserves, food crises that may occur due to the change in agricultural lands, epidemic diseases, adverse effects on natural resources, erosion, endangering biodiversity, and migration (Birchall, Bonnett & Kehler, 2023; Demirbaş & Aydın, 2020: 166; Muluneh, 2021; Wallace-Wells, 2019). Global warming causes disasters such as floods, increases in average sea level, wildfires (Luomi, 2020), heat waves, melting glaciers, extreme weather events, and agricultural and ecological drought (Baynham & Stevens, 2014; Gupta, 2014: 5; Harris, 2007: 195; Muluneh, 2021; Wallace-Wells, 2019; Wright & Nyberg, 2017: 1633).

In recent decades, the escalating threats posed by climate change have brought to the forefront the critical need for effective governance mechanisms to mitigate its impacts and foster resilience. Climate change's complex and multifaceted nature necessitates comprehensive interdisciplinary strategies integrating scientific advancements, policy interventions, and societal

engagement. This study delves into the intricate dynamics of climate change governance, aiming to critically assess the existing frameworks, identify their strengths and limitations, and propose innovative pathways for addressing the global challenge of climate change. By examining the interplay between international agreements, policy instruments, scientific research, and societal participation, this study seeks to contribute to the ongoing discourse on sustainable and inclusive solutions for managing the complexities of climate change at "***local, national, and global***" levels (Birchall & Bonnett, 2021).

2. Concept of Climate Change Governance

Climate change governance (CCG) is a concept that includes policy, legislation, international agreements and various institutional structures implemented to combat climate change and limit climate change impacts worldwide and requires collective action (Meadowcroft, 2009). The modern concept of climate change governance dates back to the second half of the 20th century. The evolution of international climate change agreements reflects the increasing recognition of the urgency to address the complex challenges posed by global warming. Milestone agreements, such as the United Nations Framework Convention on Climate Change (UNFCCC) and its subsequent protocols, including the Kyoto Protocol and the Paris Agreement, have laid the foundation for multilateral cooperation in mitigating greenhouse gas emissions and adapting to the impacts of climate change. These agreements have provided a framework for countries to set targets, define commitments, and implement measures to reduce their carbon footprints.

In the late 1960s and early 1970s, environmental issues and the sustainable use of natural resources gained importance. During this period, governments, scientists, civil society organizations and the international community began to discuss policies and strategies to address climate change and environmental problems.

2.1. Key Developments in Climate Change Governance;

1950s-1960s: The first scientific research and warnings about climate change emerged. Climate scientists suggested that rising levels of greenhouse gases could increase the planet's temperature (Le Treut et al., 2007; Willett, 1950).

1970s: organizations such as the United Nations Environment Programme (UNEP) were established and agreements were signed to ensure international cooperation on environmental issues.

In 1988- The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts, and future risks, as well as options for adaptation and mitigation (IPCC, 1990).

1992- United Nations Framework Convention on Climate Change (UNFCCC),

1997- The Kyoto Protocol,

2015- The Paris Agreement.

2.2. Understanding the Complexity of Climate Change Governance

Climate change has emerged as one of our most critical global challenges, and it requires robust governance structures and mechanisms to address its multifaceted and complex nature. The intricate interplay of environmental, social, economic, and political factors demands a comprehensive understanding of climate change governance. Climate change governance represents a multifaceted landscape characterized by intricate interdependencies, diverse stakeholder interests, and dynamic policy frameworks. As climate change transcends geographical and sectoral boundaries, governance structures addressing this complex phenomenon face unprecedented challenges in balancing environmental sustainability with socio-economic development.

Climate change governance operates within a multi-level framework that spans the local, national, and international spheres. At the local level, communities and municipalities increasingly recognize the need for sustainable practices and localized climate action plans. National governments play a crucial role in formulating and implementing policies, setting emissions targets, and facilitating the transition to a low-carbon economy. In addition, the international community seeks to foster global cooperation and commitment to mitigate climate change through initiatives such as the Paris Agreement. Understanding the dynamics and interactions within this multi-level framework is critical for effective climate governance.

Climate change governance encounters numerous challenges stemming from its multifaceted nature. One significant challenge involves balancing the interests of various stakeholders, including governments, businesses, civil society,

and affected communities. Conflicting priorities and divergent approaches often impede the formulation of unified and effective climate policies. Moreover, climate change's intricate scientific, technological, and economic dimensions demand a nuanced understanding to develop sustainable solutions.

2.3. The Components of Climate Change Governance

International Agreements and Protocols: Climate change has emerged as one of the most critical global challenges of the 21st century, necessitating comprehensive international efforts for effective governance. International agreements and protocols are crucial in facilitating coordinated action among nations, setting targets, and establishing frameworks for combating climate change (Barrett & Stavins, 2002; 2003). Despite their significance, implementing international agreements and protocols faces numerous challenges. Issues such as varying national priorities, limited enforcement mechanisms, and inadequate financial support pose significant obstacles to effective governance. Furthermore, the absence of universal participation and the lack of binding commitments from some countries undermine the comprehensive impact of these agreements. Overcoming these challenges requires strengthened global partnerships, increased financial commitments, and the development of innovative technological solutions.

Promotion of Global Cooperation and Solidarity: International agreements and protocols are pivotal in promoting global cooperation and solidarity among nations with varying socio-economic backgrounds and environmental priorities. By fostering a shared understanding of the interconnectedness of climate impacts, these agreements encourage collaborative efforts to address common challenges. Enhanced technology transfer, capacity-building support, and financial assistance to developing countries have been integral in promoting equitable participation and ensuring the inclusivity of climate change governance initiatives.

Policy Harmonization and Standardization: The standardization and harmonization of policies and regulations across nations are essential for ensuring the effectiveness and efficiency of climate change governance. International agreements facilitate the alignment of diverse national policies, enabling the establishment of common frameworks for monitoring, reporting, and verifying progress towards climate goals. The adoption of unified methodologies for measuring emissions, tracking progress, and assessing climate impacts enhances transparency and accountability, fostering trust and

confidence among participating countries.

National Policies and Legislation: National policies are crucial for reducing greenhouse gas emissions, promoting renewable energy adoption, carbon taxes, emissions trading schemes, and integrating climate considerations into various sectors, including energy, transportation, and agriculture (Birchall & Bonnett, 2021 Bulkeley & Tuts, 2013: 646). They facilitate the creation of regulatory frameworks that incentivize sustainable practices and encourage the transition to low-carbon economies. Furthermore, comprehensive adaptation policies ensure the resilience of communities and ecosystems to the impacts of climate change, thereby reducing vulnerability and enhancing preparedness. Effective legal frameworks provide regulatory support for implementing climate policies and enforcing mitigation and adaptation measures. They establish accountability mechanisms, set emission reduction targets, and outline specific guidelines for monitoring and reporting progress. Additionally, institutional mechanisms, such as dedicated climate change departments (ex., The Ministry of Environment and Climate Change in Turkiye), task forces, and advisory bodies, enhance coordination among various government agencies and stakeholders, fostering a collaborative approach to climate action.

Local Governments: Municipalities and local governments play a crucial role in combating climate change (Reckien et al.2018; Samnuzulsari et al., 2021). Decisions taken at the local level can include practices such as energy efficiency regulations, public transportation incentives, and environmentally friendly urban planning. Climate change poses significant challenges that require coordinated efforts at various levels of governance. Local governments, close to communities and ecosystems, are uniquely positioned to implement effective climate change policies and initiatives. Effective climate change governance at the local level hinges upon the development and implementation of tailored policies that align with global sustainability targets. Local governments often integrate climate action plans into urban development strategies, land-use planning, and infrastructure development, fostering a holistic approach to resilience building. Although it is an international and global problem, the measures to be taken should also be localized. In other words, urban interventions are necessary for adaptation and resistance to climate change (Bulkeley & Tuts, 2013: 647)

Business World: The activities and decisions of businesses have a direct and indirect impact on climate change governance. Businesses' production processes, supply chains, and use of products often contribute to carbon

emissions. Therefore, businesses can take essential steps to reduce their carbon footprint through sustainability strategies. Methods such as energy efficiency, use of renewable energy, recycling, and reducing environmental impacts help businesses to promote environmental sustainability. The environmental and social responsibility understanding of businesses has a decisive impact on climate change governance. Sustainability strategies and corporate social responsibility projects of the business world enable practical steps to be taken towards protecting societies and the environment. In this way, businesses contribute to environmental sustainability while positively impacting society.

Civil Society and Activist Groups: Civil society organizations and activist groups are crucial in raising public awareness about the urgency of climate change and its impacts on communities and ecosystems. Through advocacy campaigns, they promote informed decision-making, encourage behavioral changes, and foster a culture of sustainability. Their efforts in mobilizing public support and building grassroots movements have significantly influenced policy formulation and implementation at local, national, and international levels.

Collaborative partnerships between civil society, activist groups, and other key stakeholders, including governments, businesses, and academic institutions, have proven instrumental in promoting climate resilience and sustainable development. They facilitate knowledge-sharing, capacity-building, and technology transfer through collaborative initiatives, fostering innovative solutions and promoting best practices for climate change adaptation and mitigation. Their inclusive approach to decision-making ensures the integration of diverse perspectives and the empowerment of marginalized communities in climate action (Rietig, 2016).

Civil society and activist groups serve as critical drivers of change in climate change governance, advocating for inclusive and equitable solutions that prioritize the well-being of people and the planet. By fostering collaboration, promoting social mobilization, and advocating for ambitious policy measures, they contribute to realizing global climate goals and creating a more sustainable and resilient future for all.

Scientific Research and Technological Innovation: Scientific research is a fundamental basis for developing comprehensive climate policies and strategies. It provides critical insights into the causes and impacts of climate change, facilitating informed decision-making and the identification of effective adaptation and mitigation measures. Integrating scientific findings into policy frameworks enables the development of targeted interventions and the allocation

of resources to address the most pressing climate-related challenges at local, national, and global levels.

Technological innovation is vital in accelerating the transition to low-carbon economies and fostering climate resilience. Developing renewable energy technologies, climate-smart agriculture practices, and sustainable urban planning solutions have significantly contributed to reducing greenhouse gas emissions and promoting environmental sustainability.

Education and Awareness: Social, economic, cultural, and socio-demographic characteristics of countries also differentiate their sensitivity to climate change and their practices (Busby et al., 2014, p. 719; IPCC, 2007). However, education is a cornerstone in building a resilient, informed society addressing climate-related challenges. Integrating climate change and sustainability topics into formal education curricula at all levels, from primary schools to universities, facilitates the development of environmentally conscious individuals. A comprehensive understanding of climate change science and promoting sustainable practices fosters a culture of proactive engagement with climate issues. Studies have been conducted by scientists investigating the knowledge and awareness of students at different levels of education about global warming (Aydın, 2010; Freije et al., 2017; Shepardson et al., 2011), climate change (Sauer et al., 2021; Shepardson et al., 2011; Zeeshan et al., 2021) and greenhouse gas effect (Andersson & Wallin, 2000; Boyes & Stanisstreet, 2001; Shepardson et al., 2011).

Public awareness campaigns stimulate behavioral change and promote responsible environmental practices. Raising public consciousness about the adverse effects of human activities on the climate fosters a sense of collective responsibility and encourages individuals to adopt eco-friendly lifestyles. Effective communication strategies, including mass media, social networks, and community engagement initiatives, are pivotal in disseminating accurate and accessible information to diverse populations. By cultivating a culture of environmental consciousness and responsibility, communities can actively contribute to implementing climate-friendly policies and initiatives.

Stakeholder Engagement and Participation: The active engagement of diverse stakeholders, including government bodies, private sector entities, civil society organizations, and local communities, is essential for inclusive climate change governance. Stakeholder participation fosters collaborative decision-making, enabling the integration of multiple perspectives and interests into climate policies. Empowering stakeholders through education and awareness

initiatives encourages collective action and ownership in pursuing climate resilience (Anguelovski & Carmin, 2011, p. 171; UN- FCCC, 2019).

3. Conclusion

Since the issue of climate change has many dimensions, it is challenging to address it with all its aspects. Starting from scientists who research global warming, policymakers, governments, economists, sociologists, management scientists, business people, agricultural engineers, biologists, and many other specialists are on one side of this issue. Thousands of scholars have been researching the management of for-profit and non-profit organizations for centuries. Nevertheless, a single management style is not and cannot be valid worldwide. Managing or attempting to manage the climate crisis is a global challenge, but one that pushes the limits of management and strategy (Okereke et al., 2009: 7). It is even more difficult to unite and mobilize all countries, country administrators, policymakers, bureaucrats, politicians, and all humanity for the same purpose.

On the other side, the possible consequences of not taking measures against global climate change may be economic losses, reduction of water resources, agriculture and food security problems, health problems, natural disasters, coastal erosion, migration, and international relations problems.

Given the transboundary nature of climate change, global commitment and collaboration are imperative for successful governance. Creating platforms for knowledge sharing, technology transfer, and financial assistance can facilitate the implementation of climate-resilient practices in vulnerable regions. Enhanced cooperation between developed and developing nations is crucial for achieving a collective vision of a sustainable future. Climate change governance is a complex undertaking that demands comprehensive strategies, multi-level coordination, and global cooperation. Understanding the intricate interplay of environmental, social, and economic factors is essential for formulating effective policies and fostering sustainable development. By addressing the challenges and complexities inherent in climate change governance, the global community can collectively strive toward a more resilient and sustainable future for future generations.

The components of climate change governance are interconnected and interdependent, forming a comprehensive framework for addressing the challenges of climate change. Policymakers can foster a more resilient and sustainable future by recognizing the significance of policy frameworks,

institutional mechanisms, stakeholder engagement, scientific research, technological innovation, and financial mechanisms. A holistic approach that integrates these components is essential for promoting global cooperation and achieving climate resilience at both local and international levels.

Climate change governance can be strengthened by establishing collaborative frameworks that actively engage governments, businesses, and civil society. Integrating climate action into broader development agendas and fostering inclusive decision-making processes is crucial for ensuring the effectiveness of international agreements. Additionally, initiatives aimed at sharing knowledge, promoting technological innovation, and enhancing capacity-building efforts can significantly increase the resilience of communities vulnerable to the impacts of climate change.

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CHAPTER IV

GREEN MANAGEMENT AND CLIMATE CHANGE

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1. Introduction

The concept of management is one of the oldest and most universal concepts in terms of human history. Management is a process of managing human communities to solve problems. Individuals have been establishing organizations and trying to manage them in order to achieve their goals by using the resources available to them effectively and efficiently from past to present. The phenomenon of management is important for the effective functioning of established organizations, the use of resources, and the realization of objectives. Although management is an old concept, it is a concept that maintains its importance in every field from the business world to non-governmental organizations, from state administration to interpersonal relations. The phenomenon that enables these elements to achieve their goals by using their resources in the best way is management. The concept of management includes basic functions such as planning, organizing, leadership, coordination, and control as well as effectiveness and efficiency, objectives, and resources. For an organization to be successful, these functions must be implemented in a balanced manner. The concept of management has an important place in a constantly changing and developing world, especially in business life. Factors such as technological developments, globalization, environmental factors, and social changes require organizations to constantly review their management approaches. Successful management stands out with its ability to be compatible with these variables.

Management is an important factor affecting the success of organizations and this discipline has been handled scientifically and shaped by researchers over time. Management approaches; classical management approaches, behavioral management approach, contingency approach, system approach, and modern approaches have been developed by putting forward many theories. These approaches have been developed and applied in different periods and according to different needs in the management world. Today, when modern management approaches are examined, it is seen that they are developing under the influence of technological developments, social events, global reflections, and many other factors. Green management, one of the modern management approaches, is seen as a management model based on environmental sustainability and the protection of natural resources. The related concept aims to reduce the (positive/negative) impacts of profit-oriented or non-profit enterprises and organizations on the environment and to fulfill their social responsibilities as well as their purpose of existence. Green management includes issues such as environmental sensitivity, energy efficiency, waste reduction, and sustainable use of natural resources, and one of the main objectives of the concept is to minimize environmental impacts. In green management, not only the main goal is to protect nature but also to contribute to the long-term sustainability of businesses. For example, production enterprises should take into account that recycling will be recycled when designing the products to be put on the market and may have implemented green management practices by minimizing waste levels. Adopting green management principles is considered important to contribute to a sustainable future both environmentally and economically.

On the other hand, climate change, which is one of the most fundamental and important problems of today, refers to long-term changes in the world's climate system and is generally stated as an increase in temperature worldwide due to the increase in greenhouse gases in the atmosphere. When we look at the phenomenon of climate change, it is seen that it is a more complex problem that brings along many environmental, economic, and social problems. Since climate change is a concept expressed as temperature imbalance, the increase in temperatures can cause the melting of glaciers, drought, floods, and many similar negative situations. The occurrence of all these problems reveals various problems and can cause many problems such as refugee problems, food security problems, and economic instability. Although climate change is not a problem that cannot be eliminated today, it will cause major problems for future

generations. Therefore, combating climate change problems is recognized as a responsibility of everyone today.

Green management and climate change are among the most important environmental and sustainability issues of today's world. It is seen that the relationship between the two concepts is important and the management styles exhibited by businesses play an important role in combating climate change. Businesses that adopt green management principles can play an active role in increasing energy efficiency, producing environmentally friendly products, and providing services. In terms of climate change, overuse and depletion of natural resources lead to climate change and this situation may adversely affect businesses that use raw materials. Problems such as damages due to climate events, supply chain interruptions, and increases in energy costs can threaten the sustainability of businesses. For this reason, businesses can both fulfill their environmental responsibilities and reduce the risks of climate change by adopting green management practices. This study, aims to contribute to the accumulation of knowledge in the literature by addressing the concept of green management and climate change and to provide recommendations to businesses at the point of implementation.

2. Green Management

In the literature, it is seen that the green management approach is used synonymously with the environmentally friendly activities of organizations. The Green management approach, which can be expressed as environmentally sensitive management, has meanings such as acting environmentally oriented and directing the field of activity accordingly. In general, activities such as taking into account environmental impacts in all activities carried out by enterprises, raising awareness of employees environmental awareness, providing training, and using technologies and raw materials that are not harmful to the environment express the green management approach (Karakuş & Erdirençelebi, 2018: 681).

Looking at the historical development of the green management concept, it is seen that it emerged at the end of the 20th century and gained value worldwide. Although the understanding of green management and the practices it brings with it are costly, it has been seen that they have turned into facts that create added value for businesses. It is seen that the concept of green management is used together with the concept of sustainability

in the literature and is sometimes used synonymously. Kuhlman and Farrington (2010) state that sustainability is to ensure the effective use of natural resources for businesses and to increase profitability as a result. Although it is used synonymously with the concept of sustainability, green management reveals a different understanding than sustainability. Haden et al. (2009) state that green management is the process of continuous learning, and implementation of innovations with goals and strategies in order to reduce waste, maintain sustainability, ensure social responsibility, and gain competitive advantage.

Apart from being an understanding, green management has started to take its place as a new function for businesses. Peng and Lin (2008: 203) state that green management is the whole of green products, green research and development, and green marketing elements that produce environmentally friendly products. It is reported that the practices within the scope of green management are an approach that minimizes the negative effects on the environment. In addition to these elements, Loknath et al. (2017) state that green management is an innovation process and that it is a culture that spreads throughout the enterprise instead of innovation in a product or service.

Green economies, which come with the understanding of green management, have provided businesses with various advantages. In terms of costs, it is seen that there are disadvantages and it is reported to be a challenging process. As a result of this understanding, it has been suggested by Barbiroli (2011: 24) that the transition to green and sustainable economies has advantages and difficulties, and these are shown in Table 1.

Table 1. Advantages and Disadvantages Experienced by Businesses in the Transition to Green Economy

ADVANTAGES	DISADVANTAGES
Economic goods that are adapted to nature are formed.	Prices of energy and mineral resources to be used in production increase.
With the development of new technologies in all sectors, global regional needs can be met more appropriately.	Prices of industrial products and agricultural food rise.
The functional features of newly produced goods increase the value of these goods.	High investment costs are needed to develop new technologies in all sectors.
Competition between businesses increases with the adaptation of sustainable management.	Production costs and market prices of long-lasting products increase.
Small and medium-sized enterprises are formed, new job opportunities arise.	There may be a decrease in the interaction between companies and the value of the products they produce.
Environmental balances are restored.	Unemployment may increase in large-capacity enterprises.
The efficiency of resources increases and the demand for energy resources and natural resources decreases.	There may be a decline in per capita incomes in the world.
Quality of life is greatly enhanced in sustainable cities.	People's purchasing power decreases.
If development has started successfully between industrialised and non-industrialised countries, incomes are redistributed.	In large cities and other urban centres, the transition to sustainable working and living spaces requires high costs.
Mobility in personal needs and working life is reduced, resource efficiency is increased, environmental pollution and energy use are reduced with clean products.	The investment costs used in the creation of clean transport and transport systems with economic advantages are high.

Source: Barbiroli, 2011: 24

Table 1 shows the advantages and disadvantages of green management practices. In order for green management practices to become more widespread, it is important for businesses to reduce their costs. Because the most basic goal of businesses is to make continuous profit.

In addition to the advantages and disadvantages of the green management approach for businesses, there are difficulties in adopting and implementing green management approaches. It may not be possible for organizations managed with traditional management approaches to enter the scope of green management at once. It is important that this understanding can be in a process and spread over time to ensure sustainability. In the process of adopting the green management approach to the whole organization and its stakeholders, Shrivastava (1995) reveals the differences between traditional and environmentally sensitive management. These are presented in Table 2.

Table 2. Differences between Traditional Management and Environmentally Responsible Management

Event Space	**Traditional Management**	**Environmentally Responsible Management**
Objective	Economic growth and profit Return to stakeholders	Sustainable Development Quality life Stakeholder wellbeing
Production Process	Products designed for the price Packaging that creates unnecessary waste	Environmentally friendly products Environmentally friendly products
Organization Process	Hierarchical structure Top-down decision-making Centralised authority	Democratic and participatory structure Stretchable hierarchy
Environmental Awareness	Approaching the environment as a resource Utilisation of pollution and product residues as waste	Being in harmony with the environment Effective and efficient use of resources Reduction and management of pollution and product waste
Business Functions	Marketing aims to increase consumption. Financing aims at short-term profit Accounting concentrates on traditional costs. Human resources aims to increase worker productivity.	Marketing is orientated towards consumer education. Finance aims at long-term sustainable growth. Accounting concentrates on costs related to the environment. Human resources endeavours to ensure health and safety in the workplace.

Source: Shrivastava, 1995: 130

As seen in Table 2, the main differences between traditional management and environmentally sensitive management are focussed. As mentioned above, green management is not only an understanding but also a green business function. In today's world, the spread of environmentally sensitive management approaches is considered important in order to leave a more livable world in the future.

3. Green Human Resources Management

With the green management approach, the business world focuses more on the concepts of environmental awareness and sustainability than in the past. Businesses act with the aim of reducing the negative effects of the sectors in which they operate on the environment and contributing more to society by acting beyond making a profit. Therefore, green human resources management plays an important role in contributing to the realization of these objectives. Öncer (2019: 199) emphasizes that green human resources management is one of the most important functions of the green management approach. Unlike a classical human resources management function, green management is an approach that emphasizes green jobs. It focuses on many elements such as environmental training, green recruitment, sustainability policies, performance evaluation, and encouraging environmental sensitivity.

As a concept, green human resource management has a structure that covers employees, managers, and the whole organization within the organization. Opatha and Arulrajah (2014) state that there are environmental policies, systems, and practices that will benefit business employees, the individual, society, the natural environment, and businesses. Renwick et al. (2013) stated that green human resource management is the aspect of corporate environmental management that looks at human resources. Opatha (2013) argues that the systems that aim to green the employees of an enterprise are green human resources management and it is reported that the idea of greening employees is the structure. Mampra (2013) states that green human resource management is the use of resources in the most sustainable way and encouraging this. The use of promoting environmentalism in human resource management policies refers to green human resource management. Ren et al. (2018) stated that all activities that affect the natural environment fall within the field of green human resource management and that this

understanding is to organize the relationships in the business as a system design. Zaid et al. (2018) reported that the presence of green behaviors in every element from recruitment, training, participation, performance management, and remuneration to production is green human resource management.

It is stated in the literature that there are some challenges in green human resource management practices as in every practice. Hosain and Rahman (2016) explain the challenges of green human resource management as follows:

- In every organization, there may be employees who are not willing to adopt green human resource management.
- The development and sustainability of green human resources management practices is a process that takes a very long time.
- The first stage of green human resources management practices requires a lot of cost for businesses, but the return may be low.
- It may be difficult to recruit and train business employees on green human resources management.
- It may be difficult to evaluate employee behaviors as green performance.
- It is difficult to transform employee behaviors and attitudes from traditional human resource management practices to green human resource management practices in a short time.
- The biggest challenge for human resources professionals is to select and develop future green leaders.

Since green management practices generally require a challenge and transformation, it seems quite difficult to adapt green human resource management practices to organizations. Milliman and Clair (1996) argue that green human resource management should have elements of traditional human resource management practices such as vision, training, employee performance, evaluation, and rewarding. Therefore, they emphasize that the transition from traditional human resource management to green human resource management is difficult. Although it is argued that many difficulties can be experienced, it is stated in the literature that many elements should be fulfilled in the process of transition to green human resources management. Tang et al. (2018) made a classification regarding the differences between the dimensions of traditional human resource management and green human resource management and this classification is presented in Table 3.

Table 3. Dimensions and Characteristics in the Context of Green Human Resources Management

Human Resources Management Practices	**Definitions and Basic Processes in Classical Human Resources Management**	**Green Human Resources Management Processes**
Recruitment and selection	Recruitment is the process of seeking candidates to fill vacancies in the organization. The recruitment process attracts and secures the services of skilled personnel through effective and optimum utilisation of human resources.	Organizations prefer to fill vacant positions with candidates who are environmentally conscious, sensitive and willing to contribute to this.
Education	A range of learning activities such as knowledge and skills provided to employees in line with the objectives of the organization.	Organizations implement a training system on environmental issues in order to improve employees' awareness and skills related to environmental management in their work.
Performance Management	It is aimed at the overall improvement of the performance of employees. The enterprise will compare the performance results of the employees with the targets, so that the strategic objectives will be achieved in the long term.	The environmental results of employees in the whole operation process are evaluated to determine their contribution to organizational goals and the environmental management vision of the enterprise.
Wage and Reward System	The remuneration and reward system is the implementation tool through which employees are rewarded for their performance.	Financial and non-financial rewards are given to employees whose attitudes or behaviours help the environmental management of the enterprise.

Employee Engagement	Employees are involved in the operational process with their various contributions to organizational development and are committed to the success of the company.	An opportunity is provided for employees to participate in environmental management. It includes comprehensive elements aimed at encouraging participation, a culture of support and employee commitment to the organization's environmental management.

Source: Tang et al., 2018

As seen in Table 3, the differences between the dimensions of traditional human resource management and green human resource management are presented. The basic principles of the green management approach clearly manifest themselves in the human resources function and foresee important steps for individuals, businesses, and society in the future.

4. Green Marketing

The understanding of green management is an important practice that concerns businesses in general and society in general. Therefore, when it is considered in terms of an enterprise, the green management approach spreads throughout the enterprise, especially the organizational culture, and then it is directed towards those who receive products or services from the enterprise. The basis of the green management approach is people and firstly, the business is transformed with green human resources management, and then green culture is put into service. The basis of this is green marketing.

The green marketing concept is defined as the development of products designed to minimize the negative effects on the natural environment. Since the target point in green marketing is the consumer, it is important to provide a service that can respond to the sensitivities of consumers sensitive to environmental events. In addition, it refers to all efforts such as production, packaging, distribution, promotion, and recycling of products for consumers who are sensitive to environmental events (Manjunath and Manjunath, 2013: 76).

Green marketing is defined not only as a concept around a product but also as a philosophy between businesses, society, and consumers. This concept, which progresses in the scope of sustainability, is wider than the scope of the known basic marketing concept and is the spread of activities and technical

processes from the design of products to the point of commercialization to the philosophy of the business. In green marketing, when it reaches the producer to the consumer, it should be in a way that satisfies consumers who are particularly sensitive to environmental issues (Chamorro and Bañegil, 2006: 12).

The fact that green marketing has become a part of the green management approach is accepted as an indicator of a process. Looking at the development stages of green marketing, it is stated that it has different aspects from traditional marketing. The basis of green marketing is based on the fact that this world in which we live will end one day. On the other hand, due to the constantly changing and developing structure of the world, it is stated that wars, natural disasters, new discoveries leave people vulnerable and factors such as sustainability, clean technology, and competitive advantage are other contributions to the development of green marketing. It is reported that sustainability is another step of green marketing and that it consists of processes such as product planning, development, control, implementation, and pricing, and that the processes should be compatible with the ecological system in achieving organizational goals (Özcan & Özgül, 2019: 3). The aspects of green marketing that differ from traditional marketing are presented in Table 4.

Table 4. Comparison of Traditional and Green Marketing Approaches

Criteria	**Traditional Marketing**	**Green Marketing**
Parties requiring clearing	Company and customers	Company, customer and environment
Targets	Customer satisfaction, fulfilment of company targets	Customer satisfaction, fulfilment of company objectives, satisfaction of the resulting ecological impact
Operational Responsibility	Economic responsibility	Socially responsible
The field of marketing decisions	From production to product use	The entire product value chain from raw material supply to post-consumption
Environmental demands	Legal obligations	Design for the environment outside the law
New print groups	Confrontation and passive behaviour	Starting relationships and co-operation

Source: Chamorro and Banegil, 2006: 13

In Table 4, traditional marketing and green marketing approaches are compared. Green marketing has been widely used in managerial studies thanks to the commercial and environmental advantages it provides to businesses. By its nature, green marketing tries to eliminate the incompatibilities between existing marketing approaches and the wide ecological environment and social realities in the market. In doing so, businesses are both environmentally sensitive and provide strategic advantages (Papadas et al., 2017: 7).

5. Climate Change

Climate as a system consists of land, sea, atmosphere, cryosphere, oceans, and land surface elements and these elements interact. It is the energy exchange that provides the formation of the climate system where the climate of the earth is due to this interaction (Houghton et al., 1997: 9). The concept of climate is defined as the average of weather conditions in any place in the time period on earth. The determination of the average of weather conditions is determined by synthesizing the statistical results (Barrie, 2005: 2).

When the concept of climate change is examined in general, it is defined as the creation of a greenhouse effect as a result of the sun's radiation waves hitting the earth and the greenhouse gases in the atmosphere reaching the Earth (Aksay et al., 2005: 31). In the United Nations Framework Convention on Climate Change, climate change is defined as: *"In addition to the natural climate change observed in a comparable period of time, the change in climate as a result of human activities that directly or indirectly disrupt the composition of the global atmosphere"* (United Nations, 1992). It is revealed by many scientists that climate change, which has become an important issue in recent years, has gained momentum with the Industrial Revolution. According to the studies of scientists, it is observed that the average world temperature has been increasing since the 1900s and the glacier layers have thinned by 3% compared to the studies conducted in the 1970s (Giddens, 2013: 26).

Although the issue of climate change seems to be a field of science shaped by the studies of environmental scientists with various measurements, it is seen that the factors that cause climate change also affect other branches of science. Başoğlu (2014) states that the effects of the Industrial Revolution on climate change are great, but also states that situations such as population growth rates, rapid growth strategies of countries, increasing energy consumption, and insufficiency of resources lead to environmental pollution. In general, it can be

said that the increase in the number of people and what they can do has made the problem of climate change a global issue.

In this context, addressing climate change in terms of businesses is considered important in terms of ensuring the integrity of the subject in this study. Because climate change is a global problem and it is known that commercial activities have a great impact on climate change. The focus on continuous growth in an economic process where the main goal of businesses is to achieve continuous profit affects climate change. Businesses that think that their goal of continuing their existence and existing forever is economic growth are criticized by people sensitive to environmental events in terms of the threat of destroying the world (İsaoğlu, 2014: 86).

The phenomenon of climate change has a complex structure that cannot be explained by a single theory, explanations, and events, and according to the opinions of scientific researchers and experts, it is stated that it is driven by two main effects. These are natural-induced climate change and human-induced climate change (Lean & Rind, 2008).

Considering the causes of natural-induced climate change, it can be said that volcanic forcings, the effects of continental drifts, the evolution of the plates, the differentiation of the earth's orbit around its own and the sun's axis, and the change in energy from the sun over time (Kadıoğlu, 2019: 125). On the other hand, looking at the causes of human-induced climate change, it is stated that the increase in the use of fossil fuels with the Industrial Revolution (Labatt & White, 2007: 3), six types of human-induced greenhouse gases (emissions) have an impact on climate change. It is also stated that technology is a structure developed by human hands and that technology indirectly affects climate change (Şen, 2022: 10). According to Akbulut and Kaya (2020), although climate change is human-induced, its solution is also within human power. It is necessary to accept climate change as a disaster.

While the natural origin of climate change is of course an unpredictable situation, the human origin of climate change refers to a situation that can be prevented. Because, although climate change does not harm people in the current situation, it is suggested by scientists that it will cause great destruction in the future. Therefore, the main purpose of this study is to determine the effect of businesses that directly concern people and their management structure on climate change. The green management approach, which is the subject of the study, offers a different perspective on combating climate change.

6. The Relationship between Green Management and Climate Change

Green management is an approach that includes practices and policies for sustainability in terms of businesses and reducing negative impacts on the environment, and the first factor that will be positively affected in the adoption of green management approach by businesses is climate change. Because climate change is an event that has been negatively affected by human beings for many years. Although climate change will cause more negative situations to emerge in the future, the main purpose of businesses is to make continuous profit, to continue their existence, and to survive forever. In fact, the rule of surviving forever here is directly related to climate change. Because if there is a habitable world, businesses can survive forever. Situations such as depletion of natural resources, noticeable change of seasons, and difficulty in finding raw materials eliminate the condition of enterprises to survive forever and even jeopardize the condition of continuing their existence.

Research aiming to observe how businesses are affected and how they cope with the risks that occur during the crisis periods that occur as a result of climate change and natural disasters has examined the risk levels of nearly ten thousand supplier businesses engaged in international commercial activities due to environmental changes. One of the most important findings of these studies is that natural and environmental changes and constraints have an impact on the activities, income, expenditure items, and budgets of enterprises at least 80 percent of the time; significantly creating risks on these factors (Hıdıroğlu, 2021: 6). Therefore, not only the impact of businesses on climate change, but also the impact of climate change on businesses can be mentioned.

The fact that businesses act in line with the green management philosophy has a significant impact on climate change. Paul Hawken (1993), one of the researchers working on this subject, expresses the importance of environmental awareness as a third way in addition to organizational and market conditions in terms of the sustainability of enterprises. Stating that many advances have been made since the Industrial Revolution, the researcher stated that global ecological crises await all humanity at this point and that the way to get rid of these crises is to shape the strategies and policies of enterprises according to the green management philosophy. In addition, Önel (2021: 24) lists the factors that push businesses to become green businesses as follows:

- With the green management approach, savings can be achieved by eliminating material expenses and profitability rates can be increased.

- Businesses that intend to transform into green businesses can increase their market value.
- Within the scope of green thinking, qualified people will be employed in terms of manpower.
- The number of consumer models with a lifestyle that can harm the environment as little as possible will increase gradually.
- As a business that attaches importance to environmental quality instead of harming the environment, more customers will be reached and it will become more attractive for consumers. More effective public relations activities will be carried out with green culture.
- Operating and real estate expenses will decrease with green understanding.
- The productivity capacity of the business increases.
- Businesses will create value in many areas by minimizing waste rates during their activities, using renewable energy, and creating environmentally friendly products.
- Possible risks will be reduced with a green management approach.
- Environmental problems that determine the business model and legal regulations on the subject create pressure on businesses.
- Businesses structured according to green thinking will create pressure on other businesses in terms of competition.
- Environmental responsibility can increase the motivation level of employees.
- The green thinking approach will draw a positive image in the eyes of customers, employees, and everyone who adopts and values this approach.
- Green economy, green management, green marketing, green marketing, green accounting, green human resources, and green informatics will create important opportunities for sustainable competition.

As stated above, the fact that enterprises are green enterprises by adopting the green management approach contributes to both themselves and environmental events. Therefore, the enterprise that contributes to the environment can pave the way for consumers to be conscious of the products it produces. On the other hand, while green management brings businesses to their goals with an environmental consciousness, it can also offer a strategic perspective on climate change. Because climate change needs a good risk management process since it includes elements that threaten the future. Since the desired situation includes

an improvement aim for both the present and the future, it will be beneficial to proceed with a strategic approach (Altıntaş & Akbulut, 2022: 65). Therefore, strategic green management practices should be applied to enterprises in every sense and measures should be taken by the public authority for this.

7. Conclusion

The green management approach, which is accepted as a sustainability and environmentally friendly approach, is accepted as a management approach that creates positive effects on the environment. This approach is gaining importance in public organizations, especially in private sector organizations. Green management aims to minimize negative impacts on the environment, to use natural resources in a sustainable manner, and above all to observe social responsibility. The approach is based on practices such as energy saving, waste minimization, investment in renewable energy sources, training, and awareness raising on environmental issues. The green management approach plays an important role in reducing environmental problems worldwide and building a sustainable future and is recognized as a tool that ensures harmony between the business world and the environment.

On the other hand, the concept of climate change, which poses a major threat to our planet, explains important effects such as long-term weather conditions, sea level rise, temperature, and precipitation increases/decreases in the world's climate system. These changes have accelerated especially in recent years and are associated with human impact. The main cause of climate change is seen as human-induced and is expressed as the increase in greenhouse gases accumulated in the atmosphere.

Considering the relationship between green management practices in enterprises and climate change, it can be said that they interact in many ways. For example, greenhouse gases, which have a significant impact on climate change, can be reduced through green management practices. While public and private sector organizations aim to increase energy efficiency, they can reduce greenhouse gas emissions by improving transport systems and investing in renewable energy sources. On the other hand, sustainability and sustainable resource utilization, which are at the basis of the green management approach, have a significant impact on climate change. Promoting the sustainable use of natural resources, efficient use of forests and water resources, and recycling practices can contribute to reducing the negative impacts of climate change.

Environmental awareness and consciousness-raising, innovative technology and green innovation practices can be counted among the positive effects of green management on climate change. Finally, the development and shaping of public policies are considered important in terms of environmental practices. A public authority can contribute to the promotion of green policies by putting environmentally friendly practices on a legal basis. Private sector organizations, on the other hand, can ensure the spread of green management by setting similar targets to the practices implemented by the public sector in order to provide a competitive advantage. The understanding of green management is reflected in the products and services starting from the internal environment of the enterprise, and then it can create awareness of climate change by meeting with consumers. For example, in Turkey, the introduction of plastic bags for a fee on 1 January 2019 by the Ministry of Environment, Urbanisation and Climate Change (www.csb.gov.tr, 2023) has contributed to reducing the negative impacts on the environment by reducing the use of plastic bags.

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CHAPTER V

ECOLOGICAL DIVERSITY IN THE PERSPECTIVE OF CLIMATE CHANGE

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1. **Introduction**

Disasters are the consequences of events that cause social, environmental, physical, economic, and political losses in societies, disease, loss of life, and both physical and psychological injuries, disrupt everyday life, and cannot be managed by local capacities. One of the types of disasters that have negative impacts on living things worldwide is global climate change. As a result of both natural and man-made activities, the devastating effects of this catastrophe are being felt more and more on Earth every day.

Before we turn to the concept of global climate change, it is necessary to explain the climate phenomenon. Climate is a region's long-term average of seasonal, humid, precipitation, and temperature phenomena. Despite settlement weather can fluctuate in the short term, this is not the case with the climate phenomenon. The change in this phenomenon takes a very long time. Climate change refers to changes in the current weather situation, such as increased precipitation, temperature, or drought over a long period (World Bank Climate Change Knowledge Portal, 2023).

Global climate change is caused by nature due to volcanic eruptions or events in the solar system. Nevertheless, as a result of human activities since the 1800s, we face global climate change and its consequences. Destruction of forests, wrong agricultural and land policies, preference for fossil fuels, and unconscious use of industry, transportation, energy, and construction cause greenhouse gases (United Nations Climate Action, 2023).

The consequences of hydrometeorological disasters have recently been widespread and intense in many settlements. Mainly, man-made factors cause these disasters and their consequences to increase, and various types of disasters and their impacts occur. As a result of climate change, the number and consequences of hydrometeorological disasters are increasing (Kadıoğlu, 2012: 7).

Global climate change causes many negative impacts, as explained in the following sections of this book chapter. The impacts it causes also put pressure on the ecosystem. Due to the ever-changing climatic conditions, meteorological factors cause disruptions in the biodiversity cycle.

The species of all life forms on Earth make up the biodiversity in ecosystems that contain living things such as bacteria and forests. The consequences of global climate change cause disturbances in ecosystems in the Earth's terrestrial, marine, and freshwater areas. It is leading to a decline in biodiversity, an increase in disease rates, and a massive loss of life in animals and plants. The species extinction risk in the ecosystem is relatively high with the temperature rise. Human health is also threatened. This is because climate changes negatively impact the health structure of ecosystems. As a result, diseases can be transmitted to society through viruses (United Nations Climate Action Biodiversity, 2023).

Keeping ecosystems properly cycled plays a role in the health of communities. This prevents further disease and ensures that the climate remains in a specific order. However, due to global climate change's effects, ecosystems' biodiversity is also subject to this negativity, and threats to human health are occurring worldwide. As a result of global climate change, carbon levels in the atmosphere lead to acidification of seas and oceans, negatively impacting biodiversity in each region. Furthermore, extreme weather events in the terrestrial realm negatively impact many biodiversity structures. In general, the consequences of ecosystem disturbances in both marine and terrestrial environments affect societies' health (World Health Organisation Biodiversity and Health, 2023).

This book chapter aims to explain the relationship between the global climate change and ecological diversity. Important topics include global climate change and its significance, its impact on biodiversity, some critical international agreements and conferences, and adaptation to global climate change in the context of disaster risk reduction strategies.

2. Introduction to Global Climate Change

Climate phenomenon is the concept that explains the long-term weather conditions of any settlement. In other words, it is the phenomenon that

determines the annual rainfall in the region and the air temperatures in summer and winter. It constantly interacts with the climate, living things, atmosphere, land, ice, and water bodies. The climate system is influenced by nature, e.g., by solar radiation and man-made factors related to the use of fossil fuels. Global climate change describes the changes in the current climate in all places and all periods. This negative situation also affects the changes in the current weather conditions in the world and the incidence of disasters such as drought, storms and floods (Adedeji, 2014).

2.1. Greenhouse Gas and Its Importance

In emphasizing the importance of the climate system, the greenhouse effect should be highlighted. It should be underlined that the greenhouse effect is also related to the atmosphere. The atmosphere is of vitally importance for the warming of the Earth, as it acts as a philter for the rays coming from the Sun and retains the heat. The atmosphere that makes the world a habitable environment consists of 20.95% oxygen, 0.03% carbon dioxide, 78.08% nitrogen, 0.93% argon, and 0.01% other gases. Short-wave rays from the Sun penetrate the atmosphere and reach the Earth, where they are absorbed. Long-wave rays coming from the hot regions of the Earth are absorbed by the greenhouse gases (methane, water vapor, nitrogen monoxide, and water vapor) in the upper atmosphere and prevented from escaping into space. These rays can reach the Earth again. In this way, the temperature balance of the world is maintained. This situaiton is called the greenhouse effect (Türkeş, 2000: 189).

The man-made changes in greenhouse gases since the Industrial Revolution have also revealed some problems in contemporary life. The increases in the rates of greenhouse gases such as chlorofluorocarbon, carbon dioxide (Tuckett, 2019: 362-364), diazot monoxide, carbon dioxide and methane has led to the thinning of the ozone and also caused an increase in the temperature rates on Earth. This event has brought to light the problem of global climate change. There has been an increase in the temperature rate on Earth by 0.3-0.6 C since the mid-nineteenth century. According to scientific studies, it is estimated that the world's temperature will increase by more than 0.1 C^{o} every ten years. The effects that may result from this global warming are as follows:

- Changes in underground and surface water resources and soil structure,
- Droughts and desertification set in,
- Causing damage to the socio-economic lives of societies around the world,

- Negatively affecting many living systems and even causing loss of life,
- Causing changes in large ocean current systems (Özmen, 2009: 43).

2.2. Factors Causing Global Climate Change

The climate on Earth is subject to changes that depend on many factors. This situation also leads to some problems. Natural factors that cause global climate change:

- Gases released from volcanic eruptions, such as that of the Pinatubo volcano, form a layer. These layers, which block the passage of sunlight, cause the temperature on Earth to drop,
- Differences in wind direction and ocean currents due to shifts that can occur on the continents,
- Problems with the amount of energy reaching the Earth due to spots on the Sun,
- Determining that the world axis has 23,000 years of deviation and 4000 years of time shift,
- The Antarctic continent has serious responsibilities in terms of climate, as it is important in terms of the existing systems in the oceans, the formation of winds and the reflection of the majority of the Sun's rays (Aksay et al., 2005: 30).

As a result of human-induced situations that place additional stress on the natural factors described above, the rate of climate change and its consequences are increasing. The use of fossil fuels in many products people use daily supports this situation (Adedeji, 2014). The increase in carbon dioxide content due to increasing industrialization since the Industrial Revolution is an essential factor that has triggered global climate change. In addition, improper waste disposal, increasing density of transportation networks, uncontrolled agricultural practices, and destruction of forests and humanity are the factors that cause climate change and its outputs. (Kiliç, 2009: 23-38).

2.3. Urban Heat Island and Its Consequences

The factors that cause global climate change include technological development, population growth, and individual attitudes. In addition to these factors, from the urban heat island perspective, there are differences in temperature rates between cities and rural areas due to the heat retention function of reinforced concrete structures and the uncontrolled presence of harmful

elements (Karl and Trenberth, 2003: 1720-1722). Global climate change can lead to an urban heat island, negatively impacting settlements' economies, environment, and public health (Corburn, 2009: 414).

Urban heat island phenomenon; as a result of human behavior, the temperature observed in cities is higher than in rural settlements. During the afternoon, the temperature difference between cities and rural settlements can exceed 10 C°. Nonetheless, the study of it is based on the temperature difference that occurs at night rather than during the day. Temperature rates in short regions are considered a global warming problem, and temperature differences between cities and rural settlements signal urbanization. The urban island effect problem arises because the reflectivity of building materials used in cities is lower than that of areas with vegetation (Özey and Ünlü, 2022: 106-107). In other words, some buildings and streets absorb solar energy in cities. When this adverse situation is added to areas with little vegetation to control moisture in the environment, temperatures in cities begin to rise (Corburn, 2009: 416).

2.4. El Nino and La Nina Phenomenons

In the year1891, Luis Carranza discovered a countercurrent in Peru with a direction from north to south. In time, this current was named El Niño. The same year, Peru had abundant rainfall, and hot water currents were observed in the region. In this context, it was determined that there was a climatic link between the Pacific Ocean and the atmosphere (Cane, 1986: 43-46).

In general, El Niño is a condition of unusually warm sea surface temperatures in the eastern Pacific region of the equator, in direct contrast to the La Nina, which is defined by unusually cold sea surface temperatures in the tropical eastern Pacific region. This situation resulted in abundant rainfall in Peru, bushfires in the Australia and southern USA., and severe droughts and floods in the western Pacific. The concept of La Niña, compared to El Niño, is abnormally cold water temperatures in the Central American portion of the equatorial Pacific Ocean. One of the effects of the La Nina is that the average winter temperature is higher than expected in the southeastern parts of the U.S. At the same time, La Nina phenomenon is cooler than average in the northwestern regions of the same country. Another example: While the temperature in the northern regions of Indonesia and Australia was 32 C°, the sea surface temperature in the western regions of South America at the same latitude was between 26-27 C° (Kayhan and Alan, 2014: 4-10).

La Nina and El Nino are phenomena that contribute to global climate change. La Nina is a phenomenon that affects precipitation and temperature factors in the context of climate values. The first and strongest impacts occur in areas near the sea or ocean where the event occurs (Akbulut, 2019: 21).

According to the World Meteorological Organization, the probability of El Niño occurring after June 2023 is 90%. They attribute the changes in the oceans in the tropical Pacific regions to this situation. It was also noted that abnormal temperature rates in the eastern Pacific regions do not only affect this area but also the west (WMO, 2023: 1-3).

2.5. Effects of Global Climate Change

The consequences of the global climate catastrophe are causing many adverse effects on a global scale daily. The increase in the types and number of disasters caused daily by the consequences of this disaster can further increase the threat to societies.

Among the consequences of climate change:

- Rising sea level rates,
- Drought and desertification,
- Migration due to global climate change,
- Effects on the economy (Kadıoğlu, 2012: 1-13),
- Increased temperature rates,
- The increasing likelihood of tropical storms,
- Ocean acidification,
- Increasing precipitation factor,
- Risk of decline in water resources,
- Causing negative effects on the Earth's ecosystem,
- Food shortages,
- Causing diseases and loss of life,
- Poverty (United Nations Climate Action, 2023),
- Negatives on agriculture,
- Melting of glaciers, (Houghton, 2005: 1383-1387).
- Fission of methane hydrants,
- Observation of extreme weather events,
- Observing the complexity of energy demand,
- Increase in storms in the mid-latitude region,
- Flooding due to sea level rise in coastal regions (McKibbin and Wilcoxen, 2002: 113-114).

3. Ecological Diversity

3.1. What is Ecology?

In 1866, Ernst Haeckel defined the connection between living things and their habitats as ecology. He developed this concept by combining the words oikos, meaning campus, and logos, meaning word. As Darwin noted, plants or animals' positive or negative relationships with other living things fall within ecology. In general, the branch of ecology examines the connection between living organisms and their environment. (Keleş et al., 2015: 29-30).

Biodiversity in the context of ecology is the element of diversity determined by the unique age, sex, and hereditary variables of species. Diverse biodiversity is also an ecosystem phenomenon. Climate, land and water resources use, and water and soil characteristics lead to ecological consequences due to human activities and natural resources changes. As a result, global change is occurring (Schmitz, 2013: 4-7).

With the deepening of ecology, the study of the relationships species and organisms and resource use has also increased. In general, biosystems ranging from genetic systems to ecosystems are inferred from the interaction of abiotic and living factors of the ecological process. Within this process, the living components, i.e., biotic, consist of genetics, cells, organs, organisms, populations, and communities. Moreover, the abiotic, i.e., non-living, elements consist of energy and matter. Each link in the ecological process is interconnected. Situations such as the organism cannot survive for a long time without a population are an example of this explanation. The process then extends from ecosystems to the ecosphere (Odum and Barrett, 1971: 3-9).

3.2. Consequences of Climate Event on Ecological Diversity

Climate is a phenomenon that is important for living things in ecology. In addition, humidity and temperature play a role in the life functions of living things within the framework of these factors. The energetic relationship of living beings with their environment, the region's seasonal differences, and the solar radiation changes can negatively affect species. Physiological structure plays a role in the relationships of each living species to its physical environment. Variations can occur in the physiological processes of species depending on time and opportunity. To illustrate this example, respiration and photosynthesis are related to temperature. Global climate change is also believed to have an

impact on wild species. It has been explained that temperature rise and solar radiation can negatively affect these creatures' physiological and biochemical structures (Schmitz, 2013: 26-40).

As human-induced activities increase day by day, there is also an increase in the amount of CO2 in the atmosphere, acidification of water resources occurs. It depends on the event, marine creatures' shells and skeletal structures are irritated. As the heat threat increases, some problems arise between the atmosphere and the water cycle.

High-temperature levels also lead to increased evaporation level. Thus, heavy rainfall may be encountered. As this situation develops, floods may increase, and the soil structure may dry. Experiencing all the negative consequences described will have adverse effects on ecological systems and lead to the possibility of species extinction (Dursun et al., 2016: 52-53).

Due to climate change, some unfavorable situations are encountered, such as increases in sea levels and temperature rates and changes in the current climate and precipitation patterns. It has been announced that the outputs of climate change, especially the increasing CO2 concentration in the atmosphere, will significantly affect ecological restoration (Harris et al., 2006: 170-171).

Due to increases in greenhouse gas levels, ecosystems are negatively affected by this situation. Problems may arise in water resources due to temperature increases, possible dangers to animal and plant species due to damage to the ecological cycle, and disruptions in animal husbandry and agricultural activities (Şanlı et al., 2017: 210).

The climate-related humidity level is fundamental to the ecosystem types found in the terrestrial area. Climate and, more importantly, current and wind factors affect ecosystem types in the oceanic region. There are differences in the species seen in the region due to high climatic temperatures and variations in precipitation rate. Tropical forests are seen in areas where the temperature is high, and rainfall is high, savannas are seen in moderate areas, and deserts are seen in areas where it is very low. There are temperate forests in places where the temperature is slightly lower, and the precipitation level is higher, temperate grasslands in places with moderate levels, Mediterranean biomes in areas where it is lower, and deserts in areas where it is even less (Begon et al., 2014: 92-99). The habitats of the ecosystem types described above may be damaged due to global climate change. Due to the occurrence of extreme temperatures over time, imbalances in precipitation patterns, the increase in extreme weather events, and

tropical storms may have a threatening dominance over the current ecological cycle.

Global climate change may negatively affect plant species and factors such as ecosystem energy. Besides, divisions in peat species may increase due to climatic warming. This resulting factor is one of the situations that cause increases in carbon dioxide and temperature rates. The annual growth rate of plants in the ecosystem is called NPP (Net Primary Productivity). Measurement is provided in grams of carbon in new plant species annually. Any change to this extent directly affects the ecosystem negatively. Based on plant species' amount and growth rates, this measure is affected by humidity, atmospheric carbon dioxide, and temperature factors. In other respects, as the humidity or temperature increases, the ratio in the measurement also increases. However, when the temperature increases to severe levels, a situation opposite to the increase in temperature may occur. In addition to these situations, problems encountered in species' habitats due to global climate change may cause migration. This situation due to anthropogenic global warming may cause anxiety (Malcolm and Pitelka, 2000: 13-21).

4. Global Climate Change Adaptation within the Scope of Disaster Risk Reduction Activities

The consequences of disasters continue to have devastating effects on many societies worldwide. As explained in the Sendai Disaster Risk Reduction Framework, between 2005 and 2015, due to the negative consequences of disasters, thousands of people lost their lives, more than one million were injured, and millions had to leave their residences. In addition to these destructive consequences, the resulting economic losses have reached severe levels. Apart from all these negativities, the consequences of disasters due to climate change have been factors that slow down the sustainable development policy (UNISDR, 2015).

As described in the literature, the outputs of climate change bring many destructions. International countries face unexpected and severe situations, mainly due to increased species and many disasters. The disaster experienced in Libya supports this statement. As Naıdoo and Mbiyozo noted, Storm Daniel, which caused severe damage in Greece due to global climate change, moved toward the Mediterranean region, where temperatures are highest this year. Due to the high-temperature factor, the water in the Mediterranean Sea warmed up

and provided the opportunity to add much moisture to the incoming storm. Due to this situation, very heavy rainfall occurred in Derna, Libya. Due to the negative meteorological situation, destructive floods were observed in the region (Naıdoo and Mbıyozo, 2023). The magnitude of the hazard further increased when two dams in the region collapsed due to flooding. While more than 4,000 individual lost their lives due to this disaster, more than 8,000 people were classified as missing (World Health Organization-Libya, 2023)

Climate change and its consequences on global ecosystems, societies, and economies are increasing daily. The sustainable development policy may slow down if we fail to guard ourselves against the outputs of global climate change. Stretching barriers against disaster and climate change risks against these negativities, to increase resilience to the consequences of these events, and, in short, to integrate every individual in the global society into climate and disaster risk management based. As stated disaster and climate risk management:

- Emerging hazards and climate change impacts do not affect every society similarly. Disaster and climate risk planning must ensure capacity development by prioritizing vulnerable communities,
- Disaster and climate risks are linked to other risks and increase the potential damage,
- Identify hazard, risk, and vulnerability factors at local, regional and national,
- Developing climate change and public health plans within the scope of risk management at all levels and strengthening the governance factor,
- Conducting studies on social protection and insurance activities for the negative impacts of disaster and climate change risks,
- Strengthening all structures of local capacities, including infrastructure, within the framework of risk reduction, taking into account the multiple hazards,
- Conducting studies on the conservation of ecosystems, reforestation of coastal areas, and protection of water resources,
- Establish early warning systems in case of alert by ensuring cooperation between institutions and society,
- Being prepared for crisis management,
- It is stated that creating resilient societies by organizing training against global climate change and disaster risks (UNDRR, 2020: 6-34).

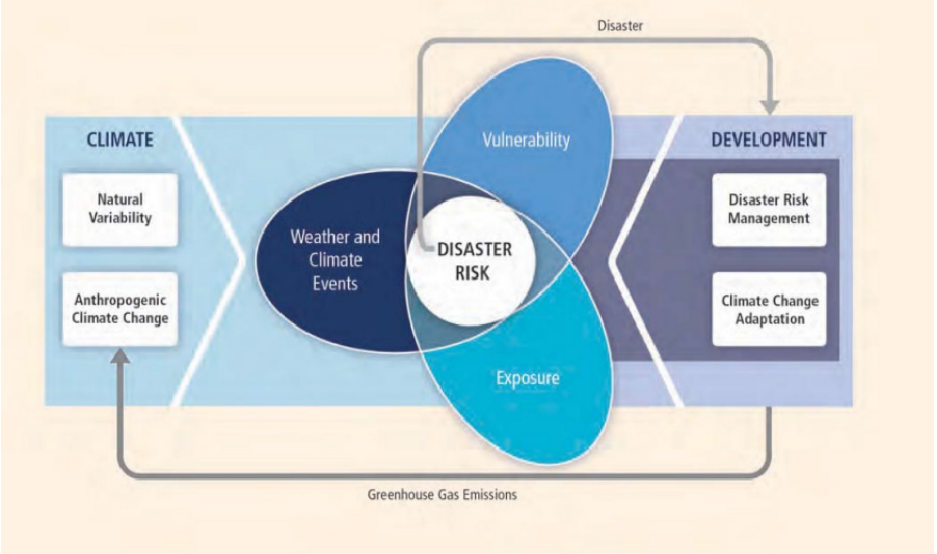

Figure 1: Diagram on the Management Of Extreme Events
And Disaster Risks To Improve Global Adaptation To Climate Change
Source: Field et al., 2012: 31

Figure 1. shows the facts that should be considered disaster risk management and climate change adaptation and how these factors relate to the sustainable development framework. It is a scheme for determining the consequences and risks of disasters by prioritizing the vulnerability in climate and weather events. Risk management and adaptation measures to global climate change play an essential role in reducing the factors that pave the way for the determine of risks and forming a sustainable development model in the socioeconomic dimension. Therefore, studies on adaptation to global climate change are based on implementing risk management-based preparedness activities for the consequences of disasters and, thus, on creating resilient societies (Field et al., 2012: 31-38).

5. Some Critical Steps Related to Ecosystem and the Climate Change

The phenomenon of " climate change" within the scope of greenhouse gas policy was described by Svante A. Arrhenius in 1896 (Bodansky, 2001: 24). He explained that changes caused by an amount of carbon dioxide located in the atmosphere, no matter how small, causes to an increase in the temperature element and thus changes in the current climate can be observed (Akbulut, 2019: 26).

In 1972, the United Nations Conference on the Human Environment was held in Stockholm. The first world conference dealt with environmental problems and protective measures against these adverse effects. Within the framework of this conference, 26 principles were established. It was declared that all people in society have equal rights and freedoms. It was stated that people have an essential duty to protect the environment so that present and future generations can live good lives. The need to protect nature, including ecosystem species, seafood, and wildlife, was emphasized. The importance of issues such as taking action against negative influences that damage the ecosystem, such as pollution, continuing the production of renewable resources, acting with the awareness that non-renewable resources will one day run out, taking the necessary precautions and controlling them, not having weapons of mass destruction in the eyes of the environment and society, and ensuring international agreements on this issue, worldwide, the creation of development models that include measures to protect the environment, ensuring international coordination and the preparation of plans when necessary, the management and monitoring of plans prepared at the national level, the facilitation of living conditions in terms of social and economic development, considering the impact on the population, the detection of environmental risks using science and technology, the community-based introduction of environmental education was emphasized (United Nations, 1972: 3-5). As a result of this conference, UNEP was established (United Nations Conferences/Environment, 2023).

Global climate change was officially recognized at the first World Climate Change Conference in 1979. The conference discussed the consequences of the climate change on societies. In this context, it was proclaimed to the international countries that the man-made changes that can cause climate change must be predicted, and precautionary measures must be taken. The conference also adopted the preparations for the "World Climate Program" in cooperation with the International Council of Scientific Unions, the World Meteorological Organization and the United Nations Environment Program (IUC, 2023).

In 1985, in Villach, Austria, under the coordination of scientists, the International Council of Scientific Unions, the World Meteorological Organization and United Nations Environment Program adverse effects of global climate change that could result from increased greenhouse gasses were discussed. Global climate change results found that most of the ozone layer, sea level, and acidity problems are due to human behavior. It was announced that

the sea level will rise due to a temperature increase between 1.5 C and 4.5 C, negatively affecting regions with coasts. It was also estimated that ecosystems could be affected by the temperature rise. It was emphasized that reducing the use of fossil fuels will reduce emissions of chlorofluorocarbons and damage to the ozone layer. This way, climate change and its outputs can be reduced (World Climate Programme, 1986: 1-5).

As for the problem of ozone layer depletion, the Vienna Convention was drafted in 1985, and the Montreal Protocol in 1987. The Vienna Convention explains the reasons for the thinning of the ozone, the effects that may result from this situation, and the need to take the measures to prevent damage to the atmosphere in coordination with countries. The Montreal Protocol states that reducing chlorofluorocarbon gasses and the phase-out of halons is mandatory (UNFCC, 2023).

In 1988, under the direction of the Intergovernmental Panel on Climate Change, the United Nations Environment Program and the World Meteorological Organization was established to address the consequences of climate change and measures to combat these adverse effects (IUC, 2023).

In 1992, the Rio Declaration was held by United Nations. The conference established principles for international states and societies to create environmentally friendly management policies. The primary purpose of this declaration was to include the environmental protection factor within the sustainable development framework. It was also stated that while states should use their resources under development and environmental factors, they should do so in a way that does not harm the regions of other states. It was stated that measures should be taken to protect the current structure and health of ecosystems on Earth and that states should cooperate internationally. It is stated that states should legislate at the national level on environmentally harmful substances and other environmental damage. It was stated that all practices and materials harmful to the environment and human should be prevented and that states should act in a coordinated manner on this issue. Twenty-seven universal principles were established, such as interstate communication about emergencies or natural disasters that may threaten the environment (United Nations, 1993: 2-8). The Forest Principles were also adopted with this declaration. Furthermore, during the conference, within the United Nations Climate Change, Convention to Combat Desertification and Framework Convention on Biological Diversity were submitted for signature under the guidance of decisions made at the 1994 conference (Ministry of Foreign Affairs, 2023).

The Convention on Biological Diversity was adopted in 1992 and adopted in the Rio Declaration, organized under in the same year. It entered force in 1993 (Karagöz, 1998: 1-2). In general, four main objectives were set in this agreement: Protection of biological diversity from all kinds of factors, sustainable use of the elements of this diversity, easy accessibility through priority rights to genetic resources and technology, and equitable sharing of positive factors associated with the use of genetic resources. It was stated that interagency plans for biodiversity protection should be established, and training programs for the public should be created regarding the precautions to be taken (United Nations Convention on Biological Diversity, 1992: 3-9).

The Kyoto Protocol to reduce greenhouse gas emissions was adopted in 1998 and entered into force in 2005 (UNFCCC, 2005: 7). This protocol contains measures to reduce greenhouse gas emissions through sustainable development policies. Significant issues such as the following were prioritized: Reforms in energy activities at the national level and increasing renewable energy types, implementation of activities such as tree planting, increasing sustainable agricultural practices under the guidance of global climate change, implementation and development of technology studies that separate the carbon dioxide factor, reduction of methane emissions under waste management and cooperation among states. It also established that the rate of greenhouse gas emissions between 2008 and 2012 must be at least 5% below 1990 emission levels (United Nations, 1998: 1-5).

The United Nations Framework Convention on Climate Change was adopted in 1992 and entered into force in 1994 (Bodansky, 2001: 32). This agreement (UNFCC) formed the basis for many agreements elaborated on the critical perspective of climate change, such as the Paris Agreement. The main goal of the UNFCC is to reduce the intensity and emissions of greenhouse gasses and the impact of anthropogenic elements that threaten the climate system (Kuh, 2018: 505).

The World Summit on Sustainable Development was held in Johannesburg in 2002. This summit aimed to facilitate access to energy, clean water resources, shelter, sanitation, and health. In addition to this statement, it also states the need to control and protect biodiversity and food security. The destruction of the environment is increasing day by day. Increasing pollution is one factor that worsens the environment's condition. It turns out that the damage rate is even higher due to natural disasters and climate change. Moreover, there is a decline in biodiversity as well as a decline in fish products on Earth. The threat

of desertification on fertile land worsens the situation. During this summit, these negative situations were discussed with the sustainable development policy, and proposed solutions were presented. Regarding biodiversity, it was stated that these living beings must be protected, especially considering the endangered species. It was stated that it is essential to control invasive wild species at the international, national, and regional levels (United Nations Johannesburg, 2002: 3-35).

In 2009, the United Nations climate summit, the "Copenhagen Consensus," was held in Copenhagen, Denmark, to ensure the global temperature increase would not exceed 2 C. Under this agreement, important issues such as reducing greenhouse gas emissions, preventing the destruction of forest areas, and developing countries cooperating with developing countries on climate change activities were discussed (MGM, 2023).

In 2012, Rio+20 was held in Rio de Janeiro. This conference is also called Rio+20. The conference set development policies based on the Millennium Development Goals after 2015 (United Nations Rio+20, 2023). All the Sustainable Development Goals consist of 17 interconnected principles. These principles are eradicating poverty and hunger, ensuring quality and adequate education levels, eliminating gender discrimination, ensuring that every person in the world has access to clean water resources, providing affordable energy services, ensuring economic development, innovative activities, and industrial and infrastructure development, ending global inequality, cities that have the potential to meet the needs of all people in society, elements to be included in production and consumption patterns, steps to counter the effects of climate change, protection of seas, oceans and aquatic products, protection of ecosystems in the terrestrial realm, preventing desertification, preventing the destruction of forests, and preventing the decline of biodiversity, ensuring access to justice for all people in society, maintaining a peaceful environment and creating accountable institutions, and ensuring global coordination for sustainable development, i.e., seeking partnerships (United Nations Sustainable Development Goals, 2023).

The primary purpose of the Paris Agreement, which was adopted in 2015 and entered into force in 2016, is building global resilience to the threat of global climate change (T.R. Ministry of Environment, Urbanization and Climate Change, Climate Change Presidency, 2023). The Paris Agreement encompasses the fight against global climate change and its negative impacts. In this context, it was established that the global temperature increase should be kept below 2 C

and even below 1.5 C compared to the pre-industrial era. Building resilience to greenhouse gasses and global climate change is explained. It was noted that it is essential for parties to work together to prevent poverty in the dimension of global climate change and to ensure sustainable development policies. It was highlighted that vulnerable groups, sites, and ecosystems have been prioritized, national adaptation plans have been prepared, and preparedness activities have been assessed. The need to implement sustainable forestry policies to reduce emissions resulting from forest degradation was explained. The need to increase the resilience of ecological and socioeconomic systems was pointed out. Regarding the negative consequences of global climate change, the following should be said: prevent damage and minimize it as much as possible, build early warning systems to avoid this situation, be prepared for possible events, detailed risk management, risk insurance options, climate risk structure, training on global climate change and make efforts to facilitate the dissemination of information to the public (United Nations Paris Agreement, 2015: 1-25).

6. Conclusion

The consequences of the global climate catastrophe have harmed many societies from the time of industrialization to the present. The consequences will likely become more severe if precautionary measures are not taken. As the literature explains, natural and man-made factors lead to climate change and its outputs. In order to combat this situation, it is of great importance to establish policies based on risk management. This is because many negative situations can occur daily, especially the problems they cause to the ecological cycle.

As explained in the content of the book chapter, the changes in biodiversity due to climate change and its outputs cause some problems for living beings. Human health will be at significant risk if this negative situation cannot be controlled. In general, a policy based on risk management should be established, and the following suggestions can be made together with the declared:

- Considering that the consequences of a global climate disaster may involve multiple hazards, risk-based activities must be carried out from international to local levels. Activities related to protecting species in the ecological cycle must be included in the plans to be prepared.
- Early warning and alert systems should be established and updated based on evolving technology.

- International agreements, conferences, and meetings dealing with global climate change, the environment, and ecology should be included. The principles established through these negotiations should be entered into force at the local and national levels.
- Biodiversity conservation goals should be achieved through inter-institutional cooperation. The results achieved should be shared with the public.
- Destruction of forests should be prevented. If possible, reforestation efforts in settlements, especially in coastal areas, should be strengthened with green environmental policies.
- Educational activities should be organized to protect ecosystems that are the negative consequences of global climate change, considering factors such as the sensitivity and age of each individual in society. Educational practices should be updated over a while.
- Communications about the importance of water resources management should be disseminated globally as a public service announcement to everyone.
- Society, especially institutions with local capacity, must attach importance to the issue of pollution and waste management.
- Endangered species threatened by global climate change should be studied. Conducting scientific research on biodiversity when there are changes in temperature, humidity and carbon dioxide levels is a precaution against possible dangers.

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CHAPTER VI

RELATIONSHIP BETWEEN CLIMATE CHANGE AND WASTE

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1. Introduction

Today one of the global environmental problems is waste (Wilson et al., 2015). People produce approxiamately 2.24 billion tons of municipal solid waste in a year. In addition to this, roughly 931 million tons of food waste is produced every year. Only 55% of this waste is managed in controlled facilities. According to some predictions, it is expected that up to 37 million tons of plastic waste will enter the oceans annually by the year of 2040 and it is also expected that an average of 3.88 billion tons of waste will be generated yearly by the year of 2050 (UNEP, 2023). The waste threatens environment and public health if it is not managed properly (Wilson et al., 2015).

Waste management applications release some gases called greenhouse gases. (IPCC, 2021; UNEP, 2010, Nnaji and Utsev, 2011). Greenhouse gases cover the atmosphere and cause the world to get warmer than normal (NASA, 2023). In a nutshell, these greenhouse gases accumulate in the atmosphere and they accelerate climate change (EPA, 2016; Olivier and Peters, 2020). Climate change causes temprature increase, change of precipitation, drought and flood (Beniston, 2010; Jay et al., 2018; Reidmiller et al., 2018).

Climate change will alter the lives and livelihood systems of most of the world's population in the next decades. It is expected that some residential areas to be flooded, soils in some areas to lose their productivity, people to decrease their life quality, conflicts to increase and large population movements to occur because of the effects of climate change (Henderson et al., 2022). Moreover, the possibility of climate change affecting economic growth of almost all the

countries in the world in a negative way is also among the expected situations (Batten, 2018; Dellink et al., 2019; Hernández and Madeira, 2021; Engelhard et al., 2019).

Climate change and waste are conditions affecting each other (Nnaji and Utsev, 2011). Knowing the relationship between climate change and waste which are among the problems of today will ease the solution of these problems. Taken measures will be a roadmap for a sustainable planet by means of aforementioned relationship. This work aims to present the relationship between waste and climate change and to show pathfinder solutions for the problems.

2. Conceptual Framework

Global warming and climate change is not a new phenomenon in the world history. It is seen that world's climate has always been changing according to the geological records. This is a natural process. However, global temperature began to rise rapidly after the industrial revolution. The gas component of the atmosphere has started to change considerably on the grounds of reasons such as industrial revolution and the use of fossil fuels like coal (Zeng et al., 2010).

Greenhouse gases absorbing and re-emitting infrared radiation are gas components which are both natural and human induced (UNFCCC, 2023). In general terms, gases trapping heat in the atmosphere are called greenhouse gases (EPA, 2023a).

Climate change is a long-term alteration for the average weather conditions, which defines earth's local, regional and global climate (NASA, 2023b). In other words, climate change is defined as an alteration in average temperature and/or characteristics of the climate. It is also characterized as a change that lasts for a long period of time and can be identified with the use of statistical tests. Climate change may be due to natural internal processes or variability of solar cycle, volcanic eruptions and change of components in the atmosphere or human induced permanent change of land usage (IPCC, 2014). In a nutshell, climate change is a situation that human activity causes directly or indirectly and it changes the components of global atmosphere (UNFCCC, 2023).

The concept of waste means that a matter or object whose owner throws or plans to throw (European Parliament, 2008). Production of waste is a natural result of urbanization, economic growth and population increase. As countries and cities have more population and individuals take part in global trade in order to consume more products and services, produced amount of waste increases (Kaza et al., 2018). Many different types of municipal solid waste including

hazardous waste, non-hazardous industrial waste, agricultural and animal waste, medical waste, radioactive waste, construction and demolition waste, mine hoisting and mining waste, oil and gas production waste, fossil waste is produced (EPA, 2023b). One of the services that supports society in 21st century is waste management. Waste management is accepted as a human need (Wilson et al., 2015).

3. Relationship between Climate Change and Waste

Literature search conducted proves that there is a relationship between waste management practices and climate change. This relationship has a complicated structure. That is to say, there is a two-way relationship between these two concepts, not a one-way relationship.

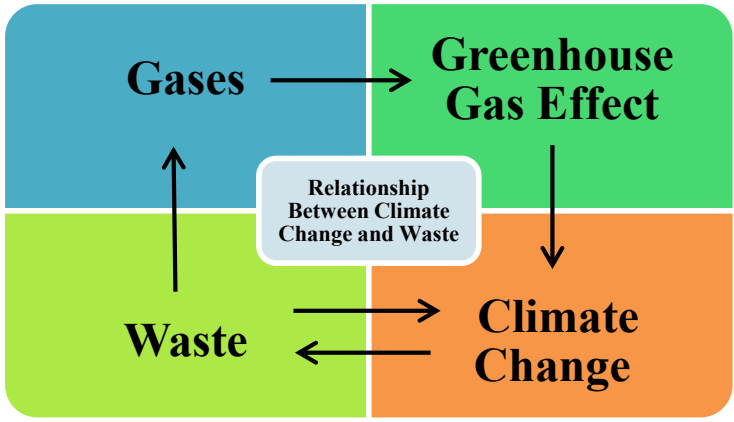

Figure 1. Relationship between Climate Change and Waste Diagram
Source: It was produced by the researcher as a result of the literature review.

The relationship between waste and climate change will be discussed in this part under these two titles:

- The Impact of Waste On Climate Change
- The Impact of Climate Change On Waste

3.1. The Impact of Waste on Climate Change

Energy generation causes emissions of gas and particulate pollutants including human activities such as agriculture, transportation, industrial processes, waste management, domestic heating and cooling. This situation brings about degradation of air quality and climate change (Szopa et al., 2021).

Waste management is among the fields that causes climate change because of the emission of greenhouse gases (IPCC, 2021). Every waste management application produces both directly (emissions arising from method) and indirectly (via energy consumption) greenhouse gases (UNEP, 2010). It is proved by many scientific researches that waste management processes emit greenhouse gases (Kristanto and Koven, 2019; Paes et al., 2020; Branschel and Posch, 2013; Ho et al., 2020; Lu et al., 2015). It is found that greenhouse gases affecting climate change mostly due to waste are carbondioxyde (CO_2), methane (CH_4), nitrogendioxyde (N_2O) (EPA, 2023a; Isaksson et al., 2020). Global carbondioxyde (CO_2) concentration existing in the atmosphere peaked in 2019 and total greenhouse gas emission also increased in the same way (Olivier and Peters, 2020). It has determined that waste is the 4th source of world's total greenhouse emission (EUROSTAT, 2020). Briefly, solid waste management application such as waste collection, storage, incineration and composting emit greenhouse gases. Emitted greenhouse gases cause global warming and climate change to accelerate (Nnaji and Utsev, 2011).

Waste is composed of organic materials. Microorganisms begin to consume the carbon existing in the organic materials when the waste is brought to the storage space. This situation causes decomposition. In the waste storage spaces, there are bacteria which produce methane under the circumstances of anaerobics. Microorganisms decompose organic materials slowly. Methane, carbondioxyde and other gas components are released as a result of this decomposition process (UNEP, 2010). These gases prevent the heat from leaving the atmosphere. Thus, the average temperature of the world increases. Rising of the world's average temperature is called global warming. World getting warmer causes local and regional climates negatively and enables alterations (National Geographic, 2022). While biodegradable waste cause to emit methane, these emissions give rise to both climate change, fire and explosion risk (Ağaçayak, 2019). Furthermore, wrong application of waste management includes situations such as illegal storage of waste, not processing the waste, not recycling the waste, disposal of inappropriate waste. These applications let greenhouse gas emission to raise (UNDP, 2021).

Continued emission of greenhouse gases will accelerate global climate change (IPCC, 2023). Increasing of greenhouse concentrations in the atmosphere affect lands and seas to get warmer, ice sheets and glaciers to melt, sea levels to rise and seas to get warmer and acidify (WMO, 2023).

Solid waste is defined as the source of greenhouse gas emissions. It contributes global greenhouse gas emissions with the rate of 5% by the help of CO_2, CH_4 and N_2O. Most crucial one is CH_4 gas which is mostly released in the decomposition process of organic materials and is produced in the sanitary landfills. However, inorganic waste doesn't contribute to greenhouse gas emissions directly unless they are burnt (Gichamo and Gökçekuş, 2019).

Simply put, the physical problem causing climate change is emitting greenhouse gases. Greenhouse gases released to the atmosphere increase the gas concentration in the air. This causes earth surface to get warm slowly (Lackner and Jospe, 2017). Thereby waste which are the source of greenhouse gases accelerate climate change because of overheating the atmosphere.

3.1.1. Waste Management Hierarchy and Climate Change

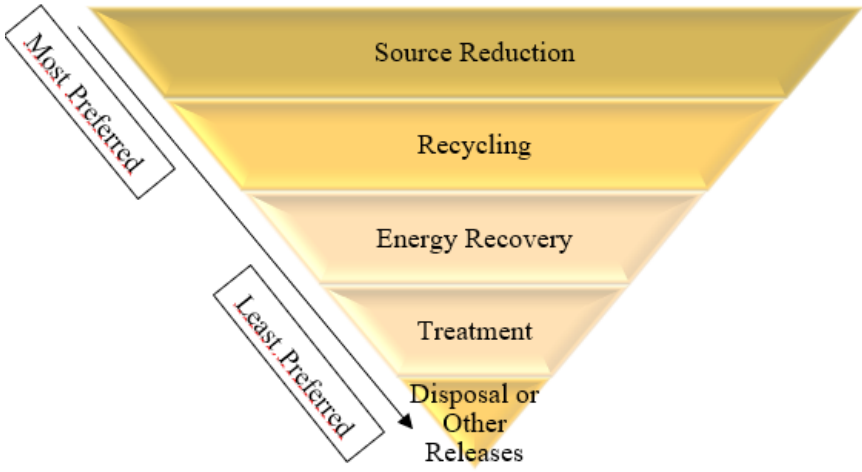

Figure 2: Waste Management Hierarchy
Source: EPA, 2023.

Waste management hierarchy is a method that is used for non-hazardous waste. Highest priority in the waste management hierarchy is waste prevention. If waste cannot be prevented, it is primarily suggested that they should be used in recycling activities. Later on, waste should be managed with the steps of recycling. Next steps are energy recovery processes (if the waste is appropriate) and storage steps respectively (EPA, 2023).

Waste management hierarchy is a guide about the order and steps of managing the waste.

Waste reduction which is a step of waste management hierarchy may prevent the acceleration of climate change. That is to say reducing the waste amount (for instance food waste) decreases gases being emitted to the atmosphere. Thus, gas amount released to the atmosphere declines. This is an important step to keep the risen temperature levels constant (Gromko and Abdurasulova, 2019; UNEP, 2021c). So, activities such as waste prevention and waste reduction are substantial steps to mitigate climate change (Zeng et al., 2014).

Steps of recovering, reusing and recycling waste are important factors of waste reduction. Application of these steps properly has a big potential that will decline greenhouse gas emissions released to the atmosphere. Thanks to the application of these steps, a contribution is made for decreasing the climate change (Hammed et al., 2018; Hupponen et al., 2023).

There is a close relationship between the rise of waste production and rise of population. In other words, waste amount increases as the population rate rises in a region. This situation increases air pollution. Polluted air enhances the intensity of greenhouse gases. Then it causes global warming and climate change (Budihardjo et al., 2023).

Waste prevention and recycling are also strong strategies for decreasing greenhouse gases (EPA, 2016). So, adoption the strategy of waste recovery, reducing the amount of waste, reusing and recycling of waste has a great potential for decreasing greenhouse gas emissions.

3.2. The Impact of Climate Change on Waste

Climate change may affect to the future improvement and operation of waste management facilities and infrastructure. So, it may cause an alteration in a range of factors affecting waste management processes (Christian, 2010).

It's required to know the effects of climate change in order to better comprehend the relationship between climate change and waste. The effects of climate change are generally discussed in the literature as follows:

- Extreme Colds
- High Temperatures
- Flood and Heavy Rain
- Tropical Cyclons
- Violent Storms
- Warming and the Rising of the Oceans
- Temperature, Drought and Forest Fires

- Loss of Species in the Ecosystem
- Health Risk
- Poverty
- Migration (Seneviratne, 2022; WMO, 2023)

The results of natural disasters over waste that will occur stronger and more frequent because of the climate change are as follows:

- The amount of waste that is produced because of disasters rises.
- Rise of the amount of waste increases the greenhouse gas emissions that is released during waste management process.
- Existing waste management capacity becomes deficient for the proper management (recycling, treatment and disposal) of the large amount of waste produced.
- More various waste is produced at the same time.
- This may affect larger areas (local, national, international).
- The possibility of waste management facilities being affected from the occurred disasters increases.
- Existing waste management options may decrease (EPA, 2022b).

It is expected that climate change to cause more frequent and stronger natural disasters and the amount of produced waste to increase in accordance with the disasters (EPA, 2022b). So it is an anticipated situation that the amount of waste will increase because climate change will cause flood violent storms and sea levels to rise.

Because of the risen flood and sea levels with the effect of climate change (Kiele et al., 2013; The World Bank, 2018; Winne et al., 2012.):

- Amount of domestic waste that may clog the drainage systems increases.
- Waste storage areas that are close to flood and risen sea levels will be affected.
- Waste storage areas and wasteyards may collapse.
- The infrastructure of the city may be spoiled.
- Waste may be scattered to residential areas and environment.
- Disposal activities of medical waste and other waste affect negatively.
- Contagious diseases may occur as the sanitation problems increase.

Especially waste storage areas in the coastal areas are affected from risen sea levels and floods due to the climate change. This case causes waste to scatter around (Beaven et al., 2020; Winne et al, 2012). This situation lets waste amount

to rise and makes pressure to nearby waste areas (Winne et al., 2012). To give an example, it can be expected that waste to scatter residential areas especially if the flood occurred in the coastal areas and sea levels to rise etc. Waste scattered around the residential areas may pave the way for contagious diseases like cholera (United Nations Habitat, 2013). Besides, it may happen that interruptions in the waste transportation infrastructure activities to increase and so waste delivery to disrupt. In addition, it should not be ignored that facilities in the low coastal areas to be flooded and erosion (Bebb and Kersey, 2003).

Cold weather conditions resulting from climate change harden the transportation of waste and access of the waste areas (Winne et al., 2012).

Hot waves resulting from climate change increase the amount of bad smell coming from the waste areas, dust and insects. (Winne et al., 2012; Bebb and Kersey, 2003). Increased bad smell, dust and insect problem in the waste areas causes residents to disturb and decrease their life quality (Bebb and Kersey, 2003).

4. Conclusion

The role of waste management in the climate change is important. Greenhouse gas emissions stemming from waste may be decreased with a complete and holistic waste management strategy (Nnaji and Utsev, 2011).

As the municipal waste amount increases, it is required that political approaches in the developed and developing countries to let new technologies enabling innovative applications facilitating waste storage areas to realize the highest methane reduction (Powell et al., 2015).

Waste management is a factor that not only municipalities but also individuals ought to take responsibilities for. Therefore, every individual should pay more attention to waste management in order to diminish climate change. Individuals producing less waste personally may reduce greenhouse gas emission. As a result, speed of the climate change may also decrease thanks to the decreasing greenhouse gas emission (Nnaji and Utsev, 2011). People are supposed to embrace reusing, recycling and compost applications in order to reduce the effects causing climate change (UN Habitat, 2010).

High income countries are tend to distract waste from incineration plants and wasteyards. On the other hand, they are trying to increase the adoption of waste reduction and recycling (The World Bank, 2018). In order all countries to apply these steps, they are supposed to be engaged in incentivizing activities.

Every individual practicing waste reducing activities means that greenhouse gas emissions which are significantly resulting from waste reduce.

Suggestions for decreasing climate change with the steps of waste management as follows (Hogg and Ballinger, 2015):

- Figuring out the relationship between waste management and climate change better and emphasizing it is significant.
- Awareness of contributing to climate change by people reduce waste production should be improved.
- Waste management strategies should be focused on reducing greenhouse gas emissions.
- A balanced approach between waste management options such as waste prevention, recycling and energy generation should be adopted.
- Waste management policies should be focused on reducing greenhouse gas emissions.
- It is important that organic waste in contact with soil to be evaluated for recycling and reusing before energy generation.
- It is required to integrate waste management into climate change policies and to set a target towards reducing greenhouse gas emissions.
- In the contrastive evaluation about waste management, it is important that CO_2 emissions stemming from non-fossil sources to be included.
- Funding strategies towards waste management projects should be reviewed in order to incentivize waste prevention, recycling and reusing projects.

Change of climate structure should be taken into consideration. Therefore, waste management systems should be aligned with changing climate structure. For instance, waste management systems are supposed to be arranged to be prepared for extreme weather conditions caused by climate change. The durability of collection, transportation and disposal systems should be enhanced (The World Bank, 2018).

As an answer for climate change and loss of bio-diversity crisis, it has a huge significance to limit global average temperature to 1.5°C as it is stated by the call of scientists. This is why there is a need an urgent significant decrease in the emission of global greenhouse gases in all sectors fast and constantly. Especially, reducing the use of fossil fuels gradually and accelerating the use of energy systems are important (IUCN, 2022).

Societies need to be sensitive about risk management targeting the waste problem that may be occurred during the disasters stemming from climate

change. So, societies are supposed to increase their preparations by the use of planning before the incidents realize. Planning before the incident, during the incident and after the incident:

- May accelerate the disposal of waste.
- May decrease the danger of disease vectors.
- May decrease the fire incidents.
- May decrease the personal injuries
- May determine the waste management opportunities and strategies (EPA, 2022b).

The impact of waste management on climate change can be reduced with the following steps:

4.1. Reducing the Emissions Stemming from Energy Consumption

The effective way of reducing the emissions of greenhouse gases is applying the steps of reducing municipal waste, reusing and recycling (Hyman et al., 2013). The most effective one among these applications is reducing the waste (EPA, 2016). In a nutshell, the best waste is the one which is never produced (UNDP, 2021). Recycling maintains energy conservation. This is because less energy is spent while producing products from recycled materials than producing from raw material. Moreover, less fossil fuel is used when the energy demand decreases. So, less carbondioxyde is released to the atmosphere (EPA, 2016). Shortly, using waste materials as the secondarily material or energy will reduce the need for traditional fuels like fossil fuels. As a result, changing need will contribute emissions to be prevented (UNDP, 2021).

4.2. Reducing the Emissions Stemming from the Incineration Plants

Removal of waste from incineration plants by prevention and recycling reduce the greenhouse emission in the atmosphere.

4.3. Reducing the Methane Emissions in the Storage Areas

Recycling (including compostion) and prevention of waste and enables organic waste to be removed from wasteyards and decreases the methane amount that is released during the decomposition of these materials (EPA, 2016). Prevention of organic materials reaching storage areas is an important greenhouse gas reduction method. So, this will decrease the greenhouse emissions released to air (UNDP, 2023).

4.4. Increasing the Carbon Storage

Forests take a considerable amount of carbondioxyde with a process named carbon sequestration and stores this into the wood. Waste prevention and recycling of paper products may lead more trees to survive and keep them emitting the carbondioxyde in the air (EPA, 2016). Besides, compost and similar steps increases the carbon storage of soil and it makes soil better. Therefore, conversion of organic waste into compost and similar products contributes to both reducing gas emission and making the soil better. (UNDP, 2021).

In a nutshell, waste prevention, reduction, renovation, reuse and home compost are climate friendly approaches. In addition to these subjects, optimization of waste transportation or prevention are other sources of reducing greenhouse gases (UNDP, 2021).

Local authorities are not the only responsible institutions for waste management. Waste management is actually the responsibility of humanity as a whole. In other words, today everybody produces waste in different amounts. So, waste management may not be an environment problem any longer with the help of every individual's positive attitude and behavior. If every individual applies waste prevention, reduction and recycling activities properly, there won't be a problem like waste management. For this circumstances, local authority policies, a national and international waste management system should provide an order for each individual. Briefly, an environmentally friendly and sustainable waste management policy should be selected by national and international management mechanisms. Then small scaled, medium scaled and large scaled businesses and every individual will be supposed to obey this policy unconditionally. This is the only way for waste to cease being an environmental problem and its effects on climate change be minimal.

Individuals need to be aware and educated about waste management in order for waste to be solved as an environmental problem and for its effect to climate change to be decreased. Individuals that are aware of waste management should display correct behavior and attitudes towards waste management. It is also an important factor that individuals that have correct information, attitudes and behaviors about waste management should be incentivized by local, national and international administrators.

Today, decisions that individuals made can have a bottomless and lasting effect on the world for many years. Practices made is not only good for environment but also contribute to environmental justice, personal and social health, equity, enhancement the common future and improvement of life quality (EPA, 2022a).

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CHAPTER VII

CLIMATE CHANGE POLICIES FROM PAST TO PRESENT

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1. Introduction

The climate crisis stands out as one of the paramount challenges of contemporary times. In recent years, the escalating occurrences attributed to climate change have precipitated emergencies and disasters (Akbulut and Kaya, 2020; Kadıoğlu, 2012). Given the expansive scope of climate change and its consequential problems, it proves arduous to confine its effects to a singular geographical region. Notably distinct from preceding alterations, the distinctive feature of this crisis, with its worldwide ramifications, lies in its genesis as a product of human-induced factors (IPCC, 2007b).

The surge in consumer society, escalating industrialization, rapid population expansion, deforestation, and the concomitant rise in greenhouse gas emissions have propelled our world into a more critical predicament than ever before (Aksay et al., 2005; Karl and Trenberth, 2003). While climatic variations have been inherent in the Earth's history for centuries, many factors stemming from natural planetary processes have traditionally triggered climate change (Keserci, 2019; Akbulut and Kaya, 2020). The exogenous nature of the causative factor transforms the current state into a crisis. Human beings bearing the primary responsibility for the disturbance of the existing balance have belatedly acknowledged the gravity of the situation (IPCC, 2007b). The repercussions of global climate change are growing increasingly profound, with meteorological and climatological disasters intensifying both in severity and frequency, contributing to the displacement of populations and substantial

economic losses associated with climate change-induced disasters, highlighting the gravity of the circumstances (IFRC, 2020; IPCC, 2012).

In the formidable battle against the climate crisis, a critical imperative is the necessity of a comprehensive and unified effort. As evidenced in studies, endeavors conducted at the local level prove less efficacious in addressing the current magnitude of climate change (Erdoğan, 2018; UNDRR, 2015a). Given the global impact and ramifications of this crisis, a concerted approach becomes imperative in pursuing solutions. This collective endeavor necessitates alignment at both individual and governmental levels (UNDRR, 2015a). Typically, initiating the struggle entails securing subsequent measures through international treaties, representing the foundational step in this concerted effort.

The general purpose of climate change policies is to ensure the formation of a sustainable climate system. The climate problem that emerged in the 2000s has caused not only environmental but also developmental problems (Kılıç, 2009; Türkeş and Kılıç, 2004). Therefore, the policies developed are necessary for economic and social sustainability as well as the climate system. (Deliktaş, 2021).

Climate change policies pursue objectives such as reducing greenhouse gas emissions, ensuring international cooperation, efforts to harmonize sectors against the negative effects of climate change, and technological developments. As a result, since policies are an effective mechanism for solving problems, the right policies are expected to be effective against the problem of climate change (Boswell et al., 2011; Deliktaş, 2021; Tükeş & Kılıç, 2004).

The general purpose of the study is to discuss the decisions taken, agreements made, and measures developed globally in this struggle process. These steps are policies to protect against global climate change and its impacts. The important point is what the developed policies add in terms of applicability. In this context, the research aims to address the policies developed against climate change in the international arena and what they cover and to bring the policy changes from past to present to the literature.

2. Turkey's Climate Change Policies

Our country is rich in climate types due to its geographical location (GDM, 2023). Research results show that our country is seriously affected by climate change. In addition, the scenarios predicted by the Intergovernmental Panel on Climate Change (IPCC) for our country have quite striking results. Unless measures are taken in the coming years, water scarcity, desertification,

increase in food prices, and gradual disruption of normal life are the expected scenarios our country will experience (IPCC, 2022). This situation has started to manifest with forest fires in the summer, especially in coastal areas. The General Directorate of Meteorology (GDM), which conducts climate-related research in our country, has stated that the temperature changes experienced in recent years are not normal. In parallel with the changes in the world, our country has a small share in the increasing greenhouse gas emissions. With increasing industrialization, harmful gases released into the atmosphere have gradually increased (GDM, 2023; TSI, 2023). In light of all these explanations, a number of studies have been carried out to combat climate change's effects in our country. The important titles of the policies developed and implemented are listed as follows:

The eighth five-year development plan is the first step of important steps taken to combat climate change and its impacts. Important evaluations are included in terms of policies to minimize the risks of climate change. Important points were mentioned for the first time regarding Turkey's involvement in international efforts and reducing greenhouse gas emissions (DSB, 2000). This step provided a foundation for future policies. This stability continued in the ninth five-year development plan. Differently, considering the current conditions, the work to be done to reduce emissions and adapt to the effects of climate change has been addressed within the framework of our country's conditions (DSB, 2006). Similarly, the tenth five-year development plan included the fight against climate change and emphasized green growth (DSB, 2013). The eleventh five-year development plan included important topics such as climate-friendly behaviors, raising awareness, and preparing a climate change action plan (DSB, 2019). The recently published twelfth five-year development plan stands out with the title of climate change and sustainable development (Official Gazette, 2023). These explanations indicate that the studies on climate change and the fight against climate change have a certain stability for our country. However, it is well known that this situation is insufficient, and more work is needed. The general contents of the action plans prepared as a result of the decisions taken and mentioned in the development plans are as follows:

2.1. National Climate Change Strategy Document

It is the first action plan prepared within the scope of Turkey's efforts to adapt to the efforts made in the fight against the climate crisis worldwide. The plan includes the activities to be carried out for adaptation to climate change between

2010 and 2023 and some important headings. First of all, it is a comprehensive strategy document that explains the process with the titles of purpose, vision, target, financing, and evaluation, in which Turkey includes a number of indicators specific to climate parameters. This is the first comprehensive study that includes short- and long-term plans and assigns responsibilities to institutions and organizations for the following periods (MEU, 2010).

2.2. Climate Change Action Plan

This plan is prepared after the strategy document and includes important steps to combat climate change. Covering the period between 2011 and 2023, this work offers guidance. Regarding content, titles such as water resources management, food security, natural disaster risk management, public health, and biodiversity constitute important topics of the action plan. The aim of this plan, which aligns with Turkey's national vision, is to become a country with a high standard of living in which all stakeholders participate in disseminating energy efficiency, low carbon consumption, and adaptation to climate change. (MEU, 2010).

2.3. Legal Regulations on Climate Change in Turkey

Policies developed on issues requiring solutions should have the power of sanction. If laws guarantee the prepared development and action plans in terms of applicability, their validity will be more robust. In this regard, we can list the relevant laws on climate change from the past to the present as follows:

- Environmental Law No. 2872,
- Regulation on the Protection of Air Quality,
- Regulation on Control of Pollution from Industrial Facilities,
- Regulation on Monitoring of Greenhouse Gas Emissions,
- Communiqué on Monitoring and Reporting of Greenhouse Gas Emissions (Ateş and Yavuz, 2019).
- Voluntary Carbon Market Project Registration Communiqué,
- Regulation on General Principles of Waste Management,
- Regulation on Exhaust Gas Emission Control and Gasoline and Diesel Fuel Quality,
- Regulation on Control of Air Pollution Caused by Heating,
- Regulation on the Control of Industrial Air Pollution,
- Electricity Market Law No. 4628,
- Petroleum Market Law No. 5015,

- Law on the Utilization of Renewable Energy Resources for Electricity Generation,
- Law No. 5627 on Energy Efficiency,
- Regulation on Substances that Deplete the Ozone Layer (Ateş and Yavuz, 2019).

Although the abovementioned laws are not directly related to climate change, they have formed the basis of today's struggle. While the studies have changed many times from the past to the present, the main idea has never changed. Various policies have always continued in order to adapt. The last important development for our country is the establishment of the Ministry of Environment, Urbanization, and Climate Change with Presidential Decree No. 85, published in the Official Gazette dated October 29, 2021, and numbered 31643 (Official Gazette, 2021).

2.4. International Policy Processes on Climate Change to which Turkey is a Party

With the emergence of harmful effects due to climate change, an important step was taken in the international arena, and the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992. Our country became a party to this Convention, which contains important articles, in the first place due to the structure to which it is affiliated. However, after the necessary studies were carried out due to some obligations brought by the Convention, Turkey signed this Convention in 2004 (Talu and Kocaman, 2018; Republic of Turkey Ministry of Foreign Affairs, 2023). Another important treaty, the Kyoto Protocol, is one of the international climate steps to which Turkey is a party. Due to the late implementation of policies regarding the process, Turkey was not in a position to fulfill some of its obligations (Ministry of Foreign Affairs of the Republic of Turkey, 2023). The Paris Climate Agreement, the last step of global cooperation, was signed by Turkey in 2016, but Turkey did not become a party due to financial constraints. Our country accepted this Treaty, which has important binding legal obligations, in 2021 and started to fulfill its obligations (Talu and Kocaman, 2018; Republic of Turkey Ministry of Foreign Affairs, 2023). Other important steps taken by Turkey regarding climate cooperation in the international arena are listed below:

- Vienna Convention for the Protection of the Ozone Layer
- Montreal Protocol on Substances that Deplete the Ozone Layer

- Convention on Long-Range Transboundary Air Pollution
- Protection of the Black Sea against Pollution, Bucharest Convention
- Protection of the Marine Environment and Coastal Zone of the Mediterranean Sea, Barcelona Convention
- Antarctic Treaty
- Convention for the Conservation of European Wildlife and Habitats
- UN Convention on Biological Diversity
- Convention on Wetlands of International Importance, especially as Waterfowl Habitat
- UN Convention to Combat Desertification (Talu and Kocaman, 2018).

3. Climate Change Policies In International Perspective

Since the impact mechanism of environmental problems transcends borders, the solution processes on this issue have been a global response. The effects have manifested in different ways, with extreme rainfall in some places and extreme heat in others (IFRC, 2020; WMO, 2021). The common point is that emergencies and disasters caused by climate change pose risks for all societies. Therefore, studies have concluded that a collective step should be taken. In other words, it is anticipated that reducing greenhouse gas emissions will not be sufficient for a single region. We can summarize the international policies developed in the fight against climate on three main treaties.

- United Nations Framework Convention on Climate Change
- Kyoto Protocol
- Paris Climate Agreement (Talu and Kocaman, 2018).

The UNFCCC is the first collective step taken internationally to combat climate change. When we look at the main purpose of the Convention, important topics such as limiting the use of greenhouse gases, which play the most role in increasing the current warming, are mentioned. (UNFCCC, 1992; MEU, 2023). After adopting the Kyoto Protocol, it took many years to enter into force. In general terms, important issues related to the reduction commitments of industrialized countries, which play a serious role in greenhouse gas emissions, are included. The Paris Climate Agreement is a valid treaty today and to which many countries are parties. Its general purpose is to keep global warming at a certain level (UNFCCC,2016).

These three important treaties are important international political steps in the fight against the climate crisis. Although their content has been revised

over the years, their scope and purpose is to implement the right steps to prevent the climate crisis. The general outlines of these three important steps will be discussed in more detail in the rest of the study.

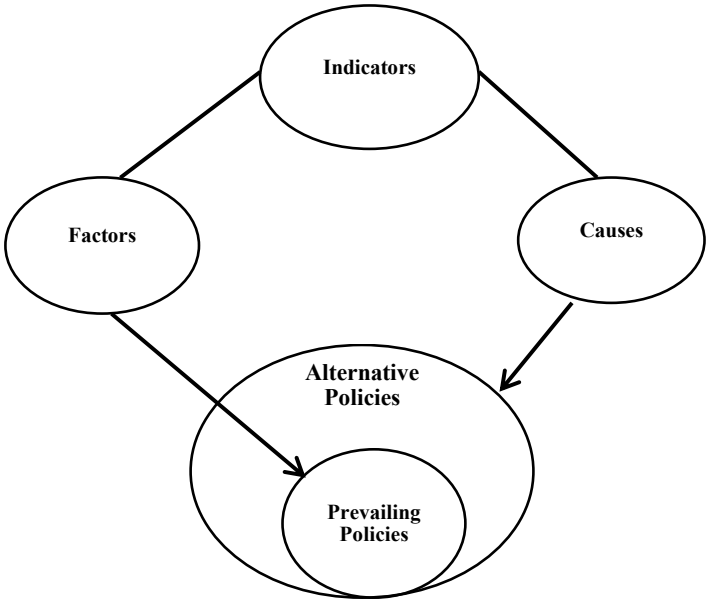

Figure 1: Relationship between Climate Change and Policies Source: Kaymaz and Tut, 2020

There are a number of strategies nations have adopted to minimize climate change and its impacts. These are also policies that enable global joint action. The common goal is reducing greenhouse gas emissions, alternative energy, and environmental sustainability. These titles constitute the prevailing policies. As illustrated in Figure 1, the level of factors plays a role in producing prevailing policies. However, factors should not be confused with causes. Since the factors level focuses only on the climate problem and the anthropogenic factors that cause it, it focuses on a more limited structure that bypasses structural relationships (Kaymaz and Tut, 2020; Kaymaz and Tut, 2001).

Alternative policies do not have constraints like the prevailing policies, which include a set of reforms involving the level of causes and are produced on this basis. It also encompasses prevailing policies as it does not proceed with any constraints. This type of policy usually includes vulnerable societies negatively affected by climate change, political strategies related to issues such as green economy, sustainable development, biodiversity conservation, and participation in local governments (Kaymaz and Tut, 2020).

3.1. First World Climate Conference

The conference held in 1979 under the leadership of the World Meteorological Organization (WMO) was the first international conference to address the importance of human-induced climate change. The conference touched on many important points, from fossil fuels to carbon dioxide (CO2) accumulation (UNFCCC, 2003; Türkeş, 1995). In this respect, it can be said that it pioneered subsequent international meetings.

3.2. Toronto Conference

In 1988, another important step was taken internationally to prevent the climate crisis. The decisions taken at the conference on 'Changing Atmosphere' organized in Toronto once again demonstrated the seriousness of the issue. At the Toronto conference: Reducing CO2 emissions by 20% until 2005, preparing a climate agreement, reducing the use of fossil fuels. Moreover, through the conference, it was again emphasized on an international platform that climate change was human-induced (Toronto Conference, 1988; Türkeş, 1995).

3.3. United Nations Global Climate Protection Resolution

Following the conference held in Toronto, the UN issued a binding resolution on the importance of the conference before the heat of the issue wore off. Accordingly, with the initiative of Malta in 1988, it was emphasized that our common heritage should be protected based on the extent of the damage caused by human beings to nature. Accordingly, the UN adopted Resolution 43/53 on 'Protecting the Global Climate for Present and Future Generations of Mankind' (Türkeş, 2001).

3.4. Establishment of the Intergovernmental Panel on Climate Change (IPCC)

IPCC is a scientific organization established in 1988 with the initiatives of WMO and the United Nations Environment Program (UNEP) operating under the leadership of the UN. There are 195 countries affiliated with this organization. Scientists united under this roof and started to carry out important studies that everyone can trust globally. With the publication of the first report in 1990, the IPCC officially showed its existence. Considering its working principle, it has important tasks related to climate change, such as conducting scientific activities, preparing reports, and providing guidance. IPCC still has an important place

in climate change with its studies and scientific reports published periodically (Türkeş, 1995; UNFCCC, 2003).

3.5. Ministerial Conference

By 1989, studies on human-induced climate change continued. A ministerial conference called 'Atmospheric and Climatic Change' was held in Nordwijk, the Netherlands. It was not a very productive meeting in terms of the decisions taken. The commitment to reduce CO2 emissions by 20%, previously taken at the Toronto Conference, was not emphasized. The countries that supported this commitment could not reach a decision to create a road map on the issue (Türkeş, 2001; Türkeş, 1995).

3.6. WMO Second World Climate Conference

This conference, held in Geneva, Switzerland, is of historical importance with the decisions it took. The conference was held in two stages, and the technical conference, which included the IPCC report and other scientific studies, was discussed with intense participation. In this conference, the Ministerial Declaration was approved by 137 countries. As a result, this meeting is a conference with important outputs on measures to reduce greenhouse gas emissions, which is one of the most important causes of climate change, the elimination of uncertainty about climate change and the preparation of a climate change framework convention (Türkeş, 2001; Türkeş, 1995).

3.7. Berlin Summit

This 1995 summit was the first Conference of the Parties (COP) after adopting the UNFCCC. The conference, where consensus was reached on many issues, also includes sustainable steps that include working for the next conference of the parties. The conference has important outputs such as implementing the UNFCCC, capacity building, and technology transfer. These conferences, where new decisions are taken, and the Convention is carried forward in terms of currency, are still actively taking place today. The last conference is the 28th Conference of the Parties and will be held in the United Arab Emirates (UAE) on November 30, 2023 (Türkeş, 2001; Türkeş, 1995).

3.8. United Nations Framework Convention on Climate Change

This Convention constitutes the first and most important step taken internationally to adapt to the negative impacts of human-induced climate

change. With its broad scope in terms of content and correct implementation steps, it has laid a foundation for subsequent international agreements.

The UNFCCC was presented for signature in Rio at the United Nations Conference on Environment and Development in 1992. There are 197 party countries to the Convention. These countries are divided into three different groups according to some obligations. This grouping as Annex-1, Annex-2, and non-Annex countries has given separate obligations to each group. While Annex-1 countries have historical responsibility for combating climate change, Annex-2 countries have financial responsibility. However, some countries do not find this grouping fair and appropriate. Turkey is among these countries. Therefore, Turkey became a party in 2004 after the necessary arrangements were made. The Convention also has the feature of a universal convention to which almost all countries are parties. Considering the framework in which the Convention is basically specialized, it is seen that it focuses on a certain purpose. What the party countries need to do in order to realize the objectives is basically to reduce and commit to greenhouse gas emissions, to reduce the negative impact of anthropogenic factors on the climate, and to fulfill the obligations of the party countries. At first, our country objected to the Convention because it was included in both Annex-1 and Annex-2 lists. With the decision taken at the 7th Conference of the Parties held in Marrakesh, it was removed from the Annex-2 list and accepted by the Convention as the 189th Party country in 2004 (UNFCCC, 1992; UNFCCC, 2003; UNFCCC, 2002). In order to see the basic understanding of UNFCCC, its basic principles are given in Table 1 below:

Table 1: UNFCCC Principles

Principle	Scope
Equality Principle	Developed countries responsible for human-induced climate change support underdeveloped countries affected by this problem.
Precautionary Principle	Uncertainty about climate change does not preclude taking action.
Sustainable Development	Development is an important factor in combating climate change. In addition, the process should be carried out with minimum cost in the steps of struggle.

Source: UNFCCC, 1992; UNFCCC, 2002

3.9. Kyoto Protocol

The Kyoto Protocol, one of the important steps taken in the fight against human-induced climate change, was established in 1997 at the 3rd Conference of the Parties in Japan. After the Protocol was opened for signature in 1998, it entered into force in 2005. In terms of sanctioning power, this Treaty has been an important treaty that imposes obligations on industrialized countries to reduce greenhouse gas emissions. The Protocol, which sets emission reduction targets numerically, is an international step taken to achieve the desired goal in the fight against climate change, which started with the UNFCCC. The Kyoto Protocol basically has three different elements (UNFCCC, 1998; MEU, 2023). These are as follows:

- Emission Targets
- Flexible Mechanisms
- Protocol Parties (UNFCCC, 1998; MEU, 2023).

Not all countries have a mitigation obligation according to the content of the Treaty. Only the countries that emit the most greenhouse gases are obliged to reduce their current emissions by 5% below their 1990 levels between 2008 and 2012. Reducing the use of fossil fuels and switching to alternative energy sources are among the conditions of the Protocol. However, since the Protocol did not make any commitments for the period after 2012, the need for a new comprehensive agreement arose (UNFCCC, 1998; MEU, 2023). This need formed the basis of the Paris Climate Agreement.

3.10. Paris Climate Treaty

After the Kyoto Protocol, the world has not achieved a treaty environment in which everyone can participate. This has led to the need for a new global climate treaty that everyone ratifies. In 2015, the Treaty was opened for signature at the 21st Conference of the Parties in Paris, France. The date of 2020 was set for the new Treaty, which was adopted unanimously, to enter into force. The Treaty, which received the approval of 175 countries in a short time, entered into force on November 4, 2016. When we look at its purpose, concrete solutions stand out. Accordingly, the goal is to keep the global temperature increase below two °C by 2030 compared to pre-industrial levels and, if possible, to reduce it to 1.5°C. Countries that cause more than 96% of global emissions have an obligation to reduce their greenhouse gas emissions (UNFCCC, 2016; Climate Change Presidency, 2023). In this respect, it has been a treaty with more binding

and sanctioning power than the Kyoto Protocol. The main elements of the Paris climate agreement are as follows:

- National contribution
- Financing
- Flexibility and transparency
- Adaptation
- Special support for developing countries
- Global Climate Fund (UNFCCC, 2016; Climate Change Presidency, 2023).

Our state signed the Treaty at the end of a certain process. Its harmonization with its domestic policies and ratification took place towards the end of 2021. Turkey, which joined the Paris Climate Agreement as the 192nd State Party, committed to reducing greenhouse gas emissions by 2030 (UNFCCC, 2016; Climate Change Presidency, 2023).

3.11 Climate Change Policies of the United States of America

The United States of America (USA), which ranks first in greenhouse gas emissions, has been one of the actors playing the most important role in the issue. The US is given a separate title because the steps it has taken in the process are of great importance. Since it has an industrialized structure, it has a serious share in the increase in CO_2 levels. However, due to increasing greenhouse gas emissions, increasing temperatures have greatly affected undeveloped countries (Atvur and Uysal, 2018; Türkeş, 2006). This situation has pushed the causing countries to take responsibility. The European Union has generally been at the center of the studies on the subject. The US, on the other hand, has been the state that has blocked the process at times with its attitude.

After the Kyoto Protocol is opened for signature, it is important to reach a sufficient number of signatories in order to make the Treaty legally binding. In 1998, the US signed the Kyoto Protocol but did not submit it for ratification in its senate. This attitude of the US, which has the largest share in emissions, has been an obstacle to achieving the desired targets (Deliktaş, 2021). Subsequently, during the George W. Bush era, the US withdrew from the Kyoto Protocol in 2001 on the grounds that the Protocol created a huge burden for the US economy and excluded developing countries from the process (Cohen and Egelson, 2003). The signing of the Treaty was again postponed to the Barack Obama era. However, during the Obama era, the climate issue was prioritized, and the US

took a leading role in forming the Paris Climate Treaty (Kansu et al., 2021). In the Donald Trump era, however, there have been undesirable situations, such as the increase in the use of fossil fuels, the removal of global warming from the agenda, and the shelving of the clean energy package. As a result, Trump announced the US withdrawal from the Paris Climate Agreement in 2017, citing economic reasons (Ağaçayak et al., 2017; McGrath, 2020).

In contrast to Trump, the last president, Joe Biden, ensured that the US became a party to the Treaty again as soon as he took office. They stated that they would make investments and take responsibility for climate change. In this context, it is envisaged to take important steps such as reducing greenhouse gas emissions to zero by 2050, clean energy policies, and financial investment. The positive attitude of the US is very important in order not to undermine the process in the fight against climate change and to ensure that the policies developed are functional. The fact that the US is strong in terms of financial resources is another point that makes its presence in the process important.

4. Conclusion

Policies include a set of strategic steps that ensure that issues that require solutions and undesirable situations enter the solution process with the right steps. The policies developed from the past to the present in the context of climate change ensure that the existing order is not disrupted and that the Earth, our common heritage, is left to future generations in a livable way. There were some main conclusions that stood out during the research process of the study. There are certain topics that policies on climate change focus on. These topics constitute the purpose of the policies. In particular, it has been observed that the steps taken on international platforms against the negative effects of climate change are still open to improvement in terms of achieving the desired goal in the process until today.

The studies carried out and to be carried out to fight against climate change have shown that developed countries have taken responsibility for the issue. The current policies are the result of this joint action. The steps taken have been in constant revision in order to fight against climate change, the most important environmental problem. First, a certain amount of time was needed to fully understand the problem, develop solutions, and implement them. Looking at the point reached today, the uncertainty about the climate has started to disappear, global powers support this struggle, and awareness is moving in the right

direction. This is an important output showing that climate policies serve the desired purpose; however, the work done is not sufficient.

Currently, it is observed that abnormal warming is continuing, the desired level of emission reduction has not been achieved, and there are problems with belief in climate change. In addition, the increasing number of climate change-related disasters is another important situation revealing some deficiencies. It is not expected that efforts to combat climate change will have an immediate impact; however, the slow process does not prevent it from being effective. Accurate and efficient work will at least be beneficial in terms of effectiveness. Not abandoning the process, continuing the struggle against climate change until the risk reaches an acceptable risk level, ensuring that the policies developed are not captive to personal interests and that every society actively participates in the process will make the struggle against the negative effects of climate change more meaningful and effective. In the conclusion of the study, which we hope will benefit the literature, some suggestions we would like to give to the readers are as follows:

- Climate change policies should be far from being generally valid and should always be sustainable.
- In the current treaties and international cooperation, especially developed countries should not go beyond the goal. Efforts should be made to eliminate an environmental problem and ensure stability. The interests of governments should not override the issue of adapting to climate change.
- More attention should be paid to energy in climate policies. Studies and cooperation on clean energy and alternative energy sources should be increased.
- Policies should also be supported financially and technologically.
- In order to ensure climate justice, more effective participation of developing and less developed countries in the process should be ensured. For the financial support specified in the Kyoto Protocol and the Paris Climate Agreement, the global powers with a major share in the increase in emissions should provide the necessary support.
- This issue should be given due attention to the steps taken to protect against the effects of climate change and related disasters. International political steps such as the Sendai Framework, which draws attention to the importance of the issue, should be advanced.
- Developing more policies on issues such as health, food, water, and air is an important issue in the fight against climate change.

- The fact that international diplomacy is always effective makes the fight against climate change more effective.
- The importance of adaptation to climate change should not be overlooked, and adaptation steps should be integrated into the process of the policies developed.
- What is more important than developing climate policies is implementing them. Therefore, we need to develop and implement the right climate policies to increase positive situations, such as stopping warming, reducing extreme events and disasters, protecting vulnerable societies, and transitioning to clean energy.

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CHAPTER VIII

CLIMATE CHANGE AND MIGRATION

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1. Introduction

Disasters affect many countries in the world. Some of the data on disasters identified in the report published by EMDAT in 2021 are shown in Figure 1. This report states that 432 disasters were reported in 2021, 10,492 people lost their lives due to these disasters, and 101.8 million people were adversely affected. The report particularly states that an annual average of 163 flood disasters occurred between 2001 and 2020, while 223 flood disasters occurred in 2021. A similar increase was also detected in the disasters caused by storms. The number of storms, which was 102 on average between 2001-2020, was recorded as 121 in 2021. Significant reports have also been made around the world in terms of drought. For example, Western USA was faced with drought and this drought cost 9 billion US dollars. The number of droughts reported worldwide is 15. Africa and Asia were the most affected regions. The highest number of disasters occurred in Asia with 174 disasters, in America with 129 disasters, in Africa with 57 disasters and in Europe with 56 disasters. In terms of countries, 43 disasters occurred in the USA, 28 occurred in Indonesia, 19 disasters occurred in India and 17 disasters occurred in China. (EMDAT, 2022)

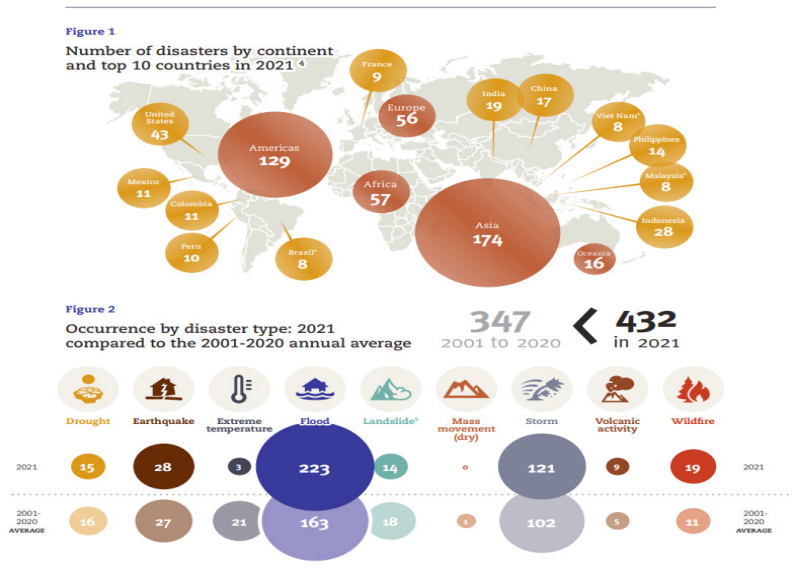

Figure 1: Countries with the Highest Number of Disasters in 2021
Source: EMDAT, 2022

There are many types of disasters that disrupt the routines of social life in a way that requires extraordinary measures to survive, create problems in many areas and weaken the power of institutions. AFAD categorised disasters as geological, climatic, biological, social and technological disasters under natural disasters and man-made disasters and explained these disasters with examples such as earthquakes, landslides, droughts, floods, hurricanes, forest fires, migrations, wars, and CBRN accidents, respectively. (Mileti, 1999; AFAD, 2023)

Disasters pose threats to the health, cultural heritage, socioeconomic assets, livelihoods and ecosystems of individuals, communities and countries and negatively affect their sustainable development (United Nations (UN), 2015). (United Nations (UN), 2015) The United Nations Office for Disaster Risk Reduction (UNDRR) states that these disasters have a much greater impact on less developed countries (LDCs). (UNDRR, 2023) Although LDCs are responsible for only 1% of global emissions, they have experienced a 5-fold increase in climate-related disasters since the 1970s and have been exposed to 70% of the world's climate-related disasters. (United Nations High Commissioner for Refugees-UNHCR, 2023a) Climate change is now being addressed as a development and security issue. The main reason for this is that climate change has become a multiplier for conflicts as well as increasing the struggle for limited natural resources. (Erdoğan and Cantürk, 2022)

Among the disasters that increase their impact more and more every day, global climate change makes its presence felt as an important disaster of the present day by increasing temperatures, causing extreme weather events, progressing slowly and creating destructive results (Kadıoğlu, 2012). The report prepared from the UN Climate Talks held by the World Meteorological Organisation in Marrakesh states that more than 50% of the major extreme weather events between 2011-2015 bear the fingerprints of human-induced global warming. The organisation reports that 300,000 people lost their lives in disasters caused by climate change in the period between 2011 and 2015. These disasters include the drought in western Africa between 2010 and 2012, the typhoon in the Philippines in 2013 and the heat waves that hit India and Pakistan in 2015 (Bilben, 2019). The effects of these disasters cause more devastation on the economies of less developed countries when compared to developed countries. LDCs are affected by disasters ten times more than developed countries. This impact is manifested in many areas. One of these areas is the fact that it is intertwined with the phenomenon of migration. For example, as a result of the disasters that occurred in 2020, 8.5 million people left their places of residence and migrated to other places and became forced migrants. (UNDRR, 2023)

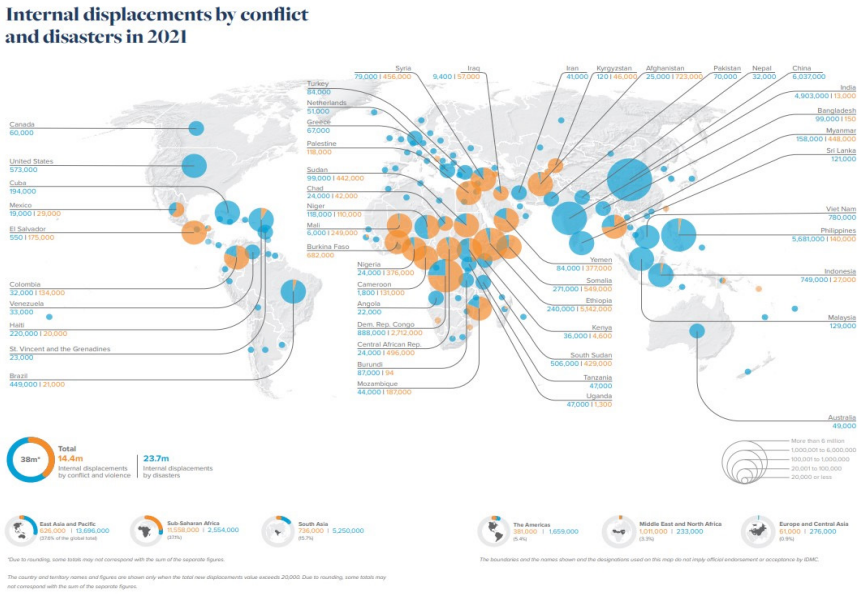

Figure 2: Internal Displacement due to Conflict and Disasters in 2021
Source: IDMC, 2022

Figure 1 shows the data prepared by IDMC on internal displacement due to conflict and disasters in 2021. It can be seen that a total of 38 million people were forcibly displaced in 2021, 14.4 million of these people were forced to leave their places of residence due to reasons such as conflict and oppression, while 23.7 million people were forced to leave their places of residence due to disasters. 13.6 million of disaster-related displacements occurred in East Asia and the Pacific, 5.2 million occurred in South Asia and 2.5 million occurred in Sub-Saharan Africa. In Turkey, 84,000 displacements occurred, all of which were disaster-related. As it can be seen from the visual, Ethiopia has the highest number of displacement due to conflicts with 5,142,000. The place where the most displacement occurred due to disasters was the Philippines with 5.681.000. Other displacements within the country are available in detail in the figure. (IDMC, 2022)

According to UN reports, the number of disasters occurring in connection with climate change has increased significantly in the last 20 years. This situation is expected to increase human mobility significantly with drought and similar dangers. (Appleyard, 1991) There is evidence of an important link between climate and migration. The movement of leaving one's place and migrating to other regions due to environmental changes is not a new phenomenon. Since ancient times, people have preferred to migrate due to extraordinary events occurring in their environment. However, it has only been since the 1950s that states have recognised this and defined it in the literature (Laczko and Aghazarm, 2009).

One of the interesting aspects is that although it is scientifically proven that disasters affect the least developed countries the most, according to the current figures announced by UNHCR, 76% of the people who migrate compulsorily are hosted in less developed countries with medium or low income. (UNHCR, 2023a) Considering that especially in less developed countries, people meet their needs from the natural environment, it can be understood that people living in these countries will be even more affected by climate change. Moreover, the expected large increase in the world population until the end of this century may cause the already limited natural environmental resources in the underdeveloped countries to be consumed even faster (IPCC, 2014a; IPCC, 2014b), which shows that migration flows due to climate change in these countries will occur at significant levels. For these reasons, it is important to take more measures against the destructive effects of climate change, especially in these countries. (IPCC, 2014b)

The aim of this review is to examine the effects of climate change as a disaster on human movements by reviewing the literature, to discuss the issue and then to make conclusions and recommendations.

2. Concepts Related to Migration, Climate Change and Climate Refugees

The phenomenon of migration, which is stated by some researchers to have given its name to the age we are in, is complex in nature and may occur due to different reasons. Many studies in the literature have drawn attention to the complexity of the phenomenon of migration (Öner, 2012; International Organization for Migration ((IOM), 2022). Migration is defined by the IOM as the process of relocation of a person in order to move within the borders of a state or to another country. (IOM, 2019)

Research on migration shows that migration can be defined under different types, different definitions of migration can be made according to the event that causes migration, and the concepts of migration and migrant are different from each other. (IOM, 2022) Migrant is defined as a person who migrates for permanent or temporary purposes within or outside the country for any underlying cause. There are two approaches in defining the term migrant: the generalising approach, which covers all forms of movement, and the residualist approach, which distinguishes those fleeing wars or oppression from the term migrant. (IOM, 2019) Currently, UNHCR has stated that the use of refugee terminology, which expresses the universal right to live on the basis of forced displacement, should be very carefully used and the required sensitivity should be shown without confusing it with the term migration (UNHCR, 2016). The Universal Declaration of Human Rights, adopted by the UN General Assembly on 10 December 1948, recognised the right to asylum as a humanitarian right and emphasized that countries of asylum should open their doors to people escaping from persecution, violence, conflict and similar tyrannies. (HSK,2023) In addition, there are different types and standards of migrant definitions in the literature, such as the term economic migrant which is used to define those who migrate for economic reasons, the term internal migrant which is used to define those who migrate within the borders of the country, the term international migrant which is used to define those who are outside the country of their citizenship, and the term undocumented migrant which is used to define non-citizens who enter a country without proper documents and stay there. (IOM, 2019)

As previously mentioned, although migration definitions generally meet on the common denominator of relocation, migration processes of very different dimensions have emerged in the new world where technological development, transportation facilities, globalisation have increased, disasters, wars and climate changes that make migration compulsory have increased even more. (Çağlayan, 2006) Examples of these types of migration can be given as voluntary migration and forced migration, internal migration and external migration, individual migration and mass migration, regular migration and irregular migration. (Erdem, 2017) One of these dimensions is forced migration. Forced migration is defined in the literature as human-caused, political and social disasters. (Kelly, 1998; AFAD, 2023) People's leaving their places and moving to other places in order to ensure their life safety as a result of armed conflicts, widespread violence, human rights violations and man-made or natural disasters occurring in various dimensions is called forced migration. (IOM, 2023)

There are various classifications about forced migration in the literature. For example, Simon classified the phenomenon of forced migration separately under the titles of space, cause and time. In his classification under the heading of "Space"; he made two main distinctions as those who stay within the country and forced migrants who move out of the country. He defined refugees, asylum seekers and international migrants as forced migrants travelling out of the country, and those staying within the country as internal forced migrants. In his classification under the heading "Cause", he defined refugees as those who meet the definition of refugee in the 1951 Geneva Convention. Since there is no international legal definition defining the rest (people displaced due to climate change, natural disasters or environmental conditions), he defined them as people who have stayed within the country provided that they do not leave the country. The third is the classification under "time". This type of classification is categorised into two. Forced migrants in the period when short-term rehabilitation efforts are needed from the moment of displacement are defined as those requiring urgent solutions. The situation of persons who have been displaced long ago and have been residing in camps or other places for years is analysed under the heading of protracted refugee situation (Loescher and Milner, 2013: Öner, 2012).

Climate change, which is shown among the triggering factors of forced migration, is generally expressed as the change in climate parameters such as temperature and precipitation over time due to human or natural factors. (Türkeş, 2008) Climate change and global warming are terms that are used

interchangeably and confused with one another in the literature. However, it is known that these two terms have different meanings. Global warming refers to the increase in atmospheric and troposphere temperatures near the earth's surface. Climate change, on the other hand, refers to significant differences in climate measurements such as temperature, precipitation and wind over longer periods such as decades. (Nda et al., 2018)

Especially with the increase in human activities, more and more evidence has started to come to light that climate is changing. (Kılıç, 2009) A significant number of studies in the literature have emphasized that the periodic climate change cycles experienced by the world in a natural process and anthropogenic climate change should be separated from each other. As a matter of fact, human-caused global climate change, which occurs due to activities such as industrialisation, urbanisation, fossil fuel use, disposal of forest areas, has become one of the greatest dangers caused by humanity. (Bilben, 2019) In addition to natural climate change, the United Nations Framework Convention on Climate Change also draws attention to the changes in the climate due to human causes with its definition as changes in the climate as a result of human impacts. (Bilben, 2019) Environmental changes that have occurred especially after the industrial revolution have revealed a new dimension. The increasing destruction due to human activities in this period has shown its effects first locally and then globally. Results such as pollution and depletion of natural resources at local level, acidification of oceans at global level, deforestation, destruction of fertile lands, desertification, destruction of biological reserves can be given as examples of local and global effects. (Mansoor et al., 2022)

With the emergence of climate change, changes have occurred in average sea levels and precipitation regimes, decreases in precipitation regimes have occurred in some parts of the world, temperatures have increased, fresh water resources have been adversely affected, especially torrential rains have started to occur and the amount of precipitation has been observed to increase in some regions. (Kılıç, 2009; Akbulut, 2020) Changes in climate parameters make some regions of the world less liveable by disrupting agricultural lands, causing desertification and showing effects such as water pollution. The concept of climate refugee, which emerged as a newer concept compared to traditional migrant definitions, refers to individuals who leave their places of residence due to sudden or slow environmental changes that adversely affect their living conditions and forms, and migrate to a region in their own country or to a different country for temporary or permanent purposes. (IOM, 2011; Akbaş, 2022)

Literature states that there is an ambiguity in the concepts of "environmental refugee-climate refugee" which are used to define individuals who migrate due to environmental conditions. It is stated that the disagreement on this issue has created debates in political and scientific circles. (Akbaş, 2022) One of the points on which the disagreement over the concepts of "environmental refugee and climate refugee" is based is the reduction of the concept of migration, which is an intricate issue in the literature, to a single place under the name of climate refugee and the statement that it rejects multiple causes. Some authors argue that migration is the result of multiple underlying and mutually influencing factors such as climate change, natural disasters, economic and political reasons. (Aitken et al., 2007)

While naturalists usually confirm the relationship between environmental changes and the decision to migrate, social scientists see environmental changes as one of the many other reasons influencing the decision to migrate. (Piguet et al., 2011) The literature that considers the climate-driven migration view as weak argues that extreme climatic events and disasters alone are not sufficient for an individual to make a decision to migrate, and that individual's traditions, attachment to their environment, family affinities and relationships, and cultural structures are also important factors in migration decisions. (Nazan et al., 2021) In fact, the migration flows that will take place in the coming years due to climate change-induced disasters will bring along policy deficiencies and legal uncertainties due to the views advocating uncertainty. (McNamara, 2007) Martin stated that climate migration caused by climate change may bring along many effects from the phenomenon of regular migration to the pressure on official and current asylum procedures. (Martin, 2010) This situation can actually be considered as a justification for ignoring climate change-induced migration flows. (Andeva and Salevska-Trajkova, 2020)

As stated by Mcnamara, interpreting migration acts due to climate change on the axis of reasons independent of climate change may bring some disadvantages. For example, as shown in the projections made, the further increase in climate-induced migration flows that may occur in the coming years will lead to deepening political uncertainties, increasing migrants without legal status and increasing legal uncertainties.

Instead of categorising climate-migration relationship in this way, it would be more accurate to adapt the intricate structure in the nature of migration to this relationship. As stated by Bilben, sudden disasters such as hurricanes, floods, storms due to climate change may directly cause migration, or they may occur in

the form of a threat multiplier as a triggering factor in terms of producing slower and less severe disasters. (Bilben, 2018) Black et al. (2011) put forward a similar view in their report. Rises in sea levels, tropical storms, changes in precipitation regimes, increase in temperatures, changes in the chemistry of atmosphere can lead to events that will directly affect migration. On the other hand, climate change may cause indirect effects on migration through its economic, political, social and demographic effects. (UNHCR, 2001)

In terms of climate-migration uncertainty, we can refer to the refugee application made by Ioane Teitota, a citizen of Kiribati, to New Zealand due to the disruption caused by climate change in her homeland. New Zealand rejected the application of Ioane Teitota. However, in a later period, judicial bodies ruled that the refugee convention was insufficient in this regard, since the judicial remedy for the responses to the applications made due to natural disasters was open. (Andeva and Salevska-Trajkova, 2020) In this context, it is recommended for states to establish alternative protection mechanisms for migration actions and migrant individuals who cannot be associated with any status in refugee and migration law, such as climate refugees. (Jaswal and Jolly, 2013)

It is thought that economic-based decision-making on the basis of migration phenomenon or security-based decision-making on which the term refugee is based affects the concept of environmental refugee. (Akbaş, 2022) However, a significant number of articles in the literature have reached a consensus on concepts such as environmental refugees and climate refugees. It has been argued that changes in the environment may cause large numbers of people to leave their places of residence and migrate to other regions. (Gray and Bilsborrow, 2013)

In terms of causing human mobility, the impacts of climate change can be discussed in two categories. One of them is sudden disasters such as landslides, floods and typhoons. The other category is droughts, sea level rises and desertification that occur over a longer time scale. These compelling and driving factors then cause temporary or permanent migration movements due to their negative impact on people's lives. (IOM,2011: Gray, 2009:) To move is to escape from threat, and escaping from threat is a natural part of adapting to change. Climate change-induced displacement differs from traditional forms of displacement in that many people are sceptical of climate change because of the anthropogenic basis for climate change and the relative speed at which climate change is occurring. (McAdam, 2011)

It can be seen that the concept of environmental refugee was first expressed by Brown et al. (1976) and started to be used frequently in the following period (UNHCR, 2001; El-Hinnawi, 1985). In an article by Nazan et al. (2021), a review of the conceptual history of climate refugeeism throughout history was made. In the review, it was stated that after the use of the concept of environmental refugee by Brown, it was defined for the first time by El-Hinnawi in 1985. It was also stated in the study of Nazan et al. that Jacobson stated in 1988 that environmental refugees could be the main source of global migration, that the US temporary protection mechanism was implemented in 1998 due to Hurricane Mitch, that Myers stated in 2002 that the definition of environmental refugee should be expanded, that the first climate refugee application was made in 2007, and that in 2020, a statement was made by the UN human rights committee that the refusal of climate refugee demand was illegal. (Nazan et al., 2021) In 1990, the UN intergovernmental report on climate change drew attention to climate migration, citing the displacement of millions of people as one of the most important impacts of climate change. (UN, 1994)

Today, when the terms "climate refugee or environmental refugee" are analysed from a legal perspective, it is understood that these terms face some problems in finding a legal equivalent. This is because the term refugee in the Geneva Convention Relating to the Status of Refugees signed in 1951 is as follows:

"A person who, due to a well-founded fear of persecution for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality and, as a result of that fear, does not wish to avail himself of the protection of that country" (IOM, 2023)

As can be seen, the Convention clearly defines the term and the definition does not include any phrase related to environmental impacts such as drought, flood, hurricane, disaster. At this point, it is thought that the conceptual framework of environmental and climate refugees should be established. (Ziya, 2012; Çelekli et al., 2023) There are some opinions and suggestions regarding the term "climate refugees" in the field of international law. One of them suggests that the scope of the relevant convention should be expanded or a different convention should be prepared by creating new refugee categories, especially since there is no reference to environmental refugees in the Geneva Convention. On the other hand, it can be seen that the term "environmentally displaced " is mostly used in IOM or UNHCR. There are also examples of the use of the concept of climate refugee at national and regional levels. For example, when the

Australian Labour Party was in opposition, it opposed the government for not using the term environmental refugee, and in the following period, called for an international meeting on the use of the term environmental refugee, especially for those coming from island countries in the Pacific, and legislative proposals were made by different parties. (Biermann and Boas, 2010)

3. The Relationship between Migration and Climate Change

There are studies in literature which suggest that disasters are important triggers in terms of causing migration. Although climate-induced migration flows seem to be a newly discussed topic in the literature, Ravenstein is one of the first authors to express this. In 1889, Ravenstein argued that bad climatic conditions could cause people to move. Ravenstein expressed this statement in his work "Laws of Migration". In fact, the work "Laws of Migration", which is the first work in which climate-induced migration is expressed, is one of the first theories put forward in the field of migration. (Ravenstein, 1889)

The impacts of climate change also differentiate mobility models and they are increasingly being used. Some authors state that climate change will be one of the major threats to people, ecosystems and development goals in the coming decades. In the future, climate change may cause more natural disasters. (Akbaş, 2022) Humans may have to leave their places due to the possibility of disasters or in order to avoid the consequences of a disaster. This situation is actually considered a survival strategy. An act of migration, which has its origin in a disaster, may occur in an internal or external position. (Hugo, 1996: 105) For example, in the aftermath of Hurricane Katrina in New Orleans, Louisiana on 29 August 2005, which was one of the biggest disasters in the history of the USA, it was found that 240,000 people were forced to migrate to Houston a week later, while some other disaster victims migrated to cities in various regions of the USA. (Varano et al., 2010) By reducing natural resources, climate change may lead to conflicts among people in order to access local resources. Negative consequences on issues such as access to food and water security may cause people living in underdeveloped regions to become even more vulnerable. Conflicts arising from the chain of problems, especially in underdeveloped regions, may cause people to migrate to other places in order to save their lives. (IOM, 2014b: 34)

Migration actions due to natural disasters caused by anthropogenic climate change were emphasised by Piguet in 3 important points. The first point draws attention to the fact that migrations can be short or long term. At this point,

Piguet stated that migration acts due to disasters such as desertification and sea levels rising and destroying settlements on islands or seaside settlements may be more long-term or permanent, while sudden disasters such as floods and storms may lead to shorter-term, temporary migration acts. Piguet's second distinction is that migration can take the form of short-distance and long-distance migration or internal migration and external migration. Piguet stated that although the perception on this issue is accepted as from south to north, the phenomenon of internal migration also occurs at a significant amount. Piguet positioned his third distinction on the concept of forced and voluntary migration. However, it is stated that it is difficult to make such a determination on existing migrants. (Piguet, 2011; Bilben, 2018)

Another analysis of migration acts due to Climate Change was made by McLeman (2017) from the University of Ottawa. McLeman studied forced migration within the context of Climate Change under two headings. These are divided into two as climate events and climate processes. Rises in sea levels and subsequent salinisation of agricultural lands, decreased access to clean water and safe food are called climate processes that cause migration.

Settlements located in coastal areas with dense populations are frequently affected by these events. Water rises in Carteret and Tuvalu islands, migrations due to hunger, water scarcity and drought in Africa can be given as examples. Developed countries fight against water rises by adopting methods such as barriers, etc., which they apply to coasts, just like the Netherlands does. However, it is not possible to say this for less developed countries. For example, countries such as Bangladesh are negatively affected by water rises. Bangladesh was faced with salinisation of agricultural lands and contamination of drinking water as a result of rising waters. On the other hand, hurricanes, tropical storms and floods are called climate events that directly cause internal displacement and international migration. The migration events that took place after the flood disasters in Asia can be given as an example. In addition, Hurricane Mitch that occurred in Central America in 1998, Hurricane Aila that occurred in Bangladesh in 2009, Typhoon Haiyan that occurred in the Philippines in 2013 and the migration events that occurred as a result of these disasters can be given as examples. (Brown, 2008; McLeman, 2017:) It can be seen that migration flows occurred between 1960 and 1980 due to drought and desertification in the north-east of Brazil. (Leighton, 2006) In 1989, it is possible to say that the conflicts between Mauritania and Senegal were actually rooted in climate change. The drought in West Africa first caused a large flow of migrants from Mauritania,

and then conflicts occurred between Senegal and Mauritania. Another example can be given through the conflicts between Somalia and Ethiopia. Again, the water scarcity experienced in this region triggered migration, and the migrants entered into conflict with the local people where they went. The examples here show that climate change causes both migration and conflict. (Cattaneo and Foreman, 2023) While conflicts can sometimes be the result of events such as water scarcity and drought caused by climate change, sometimes they appear as the cause of migration. However, in the end, it can be seen that the main underlying cause is climate change, while migration sometimes acts as a bridge between conflicts and sometimes as a last resort.

Table 1: Forced Migration due to Disasters in Turkey

Disaster	Number of events	IDP
Earthquake	13	292732
Forest fire	7	83290
Flood	23	29208
Landslide	17	1966
Avalanche	2	380
Storm	2	15
Total	64	407591

Source: Prepared by using ÜİYOİM data.

IDP: Internally Displaced Person

As can be seen in Table 1, 64 disasters that caused migration movements occurred in Turkey between the relevant dates. Due to these disasters, 407,591 people had to leave their places of residence and migrate to other places. Although earthquakes seem to be the type of disaster that caused the highest number of people to migrate, earthquakes were followed by disasters associated with climate change such as forest fires and flood disasters. In addition, as can be seen in the table, it is understood that flood disasters, which are within meteorological disasters, take the first place in terms of the number of events that cause migration.

These migration flows, which have been increasing over the years due to both climate-induced, geological, and technology-induced disasters and reasons such as conflict, turmoil, instability, persecution, have caused the local populations of developed countries to gradually decrease and their fertility to decrease, and then led to the result that the demographics of the country

were shaped by the phenomenon of migration and migrant individuals, not by the fertility in the local population. (UN, 2017) Moreover, the UN states that migration will contribute increasingly to the change in the population structures of countries. Unfortunately, the fact that the population structures of the countries are being changed at such a rate and speed by the phenomenon of migration also affects the ability to cope with disasters since it coincides with a period when the world is experiencing unprecedented natural and man-made disasters. (UN, 2019; Adu-Gyamfi and Shaw, 2021) Therefore, countries which experience changing population patterns with increasing disasters are faced with the process of initiating precautionary plans against disasters that are inclusive and meet the needs and aspirations of all elements within the population structure. (Adu-Gyamfi and Shaw, 2021) As can be understood, the phenomenon of disasters and migration have gained an intertwined dimension. Both the migration flows caused by disasters within the context of global climate change and the views that migrants constitute vulnerable groups in coping with disasters in the countries they migrate to have become the common point where the two phenomena meet. This is actually an expression of the fact that there are various dimensions of the relationship between disasters and migration in climate-induced migration flows.

There are important estimates for the migration flows that may occur in the future due to climate change. One of these is the statement by IOM that there may be 200 million refugees worldwide by 2050. (IOM, 2011) The number of displacement due to climate change between 2008-2016 is stated as 21.8 million. These extreme weather events and the resulting displacement movements affect all countries in the world; however, as mentioned before, they mainly affect developing countries. A study conducted by Oxfam found that people living in low- and middle-income countries are 5 times more likely to be displaced due to sudden weather events than people living in high-income countries. There is another situation that should be mentioned together with this data in underdeveloped countries. The inadequacy of the data collected in less developed countries suggests that the figures expressed are actually different from what is shown. It is stated that disaster-based displacements in underdeveloped countries are generally recorded with sudden onset and extreme characteristics, while the records of drought and thirst, which occur more slowly and over a wide period of time, are insufficient. (UN, 2017; Oxfam, 2016)

Important determinants of migration events that will occur due to climate change are the coping levels, adaptation policies and development levels

of countries. It is thought that human mobility will be less in countries with sufficient economic power and political stability because these countries are less vulnerable and have less socioeconomic stress. (Agrawal, 2008)

Another issue to be addressed in climate-induced migration events is addressed at the centre of preparedness. It is more difficult to be prepared for migration flows due to sudden disasters caused by climate change such as storms, hurricanes and floods. However, it may be easier to be prepared for disasters that spread over longer periods of time such as drought, increase in temperatures, famine, etc., since there will not be a sudden mass migration action. It should be considered that these migrations may also take place in the form of international migration from rural to rural, from rural to urban or outside the country. (Laczko and Aghazarm, 2009) Some sources state that since the effects of climate change will be more dominant especially in undeveloped countries, migration may occur especially through poor and vulnerable people in these countries. It is stated that this group, which is poor and vulnerable, may migrate from rural to urban or from rural to rural within the country since they do not have the financial will for international migration. It is also stated that people with a certain financial level can migrate over longer distances such as external migration, poor people may prefer internal migration instead of external migration, and the poorest people may not be able to fulfil the act of migration because they do not have sufficient financial means and opportunities. In other words, it is stated that the inability to escape from environmental risks may be an indicator of greater vulnerability. (IOM, 2014b)

There are estimates by different researches regarding the migration figures caused by climate change. Whether the disasters that occur due to climate change are disasters that occur slowly over a long period of time or disasters that occur suddenly and unexpectedly in a short period of time, it is stated that as a result of these disasters, the human population between 25 million and 1 billion can migrate in the next 40 years. (Laczko and Aghazarm, 2009) In Myers' study conducted in 2002, it was stated that the number of people migrating due to environmental impacts could reach 200 million by 2050. In a study conducted by Christian Aid in 2007, it was stated that by 2050, 250 million people will be displaced due to climate change-induced disasters such as hurricanes, floods, droughts and famine, and 50 million people will be displaced due to other disasters other than climate change. The World Bank has stated that by 2050, 140 million people may migrate from underdeveloped countries in Sub-Saharan Africa, Latin America and the South of Asia. (Myers, 2002; Christian Aid, 2007; Rigaud et al., 2018; Tacoli, 2011)

According to IOM, the groups that will be most affected by these migration flows are societies dependent on agriculture, least developed countries, island countries living with low income and the population living in coastal areas. Although the effects of climate change will be seen in every field, they will be more severe especially in countries with weak institutional competences and underdeveloped technologies whose economy depends on climate conditions. One of these effects will be the migration pressure that occurs in these countries. (IOM, 2014a) It may be possible to talk about more destructive dimensions when the fragile economies and low levels of development of the countries are combined with the risks posed by climate change. The countries where this destructive effect is more likely to occur are South Asia, Middle East and North Africa, which are called MENA countries. The effects of climate change in this region may occur at undesirable levels. (IPCC, 2014b) Climate change will trigger political instability in the MENA region countries, and will further deepen the existing instabilities and lead to the emergence of conflicts. (Sofuoğlu and Ay, 2020) In addition, the population in the MENA region is expected to double by 2080. It is stated that the effects of climate change may deepen with the increase in population, the increasing need for food in the region, and the more frequent occurrence of heat, drought and extreme weather events. (Waha et al., 2017)

In the process leading from climate change to migration decision, many effects will emerge and these may accelerate the decision to migrate. Some examples of these can be listed as follows;

- The increase in water levels and the change in the world map due to this increase (McAdam, 2009: 582). For example, an annual sea level rise of 12 mm was detected in the Pacific islands due to the increase in sea levels. As a result of this rise, it is stated that 8 islands have been submerged and two islands are in danger of being submerged. (Podesta, 2019:2)
- Energy shortages due to water scarcity experienced by countries dependent on hydroelectric energy in the energy sector. (Demirci, 2019:6-7)
- An increase in temperatures in some parts of the world. For example, these will be felt especially in a part of the USA and lead to an unliveable situation. Due to global warming, people will move towards better economic conditions and milder climates. (Lustgarten, 2020).
- Increasing energy costs and halving crop yields. These will reduce access to food and increase scarcity. (Lustgarten, 2020).

- Changes in climate parameters cause an increase in conflicts with indirect effects such as damage to agriculture, nutritional difficulties, decreased access to food. (Erdoğan and Cantürk, 2022; IOM, 2014b)

With the deepening of the effects of climate change in the future, many problems will arise. What these problems are, how they should be tackled and some questions that need to be answered have been asked. These questions are expressed as follows;

- How many people will migrate or are migrating due to climate change?
- Who will be among the migrating masses? When and in which direction will these masses migrate? Will they be able to find new settlements?
- Will they migrate temporarily or permanently?
- What are the possible consequences for migrants, for those left behind, for individuals at the destination?

In particular, it is stated that these questions should be answered by local, national and international actors. In addition, as previously discussed in this paper, it is important to resolve the uncertainty caused by the status gap caused by the refugee and migrant law of individuals who migrate due to climate and environmental conditions. (Laczko and Aghazarm; Yılmaz and Navruz, 2019)

4. Conclusion

In the literature reviews conducted to examine the relationship between climate change and migration, the following results have been reached and some suggestions have been presented accordingly;

- Events and processes that occur suddenly or slowly caused by climate change constitute the driving factors for migrations. Among these events, sudden disasters such as storms, floods, hurricanes, forest fires can directly trigger migration, while disasters that spread over a long period of time such as drought, famine, desertification, inability to access food and conflict act as a catalyst for migration and create a multiplier effect.
- Disasters caused by climate change affect less developed countries more due to deficiencies in adaptation policies, political instability and economic inadequacies.
- Individuals who migrate due to sudden or slow disasters caused by climate change are defined in various ways such as “environmental refugee, climate refugee” in the literature. However, it is understood that the terms

"environmental refugee-climate refugee" have not yet been legally recognised. This brings legal uncertainties considering the large number of refugees who may fall under this definition.

- Countries should be prepared for migration flows due to climate change, whether they are in the position of destination country, country of origin or in the position where displacement within their borders is in question. Organisational capacities and plans should be developed, especially in view of the difficulty of being prepared for sudden influxes of migrants in the event of sudden climate events and other disasters.
- Situations such as conceptual confusion, legal gaps and uncertainty regarding "environmental refugee" and "climate refugee" should be resolved by reviewing existing refugee conventions or signing new conventions.
- Models related to climate change and the figures estimated for the future show that the extent of displacement will reach significant numbers. Competent international and national institutions should continue to play their roles in the fight against the adverse effects of climate change and underdeveloped countries should continue to be included in these struggle policies.

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CHAPTER IX

CLIMATE CHANGE AND FOOD SECURITY

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1. Introduction

Global climate change, often referred to as global warming, is a scientifically well-established phenomenon supported by extensive research and evidence. It refers to the long-term increase in Earth's average surface temperature due to human activities, primarily the release of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) into the atmosphere.

The consequences of global climate change are far-reaching and include:

Rising Temperatures: Average global temperatures have been increasing over the past century, leading to various climatic effects such as more frequent and severe heatwaves.

Melting Polar Ice and Glaciers: The warming climate has caused the polar ice caps and glaciers to melt at an accelerated rate, contributing to rising sea levels.

Sea Level Rise: Higher temperatures cause seawater to expand, and the melting ice contributes to rising sea levels, which can result in coastal erosion and increased vulnerability to flooding for many communities.

Extreme Weather Events: Climate change is linked to an increase in the frequency and severity of extreme weather events such as hurricanes, droughts, floods, and wildfires.

Disruption of Ecosystems: Many plant and animal species are affected by changing temperatures and altered habitats, leading to shifts in ecosystems and potential biodiversity loss.

Ocean Acidification: Increased CO_2 levels are absorbed by the world's oceans, leading to ocean acidification, which can harm marine life, particularly organisms with calcium carbonate shells or skeletons, such as corals and shellfish.

Impacts on Agriculture and Food Security: Climate change can disrupt crop yields and agriculture, potentially leading to food shortages and increased food prices.

Health Risks: Heatwaves, increased air pollution, and the spread of disease vectors are health risks associated with climate change.

International agreements like the Paris Agreement, which seeks to keep global warming well below 2 degrees Celsius over pre-industrial levels, are just one aspect of efforts to address global climate change (United Nations, 2016). Reducing greenhouse gas emissions, switching to renewable energy sources, increasing energy efficiency, and implementing sustainable land-use practices are common tactics used to mitigate climate change. To lessen the effects of climate change and strive toward a sustainable and resilient future for our planet, public education and international cooperation are crucial.

We will concentrate on the direct and indirect effects of global climate change on food security in this section. As we approach the middle of the twenty-first century, the threat posed by global climate change is growing. Rising temperatures cause hurricanes and heavy rainfall in some locations while creating drought in others, lowering the quality and productivity of the soil. Freshwater supplies in tropical and subtropical areas are being rapidly depleted by rising world average temperatures. Farmers use groundwater for agricultural irrigation as a result of this predicament because the supply of surface water is running out. The habitats of naturally fed wetland are diminished by excessive aquifer exploitation. Groundwater resources are at peril as saline seawater replaces freshwater that has been depleted. Contrary to popular assumption, excessive rainfall actually erodes the fertile topsoil layer, lowers soil quality, and decreases agricultural productivity.

2. The General Effects of Climate Change

Global warming is unavoidable, and the majority of the observed climate changes since the 1950s are unheard of in the previous millennia, according to the IPCC's sixth assessment report (IPCC, 2023). Since the middle of the 20th century, the troposphere, the lowest part of the atmosphere, has been warming globally. Human-caused global warming is approaching to 1.5°C. The previous

30 years have been the warmest time in the last 1400 years. During this time, the seas and atmosphere have warmed, less snow and ice has formed, sea levels have risen on average, and the amount of greenhouse gases in the atmosphere has increased.

Currently, it is impossible to discuss a situation that significantly affects everyday living in terms of food security in other nations outside of the sub-Saharan region of Africa, where drought and famine are prevalent. However, the effects of climate change are becoming more and more obvious, and scientific research is being done on this subject, which has alarming results for the future. The IPCC has created certain scenarios that depict the situation in the future based on scientific evidence. Over the past century, an increase in regional and temporal trends in precipitation and aridity has been seen on a global basis. Precipitation, for instance, has increased in the Northern Hemisphere. Additionally, the buildup of greenhouse gases in the atmosphere is growing. Surface temperatures, evaporation, clouds, precipitation, and humidity are a few examples of the factors that are anticipated to alter on a regional and global scale as a result.

The atmosphere is still being filled with greenhouse gas emissions. All elements of the climate system, including evaporation and precipitation, will change as a result and continue to warm (IPCC, 2023). If immediate action is not taken, global warming will persist past the year 2100. The effects of global warming and changes in precipitation will continue to vary by region and reflect differences in yearly and decadal averages. The 21st century will see continued ocean warming. Ocean circulation will be impacted by the heat energy that has accumulated at the surface moving toward the deep ocean. Along with the rise in the world's average surface temperature, the Arctic sea ice cover will continue to shrink, as will the Northern Hemisphere's spring snow cover. Over the course of the twenty-first century, the average sea level will keep increasing. The amount of carbon dioxide in the atmosphere will increase further as a result of climate change-related global warming as carbon dioxide contained in carbonate rocks starts to breakdown. Depending on the temperature and water use, the rise in carbon dioxide in the atmosphere that causes the greenhouse effect will have various consequences on agricultural production. A combination of extremes in temperature and atmospheric carbon dioxide concentration will have a negative impact on crop productivity. Rainfall will cause the oceans to hold more carbon dioxide, which will cause the waters to become more acidic. In fact, many aspects and effects of global climate change will persist for generations even if

greenhouse gas emissions are stopped now. This result illustrates that human-induced greenhouse gas emissions have a considerable obligation to mitigate climate change in the past, present, and future (Türkeş, 2020).

3. Food Security

The term "food security" describes the situation in which all people and groups have equitable physical, economic, and social access to enough food that is safe, nourishing, and satisfies their dietary needs and preferences for an active and healthy life. In essence, food security makes sure that people consistently have access to enough food in both sufficient quantity and quality to maintain their well-being.

Food security is typically evaluated based on four main dimensions (Figure 1):

Availability: This factor evaluates how readily available food is in a certain area or nation. Considerations including agricultural production, food supplies, imports, and food delivery systems are included. To meet population demand, there must be enough food available.

Access: The financial resources of an individual or community determine access to food. It involves having the means—including money, social safety nets, and market accessibility—to buy or receive food. Access to food may be restricted by physical or financial limitations.

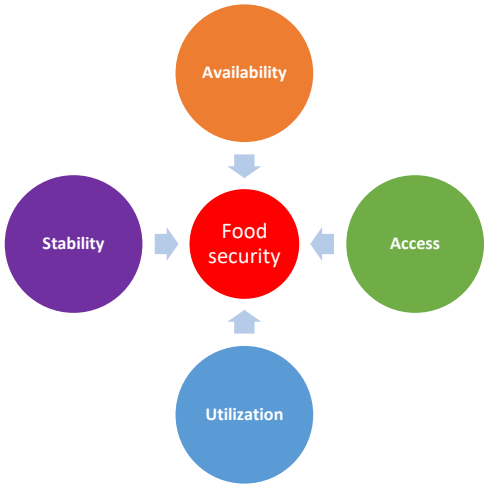

Figure 1: The Four Main Determinants of Food Security

Utilization: The nutritional content and quality of the food consumed are the main topics of utilization. It takes into account things like access to clean

water and sanitary facilities, a variety of diets, and adequate food preparation and handling. Poor use of food can result in hunger and health issues even when it is available and easily accessible.

Stability: Long-term stability includes both food security and stability. As a result, people and communities should always have access to food and be able to survive shocks or disruptions, such as natural catastrophes, economic downturns, or armed conflict, without experiencing food insecurity.

For the welfare and growth of people and societies, food security is crucial. Lack of access to sufficient and nourishing food can result in hunger, malnutrition, and a variety of health problems. Additional social and economic effects of food insecurity include decreased productivity, elevated healthcare expenses, and societal unrest.

A variety of tactics are frequently used in efforts to promote food security, including enhancing agricultural techniques, fostering equitable access to resources, bolstering social safety nets, and addressing more general problems like poverty and inequality. At the local, national, and international levels, non-governmental groups, governments, and international organizations collaborate to monitor and address issues related to food security.

4. Effects of Climate Change on Agricultural Production and Food Security

According to Türkeş (2020), food security is the state in which all people can always have enough food that is safe, wholesome, and sufficient for their needs while also having their dietary preferences satisfied. Food availability may be affected by climate change, which includes an increase in extreme weather events including heatwaves, floods, and droughts. Changes in the amount of agricultural land and the types of agricultural products have an impact on the world's food supply. Changes in food production are anticipated to have an impact on food prices in the future and limit the ability of low-income families and communities to get enough and wholesome food. The IPCC report on climate change states that sub-Saharan African countries have the least secure food systems. Hunger affects more than half of the local population. Water shortages and scarcities are a common occurrence in this region. Climate change may further constrain the region's needs, impair water availability and quality, and contribute to a large rise in sanitary issues like cholera, typhoid, and widespread diarrheal illnesses. In addition, it is possible to anticipate the spread of vector-borne illnesses, particularly those linked to the environment, like yellow fever

and malaria. Food intake can be significantly impacted by such outbreaks, and food scarcities and unhealthy eating habits can progress to a high level. Despite the fact that there is enough food produced globally to feed everyone, it is concerning that more than half of the population in this area is undernourished, and this number is rising. Food waste is out of control, and by the middle of the century, the world will need more food than it currently produces by nearly 60%. This situation creates a table contrary to Article 25 of the Universal Declaration of Human Rights: "*Article 25/1. Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control*." (United Nations, 2015).

The detrimental effects of climate change on food security are multifaceted, geographically and temporally variable, and complex. While agricultural and ecological factors contribute to the direct effects of climate change on food security, it also has indirect implications on communities in terms of income distribution and economic growth. Temperature, precipitation, carbon dioxide, and ozone are only a few examples of climate and atmospheric elements that have a substantial and direct impact on the production of various plant and animal species, posing a threat to food systems, food security, access to food, food use, and food stability. Additionally, non-agricultural production issues that affect income, processing, transportation, storage, and retail sales may also have a negative impact.

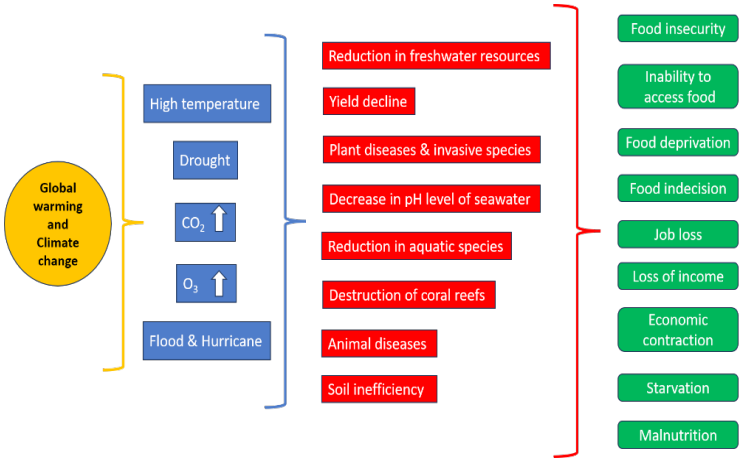

Figure 2: The Effects and Consequences of Global Warming and Climate Change

Food security may also be negatively impacted by non-climate factors such soil fertility, irrigation, fertilizers, population density, and socioeconomic structure. These factors might have direct or indirect effects on the aforementioned reactions. Figure 2 illustrates how climate change and global warming have an impact on food security and agricultural production.

Food security is significantly and intricately impacted by climate change, which has an impact on many facets of food production, distribution, and accessibility. The following are some of the ways that climate change affects food security (Figure 3):

Water Scarcity: The depletion of freshwater supplies is one of the most important negative effects of climate change and global warming. Because there are fewer water resources available, more groundwater is used for irrigation as a result of increasing droughts. Wetlands and other natural ecosystems dependent on them disappear as a result of the rapid groundwater depletion. Water scarcity can be made worse by changes in precipitation patterns, which can have an impact on both irrigated and rain-fed agriculture. For the development of crops, many areas rely on reliable access to water, and decreased water availability may result in lower crop yields.

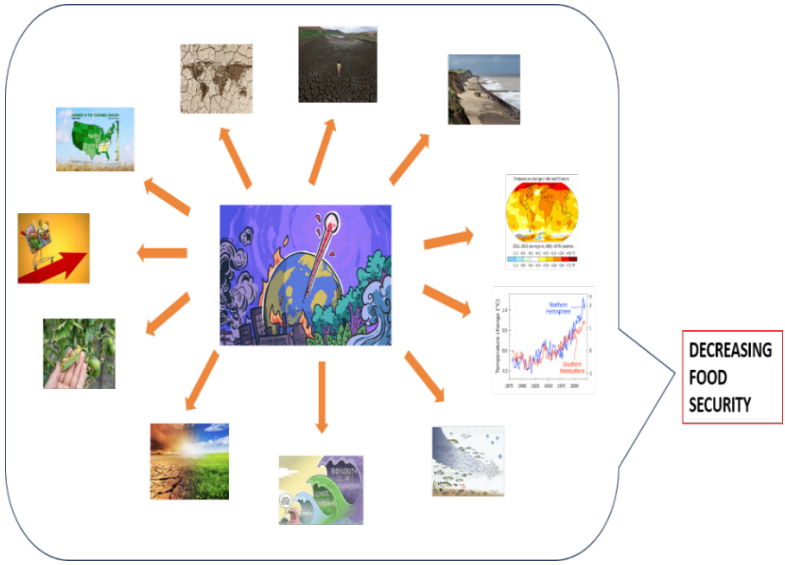

Figure 3: A Number of Different Aspects of the World are Negatively Impacted by Climate Change, Harming Food Security.

Coastal erosion can also force communities to relocate and interfere with local agriculture.

Temperature Changes: The output of agricultural goods is negatively impacted by temperature changes. According to certain studies, crop yields are negatively impacted by temperatures around 30°C. Such circumstances are already typical in many parts of the world, and global warming is making them more prevalent. If local temperature averages rise by 2°C in comparison to the late 20th century, there would be a negative impact on the output of grain crops in tropical and temperate climate zones.

Changes to Crop growth Seasons: Farmers may find it challenging to determine the ideal periods for planting and harvesting due to climate change's potential to disrupt traditional crop growth seasons. Crop rotting and decreased food supply may result from this.

Reduced Crop Yields: Changes in temperature and rainfall patterns may result in decreased crop production. The development and yield of crops can be significantly impacted by protracted droughts, extremely high temperatures, and erratic rainfall. Food shortages and price increases may result from this. In addition, the atmosphere's buildup of greenhouse gases can have an immediate effect on agricultural production. Carbon dioxide (CO_2) and a few other gases, such as ozone, are the main greenhouse gases that cause global warming. As long as their concentrations do not go above a particular point, these gas molecules are essential for the regular operation of Earth's natural life cycles, but human activities have increased their concentrations. For instance, the stratosphere of the atmosphere contains ozone molecules, which serve as a protection against the sun's UV rays. However, the amount of ozone molecules in the troposphere has increased as a result of human activity. Agriculture is suffering from this ozone buildup, particularly in areas like China and India. Strong oxidants like ozone have the potential to lower crop yields by 3% to 10%. Examples of these crops include corn, rice, wheat, and soybeans. In areas with abundant water resources at high latitudes, rising carbon dioxide levels can have a positive impact on agricultural productivity. In some places, climate change might improve the circumstances for the production of aquatic food. But according to scientific study and existing data, there are more adverse impacts than favorable ones at a global level.

Regional Climate Variability: Regional climate extremes pose a hazard to food security. One of the main contributors to food insecurity is climatic calamities, with droughts having a particularly negative effect on food production. In addition, climate change-related extreme weather events like floods and tropical storms can wipe out people's livelihoods, endangering food security.

Increased Pest and Disease Pressure: Food security may be further harmed by plant diseases and pests brought on by climate change. The spread of pests and illnesses that harm crops and livestock can be facilitated by rising temperatures. This could result in lower agricultural output and more pesticide use, which could have negative effects on the environment and human health. Additionally, an increase in atmospheric carbon dioxide may encourage the spread of invasive species, which could have a severe impact on biodiversity and agricultural output.

Loss of Biodiversity: Ecosystems can be harmed by climate change, and species distribution can vary. This may have an impact on pollinators that are important for many crops and diminish the availability of wild foods that are a dietary supplement in some areas.

Impact on Fisheries Seafood is also affected by climate change. The production of food is significantly influenced by fishing, particularly in the world's poorest nations. In 2010, each person consumed 18,6 kilogram of fish annually on average. Climate change, however, threatens marine biodiversity by raising water temperatures and altering pH levels. Marine biodiversity is being further reduced by habitat changes, overfishing, and environmental pollution. Because of dramatic temperature shifts in the Northeast Atlantic Ocean brought on by rising ocean temperatures over the past ten years, fish distribution has changed, highlighting the effect of temperature changes on biodiversity. Climate change is particularly dangerous to coral reefs, which house a wide variety of marine species. Regional causes like overfishing are threatening more than 60% of coral reefs. About 75% of coral reefs are in danger of vanishing when the potential effects of ocean warming on biodiversity are taken into account. Many fish species connected to coral reefs will probably experience reductions as a result of this reduction in coral reef area. Research shows that alterations in the variety of fish captured at particular ocean temperatures are mostly due to changes in ocean temperature. These changes have a direct impact on fishing. Productivity is under threat of extinction considerably more quickly in freshwater basins than in the seas. For instance, the productivity of Lake Tanganyika in East Africa has dropped as a result of the rising temperature, and the output of fish has reduced by around 30% (O'Reilly, Alin, Plisnier, Cohen, and McKee, 2003).

Unemployment, Displacement, and Migration: Food access may suffer from the decline in agricultural production and food security. The number of agricultural workers will decrease as the potential for industrial production based on agriculture declines. As a result, it is anticipated that unemployment rates

would grow in nations that are heavily dependent on agricultural. As a result of being compelled to leave their homes in pursuit of better living conditions and access to food supplies, persons who are experiencing food insecurity due to climate change may also experience displacement and migration. In the receiving areas, this may result in social and political difficulties.

Increased Food Price Volatility: Price changes in the world's food markets may result from disruptions in food production caused by the climate. For needy communities who would not be able to purchase more expensive food, this could have major repercussions. Access to already low food supplies may become much more challenging as food prices rise. Poor and insufficient nutrition can cause developmental abnormalities in children and make malnutrition-related illnesses more common in society.

5. Sustainable Food Security

Urgent action is required to prevent or at least lessen the effects and pressures on food security brought on by global climate change in order to secure food production, access, and appropriate nutrition security for all humankind worldwide in a sustainable manner.

Attempts to address how climate change is affecting food security include:

Adaptive Agriculture: Encouraging agricultural practices such crop diversification, water-efficient farming techniques, and the creation of drought-resistant crop varieties that are more tolerant to changing climatic circumstances.

Investment in Research and Technology: Supporting research and development of climate-resilient crop varieties and agricultural technologies that can adapt to changing conditions.

Climate (Change) Mitigation: Reducing greenhouse gas emissions to slow the pace of climate change and limit its impacts on food production.

Social Safety Nets: Implementing social safety nets and food assistance programs to help vulnerable populations cope with food shortages and price spikes during climate-related crises.

International Cooperation: Collaborating at the global level to address climate change and its impact on food security through initiatives like the Paris Agreement and efforts to enhance climate resilience in agriculture (United Nations, 2016).

Preventing Food Waste: Over 3 billion people lack access to a healthy food, and about 1 billion people suffer from hunger, according to data from the Food and Agriculture Organization (FAO) of the United Nations. Approximately 14% of the total food produced globally each year, according to FAO data for

2019, and approximately 17%, per the UN Environment Programme's (UNEP) Food Waste Index, is wasted and thrown away without being eaten. Redirecting food waste in the right way could help end world hunger, as the food that is wasted now has the potential to feed 1.3 billion people. Additionally, 8–10% of the world's greenhouse gas emissions come from food loss and waste, which exacerbates climatic instability and fuels extreme weather events like droughts and floods. These modifications have a negative impact on crop yields, may lower the nutritional value of food, and may disrupt the supply chain. In order to transition to sustainable agricultural food systems that improve the effective use of natural resources, lessen their impact on the environment, and assure food security and nutrition, it is crucial to prioritize the reduction of food loss and waste (FAO, 2022).

A multifaceted strategy that incorporates agriculture, environmental protection, social policy, and international collaboration is needed to address the complicated relationship between climate change and food security (Figure 4).

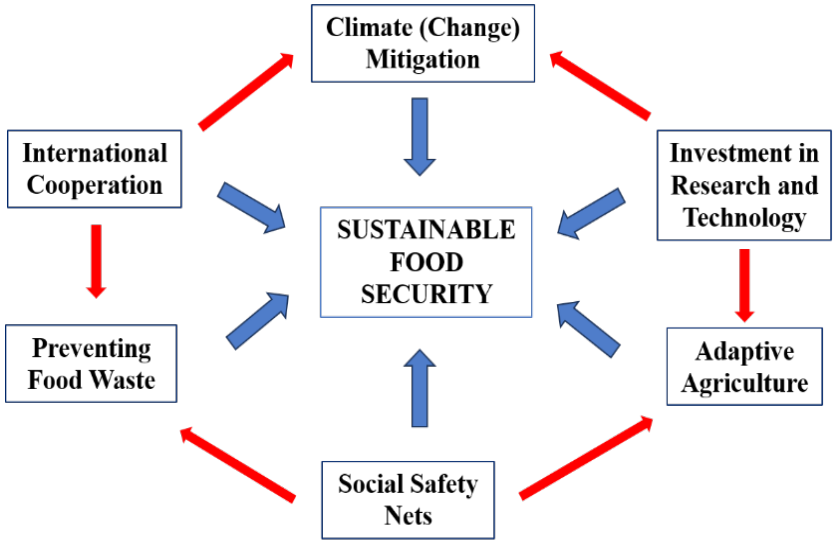

Figure 4: Multidimensional Approach for Sustainable Food Security.

6. Results

Agriculture lands are gradually shrinking as a result of climate change, drought, and wildfires, as well as global warming. Production systems based on conventional farming practices are negatively impacted by the loss of agricultural acreage or deviations from typical conditions. Depending on a

country's degree of development, this scenario may change. Developed nations with robust economies can support farmers by making investments and putting various irrigation and agricultural practices into place. In this manner, they may guarantee food security for a specific time. But in less industrialized and developing nations, things are different. In nations with fragile economies, the support that can be applied in rich nations may not be able to reach a sufficient level, leaving farmers unable to use traditional farming practices. Large corporations that produce genetically engineered seeds may be particularly interested in this circumstance. Even supportive initiatives may be pursued by governments to aid farmers.

Farmers may be compelled to forgo traditional farming practices and plant crops that are drought-resistant but unknown to the community in terms of food habits in nations that fail to take the essential steps to combat climate change as a result. Governments must incorporate cutting-edge scientific methods into their agricultural policies, give farmers the most support possible, particularly in regions where irrigation is practiced, implement water supply and alternative irrigation techniques, and take legal action to protect agricultural land in order to eliminate this possibility and guarantee future food security.

To conserve the genetic codes of their distinctive crop plants, governments must also establish seed banks and run them according to scientific principles. In this manner, a speedy return to conventional techniques can be secured in the event that circumstances return to normal or adjustments are made to changing circumstances.

On the other hand, the government should fund and encourage academic institutions to carry out scientific research targeted at modifying traditional farming practices to anticipated future situations and inventing novel techniques. Every institution should do site-specific research to pinpoint the issues encountered by farmers, particularly those connected to climate change, and develop solutions. University-based research infrastructure that is specialized in this area has to be strengthened. Positive outcomes from such research projects can be incorporated as a significant factor in the academic promotion conditions for the academics conducting these projects. The criteria for academic advancement in the nation or university should be evaluated.

Countries must demonstrate a firm commitment to halting climate change, which endangers food security and other aspects of nature. Studies show that the tropical zone, which is marked by extreme heat and drought, is growing. This unfavorable condition, brought on by extensive use of fossil fuels for

energy production and excessive environmental degradation as a result of industrialisation, is not thought to be reversible overnight. Scientific research should be promoted and supported, and newly developed techniques should be quickly adopted to enhance the use of environmentally friendly renewable ways in energy production. This will enable the adoption of renewable alternative energy sources in place of fossil fuels. To protect depleting clean water sources, a firm position should be adopted against the unchecked flow of contaminants into the environment. It is important to carry out the decisions reached by the UN on these matters.

Forest fires that have become catastrophic as a result of temperature rises and droughts brought on by climate change cause the loss of natural habitats while also boosting greenhouse gas emissions. Therefore, among the efforts to combat global warming, the creation and application of efficient methods for preventing and putting out forest fires also become crucial. In order to accomplish this, it is necessary to first replant burned areas and renew existing forest lands with fire-resistant trees, build firebreaks to stop the spread of potential fires, rehabilitate forest lands by intensifying maintenance and cleaning activities to make them more fire-resistant, maintain them under control with ongoing monitoring and active fire notification systems, and develop aerial intervention systems for potential fires.

Given the findings of the research done so far, it seems likely that Earth has the unique property of being the only planet in the observable universe that is suitable for natural life. This means that we are helpless in the face of the prospect of the extinction of life on Earth. Therefore, by placing the proper significance on this special treasure we possess, we must take the required actions to safeguard the safety and serenity of future generations.

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CHAPTER X

AN EVALUATION OF THE PSYCHOLOGICAL EFFECTS OF GLOBAL CLIMATE CHANGE

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1. Introduction

The global endeavor to address climate change, a matter of collective concern for all nations, aligns with the sustainable development goals aimed at poverty eradication, preserving human health, and safeguarding the global environment (United Nations Development Program, 2020). The shared challenge of climate change has prompted collaborative efforts among countries, exemplified by the establishment the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. One hundred and ninety-four nations endorsed the convention, primarily designed to curtail the accumulation of greenhouse gases in the atmosphere to levels deemed non-threatening. Subsequent to the establishment of the United Nations Framework Convention on Climate Change, the Kyoto Protocol was ratified in 1997. Signatory countries bear legal obligations to diminish and restrict their greenhouse gas emissions. Given the impending expiration of the Kyoto Protocol in 2020, the Paris Agreement, instituted in 2015, assumes precedence. Enforceable post-2020, this accord serves the dual purpose of upholding the UNFCCC while advancing initiatives to enhance climate change adaptation and promote low greenhouse gas emissions development (Republic of Turkey

Ministry of Environment and Urbanization). Climate change. Available from: https://iklim.csb.gov.tr/. Accessed January 2020.). In conjunction with various international agreements, the United Nations Framework Convention on Climate Change (UNFCCC) has facilitated an annual convening known as the Conference of the Parties (COP) since its inception. This forum serves as a platform to assess nations' advancements in combatting climate change. Notably, the World Health Organization authored a dedicated report on health and climate change for the 2015 COP24. This document underscores climate change as the paramount challenge of the 21st century, posing an overarching threat to all facets of society. The report emphasizes the escalating severity of its impact on health, emphasizing that implementation delays heighten the risks to human life and well-being (World Health Organization, COP24 special report: health and climate change). https://www.who.int/globalchange/publications/COP24-report-health-climate-change/en/ Accessed: January 20, 2020.).

Climate change has emerged as an imperative and inescapable global reality. Manifestations of this phenomenon, including heightened concentrations of greenhouse gases in the atmosphere, escalating sea levels, and a surge in extreme weather events, disrupt the ecological equilibrium of our planet with consequential impacts on human existence. Notably, the repercussions of these environmental challenges extend beyond the confines of the natural world, profoundly influencing our psychological well-being.

The relationship between climate change and its psychological effects has attracted increasing attention in recent years. Various factors, such as the frequency of natural disasters, changes in ecosystems, and the endangerment of the basic living conditions of living communities, are associated with climate change. This can negatively affect people's psychological health. Traumatic events caused by climate change can lead to psychological problems such as displacement, loss of identity, depression, and anxiety.

Understanding the relationship between climate change and psychological impacts can help us understand how individuals and societies can better adapt to global threats. Therefore, understanding the importance of this relationship between climate change and psychology will be a critical step towards developing more effective solution strategies.

This study aims to examine and understand the effects of climate change on human psychology. In this research study, the psychological effects of climate change are examined in more detail, and the importance of strategies to deal with climate change in providing psychological health support is emphasized.

This study examines and attempts to understand the impacts of climate change on human psychology. Climate change has been associated with increased natural disasters, environmental changes, and jeopardizing basic living conditions, affecting people's psychological health. Traumatic events associated with climate change cause psychological problems such as displacement, loss of identity, depression, and anxiety. In particular, changes in the space, place, and role to which people feel they belong, and most importantly, disruption of bodily integrity, injury, and loss of limbs are prominent elements of the psychological impacts associated with climate change. This loss makes people feel that their communities and cultural ties are in danger. In addition, it has been concluded that warming and environmental changes negatively affect cognitive functioning and may undermine the ability to resolve non-violent conflict.

With the impact of climate change, extreme weather events and natural disasters have become more frequent. This may indicate that the prevalence of post-traumatic stress disorder and depression will increase in the coming years. On the other hand, natural disasters are frightening for children and can sometimes result in losing homes, friends, or relatives. Considering that people who experience traumatic experiences in childhood are more likely to develop psychological disorders, it is thought that the prevalence of psychological disorders may increase in the future due to the increasing frequency of natural disasters. (Kar, 2009). The increased frequency of floods as a result of climate change poses the risk of increased spread of waterborne diseases such as typhoid, cholera, leptospirosis, and hepatitis, and vector-borne diseases such as malaria and yellow fever. On the other hand, summer heat waves increase mortality rates (Haines, Kovats, Campbell-Lendrum, & Corvalán, 2006). According to the report prepared by Çelik et al. (2008), an average increase of one degree Celsius in temperature values causes an increase in mortality rates by 0.2 - 5.5%. Accordingly, it is estimated that the temperature will rise by approximately three degrees Celsius in 2071-2100, resulting in 86,000 extra deaths annually.

2. An Overview of Climate Change

Since the mid-twentieth century, changes have been observed in the measured temperatures around the world and, accordingly, in the structure of climates. These changes, called climate change, were expected to have more ecological and socioeconomic impacts (Padhy, Sarkar, Panigrahi, & Paul, 2015; Trombley, Chalupka, & Anderko, 2017). However, it is now recognized that climate change poses a major threat to the ecosystem and human health. The

World Health Organization estimates that mortality rates will increase by more than 250,000 per year between 2030 and 2050 due to the effects of climate change (Watts et al., 2015). Although psychological health is an important component of health according to the World Health Organization's (1948) definition of health, the effects of climate change on psychological health are less known and often overlooked. Therefore, this review focuses on the effects of climate change on an individual's psychological health.

However, since the impact of physical health problems on psychological health cannot be denied, the direct and indirect effects of climate change on both psychological and physical health are discussed.

Global climate change continues to have increasingly negative impacts on the world, with rising temperatures and extreme weather events making life more difficult and causing despair for many. A striking aspect of this catastrophe is its slow progress and the devastating consequences it brings with it. As time passes, the impacts of climate change become more pronounced, and the challenges people worldwide face deepen.

Climate is defined by the World Meteorological Organization (WMO) as a 30-year average of various elements such as temperature, precipitation, and humidity (Barrie, 2005). Long-term statistical data are used to determine these averages. Recent statistical studies have shown the emergence of anomalous conditions leading to what is known as global climate change. The causes of these changes are diverse and are thought to be caused by both human activities and natural processes (Akbulut and Kaya, 2021).

Extreme weather events due to climate change have direct impacts on mental health. However, extreme weather events also affect the social, economic, and environmental determinants of mental health, and the consequences of this situation are felt especially by vulnerable groups such as women, children, migrants, and poor communities in need of empowerment (Fritze, Blashki, Burke, & Wiseman, 2008). In particular, climate change threatens the availability of clean air, adequate food, safe drinking water, and shelter and causes mental health problems (World Health Organization, 2021).

It is widely anticipated that climate change will lead to a massive increase in human population movement in the coming decades. Estimates of the number of people who will relocate, i.e., migrate, in response to the impacts of climate change over the next half-century vary from tens of millions to 250 million people (Boano et al. 2008; Brown 2007; Christian Aid 2007). Myers (2002) estimated that climate change would create an additional 200 million "environmental refugees" by 2050, and this estimate was widely accepted (Brown 2008).

People displaced by climate-related processes and events can face problems such as loss of land, increased health risks, and strained livelihoods (Bardsley and Hugo, 2010). This includes people affected by major environmental degradation and disasters, particularly floods, landslides, and famine. When climate change plays a role as a factor that increases displacement, health outcomes can be similar to the situation of refugees at the beginning of their flight and displacement. At this point, most regions ready to receive climate change-affected migrants are developing regions, which often have limited or inadequate public health resources (Carballo et al., 2008). Therefore, the consequences of climate change-induced displacement will not only be limited to environmental impacts but will also involve serious challenges regarding access to health services and resources.

When the possible impacts of climate change are evaluated, it is necessary to draw a road map on various issues such as world population planning and population migration movements. It affects people's perceptions of whether they would prefer to stay in their places or migrate. Current scientific assessments predict that climate change will increase morbidity and mortality rates to varying degrees across different regions and communities, reduce incomes, and significantly reduce access to natural capital. In light of this information, increased individual concern stems from awareness of the possibility of climate-related changes, particularly in their living and working environments (Tacoli 2009). Therefore, people may choose to move to areas they perceive as having the potential to offer a better life.

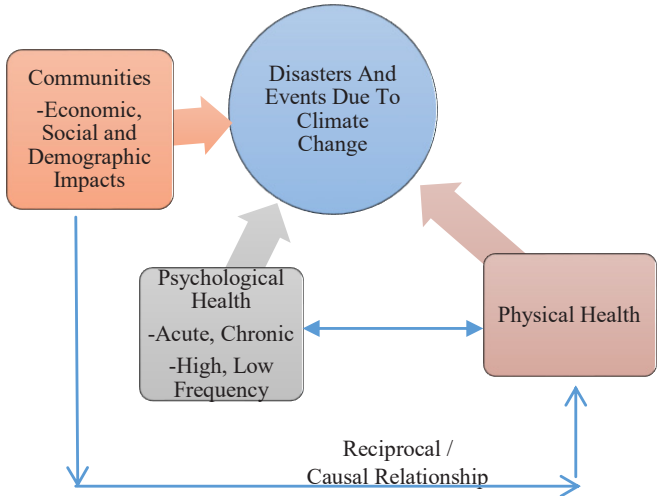

Figure 1: Psychological Consequences of Climate Change
Source: Berry et al., 2010:125.

On the other hand, it is possible to list the negative effects of climate change on human health as follows (Kiraz, 2019: 9-10):

- Sudden deaths that may occur concerning temperature
- Heart, Circulatory, Vascular, and Respiratory Diseases in Relation to Temperature
- Adverse Lung Diseases Caused by the Formation of Air Pollution as a Result of Fires in Connection with Hot Weather
- Increases in the Number of Premature Infant Deaths due to Increasing Greenhouse Gases
- Hygiene Problems Related to Water Scarcity
- Increase in Epidemic Diseases due to various reasons, especially due to hygiene
- Psychological disorders concerning environmental factors

Formun Üstü

3. Psychological Impacts and Barriers Caused by Global Climate Change

Looking at the book "The Non-Human Environment" written by Harold F. Searles (1960), it is accepted in the literature as the first book to evaluate the ecological crisis in the modern sense. Subsequently, Paul Shepard (1982) published a book titled "Nature and Anxiety," which examines the psychic states created by environmental problems in human life. Shepard was influenced by Searles while writing his book and proceeded with inspiration in his book. The most recent book evaluated in this context is Renee Lertzman's (2015) "Environmental Melancholia: Psychoanalytic Dimensions of Engagement" (Fisher, 2016: 1).

Climate change and its psychological effects are a topic that is expanding its place in the literature every day. In general, these psychological problems have been found in the literature as an increase in post-traumatic stress disorder (PTSD), major depressive disorders (MDD), anxiety, depression, complex grief, guilt, conscientious trauma, the exhausting recovery process, substance abuse, and suicidal ideation (Berry, 2009: 453; Doherty & Clayton, 2011: 268; Coyle & Susteren, 2012: 11).

Climate change is too complex a problem to be addressed only by environmental policies and technical solutions and requires improving individuals' psychological preparedness, awareness, and adaptation skills. Hrabok, Delorme, and Agyapong (2020) also stated in their research that

climate change triggers natural disasters and extreme weather events and that climate change is associated with depression and post-traumatic stress disorder. Situations such as having to leave the house due to climate change, loss of work, fear of being unable to access basic nutrients, and loss of relatives also affect people psychologically (Aras & Demirci, 2020).

Cianconi et al. (2020) stated that climate change affects a large part of the population in different geographies, but studies on mental health and climate change are delayed, there is a lack of psychiatric studies on mental disorders related to climate change, and the lack of literature is since the subject is new or complex. Some concepts have been created regarding people's psychological and emotional reactions to climate change and environmental degradation. Although awareness of climate anxiety or negative emotional responses to climate change is increasing, there is little conceptual clarity about the nature of these responses (Clayton & Karazsia, 2020). Some of these responses include ecoanxiety (Cordial, Riding Malon, & Lips, 2012), ecological grief (Cunsolo & Ellis, 2018), Solastalgia (Albrecht, 2005), environmental distress (Higginbotham, Connor, Albrecht, Freeman, & Agho, 2006), ecological stress (Helm, Pollitt, Barnett, Curran, & Craig, 2018), pre-traumatic stress disorder (Van Susteren & Al-Delaimy, 2020), climate change distress (Reser, Bradley, Glendon, Ellul & Callaghan, 2012), climate anxiety (Clayton & Karazsia, 2020).

Global climate change is one of the greatest environmental challenges facing humanity and is not limited to environmental issues but also has major implications for psychological and social dimensions. Climate change can affect people's psychological well-being in direct and indirect ways. In this context, we may face psychological barriers to coping and adapting to climate change. These barriers may include the difficulties people experience with climate change, such as lack of information, insufficient awareness, difficulty taking action, anxiety, and stress.

One of the impacts of climate change is the increase in temperature. Temperature has a significant effect on arousal. Physiologically, overstimulation leads to a decrease in attention and self-regulation skills, as well as an increase in negative and hostile thoughts. Anderson and Delisi (2011) compared violent (such as homicide) and non-violent (such as burglary) crime reports between 1950 and 2008 with annual temperature averages. They found that violent crime rates increased as annual average temperatures increased. However, it was observed that there was no such relationship between non-violent crimes and annual average temperatures. As a result of the studies, it is predicted that the

rate of violent crimes will increase by 6% with a temperature increase of one degree Celsius, and the level of aggression of people in society will increase (Swim et al., 2009; Cohn, Rotton, Peterson, Tarr, 2004; Howarth & Hoffman, 1984). The increase in the rates of social violence and domestic violence at both national and global levels will also bring to the agenda the psychological health problems that may arise in those exposed to violence.

Climate change directly and indirectly impacts people's psychological states and well-being. Direct impacts result from the physical consequences of climate change. On the other hand, indirect impacts occur due to the negative effects of climate change on people's living standards and infrastructure. Direct impacts can affect individuals' psychological well-being due to the adverse conditions created by climate change. For example, climate change-related extreme weather events and natural disasters such as floods, droughts, or hurricanes can cause serious psychological disorders such as post-traumatic stress disorder. Such events can profoundly impact the safety, property, and lives of people in the areas where they live. Indirect impacts are the result of the negative effects of climate change on people's living conditions and infrastructure. Climate change can be associated with factors such as reduced water resources, food security issues, economic hardship, and migration. Such impacts can cause people to face their daily lives and futures with uncertainty, which can lead to psychological stress and anxiety (Clayton et al., 2014; Gullone, 2000).

Studies on the impacts of climate change on physical health focus on i) deaths and injuries resulting from extreme natural events, ii) physiological effects of heat waves, iii) spread of vector-borne diseases, iv) air quality and respiratory diseases, and v) changes in food and water quality (Fritze, Blashki, Burke, & Wiseman, 2008). All these impacts are predicted to affect low-income and disadvantaged groups more (Frumkin, Hess, Luber, Malilay, & McGeehin, 2008). Obviously, climate change seems to be a new problem to overcome by those working in psychological health and public health.

There are psychological barriers to climate change mitigation and adaptation (Gifford, 2014). Acquiring the ability to cope with climate change is difficult but entirely possible with psychological support. In general, it is possible to say that many people lack knowledge about climate change. A group of people are unaware that climate change is a problem. Therefore, these people are unlikely to act consciously to ameliorate climate change. A second barrier is that people who are aware of climate change have insufficient knowledge about the issues on which action is needed, how to take those actions and the relative benefits

of different actions. People often do not know the magnitude of the beneficial effects of actions or how to go about them. On the whole, this suggests that there are some psychological challenges in tackling climate change (Gifford, 2014).

Psychologists have identified several psychological barriers hindering human response to climate change. First, the ability to grasp the complex nature of climate change is limited, as factors such as uncertainty and ignorance of the issue make it difficult to understand the threat fully. In other words, the human brain has a limited capacity to cope with the complexity of multiple environmental threats, and a tendency toward optimism can lead to underestimation of the seriousness of the situation.

Thought and belief structures also play a role; individuals' beliefs and mindsets about the world, the value placed on natural resources, and the belief that technological advances will solve the problem can complicate efforts to address climate change. Comparisons with other societies or individuals can influence personal responses, as can factors such as social norms and perceived levels of injustice. Sunk costs, such as financial investments and conflicting values and goals, can make it difficult to change existing behaviors. While mistrust of climate change and the belief that existing solutions are inadequate can limit serious responses, different types of risks associated with climate change can influence individuals' perception of the associated risk and affect their propensity to respond (Schmitt et al., 2021; Gifford, 2014; Akbulut and Kaya, 2021).

Global climate change is not only causing environmental impacts, it is also having a serious impact on people's psychological well-being. For many people, climate change is creating a reality where the world they live in is changing and transforming, requiring them to deal with a range of psychological challenges. Some of these psychological challenges and problems can be listed as follows.

Loss of Identity (Personal and Professional): This concept is a common psychological impact of global climate change. People may feel that their communities, cultures, and lifestyles are under threat as a result of climate change. Traditions and ties can be lost due to environmental problems caused by climate change, leading to identity crises (Clayton et al., 2017). Separation from one's roots, breaking away, adapting to a new order, and adopting a different cultural structure is the most natural effect of identity loss. This situation is considered as a result of the process. While change plays a mediating role in balance and harmony, the process is often painful and difficult.

Depression: Depression is another important psychological impact associated with climate change. Coping with climate change can increase the risk of depression in people due to increased natural disasters, economic uncertainty, and anxiety. These uncertainties can cause people to despair about the future (Clayton et al., 2017).

Anxiety: Anxiety is primarily a mental disorder. Nevertheless, it is not always mental. It is also seen to appear physically. It has taken place in the literature as one of the psychological effects of global climate change. As threats such as climate change, increasing weather events, and rising sea levels become more common, it can create great anxiety about the future. People may worry about whether they and their loved ones will be safe (Clayton et al., 2017). People show various physical and nervous symptoms due to the situations they are in and the fears they experience. Psychological symptoms of anxiety include irritability, difficulty concentrating, sensitivity to sound, and inability to sit still. In addition to all these, the weakening of the individual's memory can also occur due to excessive concentration on the autonomic system, distortions, and thought disorders related to feeling heartbeats and interpreting and perceiving this situation as a heart attack. In recent times, it is possible to give an example of this situation that in cases where individuals are taken to hospitals with symptoms of heart attack, it is revealed that the individual has a panic attack.

Trauma and Shock: Climate change-related disasters bring with them conditions that set the stage for psychological trauma. Such disasters can cause immediate and severe trauma, such as personal injuries, harm or death of loved ones, loss of personal property, and occupational losses. Research shows that climate change-induced disasters are closely related to psychological problems (Neria & Schultz, 2012; Simpson et al., 2011). The 36 main studies examining the relationship between climate change and its psychological impacts found that 7% and 40% of participants experienced psychological problems (Rubonis & Bickman, 1991). These psychological impacts can include a variety of problems, such as depression, anxiety, stress disorders, and suicidal thoughts. Findings showing that climate change-induced disasters can have profound and long-term impacts on the psychological health of communities and individuals emphasize that coping with climate change should not be limited to environmental measures.

Suppressed Stress: Stress is defined as a physiological response that occurs when it exceeds a person's capacity to adapt to a given situation. In this context, climate-related stress is highly likely to lead to an increase in stress-

related problems such as substance abuse, anxiety disorders, and depression. The threats posed by climate change can trigger stress responses in individuals, resulting in psychological problems. Climate-related stress can bring about negative emotional states such as vulnerability, helplessness, grief, sorrow, and hopelessness (Neria & Schultz, 2012; Aras & Demirci, 2020).

Aggression and Violence: Scientific research shows a significant relationship between temperature and human aggression. Laboratory-based experiments and field-based studies indicate that hot weather conditions increase aggression (Anderson, 2001; Simister & Cooper, 2005). In this regard, as the temperature rises, individuals are more likely to exhibit aggressive behaviors. It is known that heat has negative effects on cognitive functions. High temperatures may negatively affect cognitive functions and reduce the person's ability to resolve conflicts. This may increase the likelihood of exhibiting a more aggressive attitude (Aras & Demirci, 2020; Pilcher, Nadler & Busch, 2002: 690, 693)

Despair, Depression, Fear, Fatalism, Denial, Quitting, and Echo: Gradual and long-term changes in climate elicit a range of different emotions in the individual, such as fear, anger, feelings of powerlessness, or exhaustion (Moser, 2007: 67).

Loss: One of the most meaningful concepts for understanding the effects of climate change on human perception is the sense of "loss." Especially the sense of belonging to a place plays an important role in this context. By permanently altering the areas where people live, climate change triggers the feeling that many people have lost the places they personally care about. This psychological phenomenon is similar to the feelings of loneliness and loss experienced by migrants who are forced to leave their homes. Climate change can be difficult to define as the result of a complex set of factors influencing migration events, but a common estimate is that 200 million people could be displaced by climate change by 2050 (Fritze et al., 2008). This prediction highlights the need to understand more deeply the impact of the loss of places of personal attachment on people's mental and emotional health and to develop strategies to cope with such crises. Combating climate change should include environmental measures and psychological and emotional support systems to help people cope with these changes (Aras & Demirci, 2020).

4. Conclusion and Evaluation

Geographical displacement due to climate change, partial or total loss of property (house, car), permanent/temporary disability, or loss of life of family

members and/or loved ones cause psychological problems due to stress and anxiety. These psychological problems mainly include stress disorders, poor concentration, depression, somatic complaints, complex grief, social avoidance, anxiety disorders, sleep difficulties, sexual dysfunction, irritability, and substance abuse such as drugs or alcohol. Individuals are affected at different levels depending on the social and economic environment. In this context, the groups most affected both psychologically and physically by climate change can be listed as follows: emergency workers, children, the elderly, women, rural populations, people with low socioeconomic status, individuals who are homeless and trying to survive on the streets, outdoor workers, individuals exposed to racism, migrants and individuals with pre-existing health disorders (IPCC, 2012: 83).

In general, increasing temperatures have a much greater psychological impact on individuals in developing and underdeveloped countries than normal (Hansen et al., 2008: 1373; Trang et al., 2016: 1). Scientific studies show that individuals are more likely to commit suicide and self-harm due to increasing temperatures and droughts (Doherty & Clayton, 2011: 268). For example, in Adelaide, South Australia, it has been observed that people apply to hospitals more often for suicide and psychological support on very hot days (Nitschke et al., 2007: 662; Qi et al., 2014: 1-2).

The psychological impacts of climate change and its profound effects on people are receiving increasing attention. In particular, psychological problems such as displacement, loss of identity, depression, and anxiety are caused by traumatic events linked to climate change. We recognize that climate change is causing psychological hardship through factors such as increased natural disasters and threats to lifestyles.

In particular, displacement has become a major issue with increased climate change-induced threats such as global warming, floods, droughts, and sea level rise. This makes people feel that their communities, cultures, and ways of life are under threat. Loss of identity is a psychological impact that occurs as a result of such threats. In this context, strategies to deal with climate change should support people to protect their identities and communities.

Mental health problems such as depression and anxiety are also linked to climate change. Increased natural disasters, economic uncertainty, and hopelessness about the future can increase people's risk of depression and anxiety. Therefore, strategies to cope with climate change should include psychological support and crisis intervention services.

The effects of climate change on human psychology are an inescapable reality. Psychological impacts such as displacement, loss of identity, depression, and anxiety are the result of traumatic events linked to climate change. Therefore, strategies to deal with climate change should include environmental measures and measures to help people protect their psychological health and cope with such challenges.

It is important to conduct more research on this issue and develop more effective strategies to protect the psychological health of communities. Global cooperation and awareness-raising efforts to deal with climate change should also be increased, and more effective solutions to deal with the psychological impacts of climate change should be found to protect people's emotional health. The American Psychological Association (APA) states that psychologists have an important role in understanding both how individuals can acquire behaviors related to climate change prevention and how people cope with the effects of climate change (Swim, 2009). Again, APA (2018) states that climate change, which is included in the list of current issues in the science of psychology, should be addressed by psychologists both because the human factor has an impact on reducing the impact of climate change and because the consequences of climate change affect people. Those in the psychological science field who know about attitude change, decision-making processes, and behavior change should support society, politicians, and legislators to prevent and reduce climate change.

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CHAPTER XI

CLIMATE CHANGE AND DISASTER MANAGEMENT STRATEGIES

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1. Introduction

As the World citizens, past few years, we all have been talking about climate change and adaptation by the impact of the increasing frequency and severity of the disaster, emergency and crisis situations. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "*directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*". Another widely used definition is provided by the Intergovernmental Panel on Climate Change (IPCC) as *"a change in the state of the climate that can be identified ... by changes in the mean and / or the variability of its properties, and that persists for an extended period, typically decades or longer".* The common and mutual understanding and use of these definitions can be shortened as a long-term summary of weather conditions considering the average *conditions* and the *variability of these conditions*. Some occur very suddenly, some comes slowly as a changing climatic phenomena such as the El Niño.

Some indicators that scientists and policy makers consult to to express the climate change can be listed as (UNISDR 2008):

- The global average surface warming (surface air temperature change), will increase by 1.1 - 6.4 °C.
- The sea level will rise between 18 and 59 cm.
- The oceans will become more acidic.

- It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent.
- It is very likely that there will be more precipitation at higher latitudes and it is likely that there will be less precipitation in most subtropical land areas.
- It is likely that tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures.

If the continental geography is considered, we can express the effects of climate change as follows.

Africa is mainly vulnerable to drought as the local populations has vulnerabilities such as poverty, conflict and economically being less developed. In the continent, the frequency of weather- and climate-related disasters has increased since the 1970s, and the Sahel and Southern Africa have become drier during the 20th century. It is estimated that by the 2080s, the area of arid and semiarid land in Africa will likely to increase by 5-8% (UNISDR).

Rapid urbanization, industrialization and speedy economic development have placed pressure on natural resources, which increases the challenge in climate change impact in **Asia**. Access to fresh water will be the main challenge by the 2050's for more than a billion people in the region. In the next 20 to 30 years, increased risk of flooding and rock avalanches and are highly probable due to the continued melting of glaciers in the Himalayans. The coastal areas with its heavily populated delta regions, will be more prone to increased flooding because of both rising sea levels and river flooding.

Europe will need to cope with retreating glaciers and extend of permafrost, less precipitation in Southern Europe. Moreover, there is a possibility of droughts in some areas and increased risk of flash floods. Health risk is expected to increase by the higher temperatures and heat waves, which also triggers the wildfires. For Southern Europe, less water will reduce hydropower potential, tourism and crop production, which will cause economic interruption. One of the wild and untouched areas of the World, **Australia and New Zealand**, may face more frequent extreme events such as heat waves, droughts, fires, floods, landslides and storm surges. These will cause ecosystem changes, stress on water sources and agricultural land.

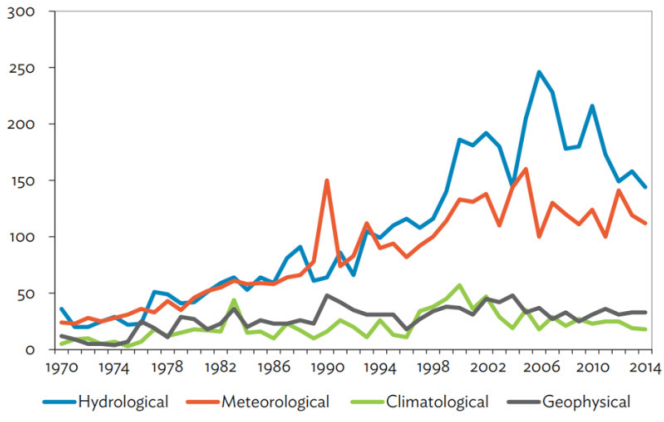
Desertification of agricultural land is one of the main issues in **Latin America**. The productivity of some crops and livestock will decrease, with adverse consequences for food security. It is estimated that the rise in the sea levels can cause increased risk of flooding in low-lying coastal areas. In the **North America** decrease of mountain snow due to rising temperatures will lead

to increased winter flooding and reduced summer flows. Some areas are expected to experience more, longer and hotter heat waves, with a greater potential for adverse health impacts. Forest fire risk will also increase. Coastal communities will be at-risk of tropical storms increases.

The thickness of glaciers and the extent of ice sheets in the **Arctic** will be reflected in changes in infrastructure and traditional or indigenous ways of living. We should not forget **the Small Island States** and their vulnerabilities to the effects of climate change, rising sea levels and extreme weather events. Millions of people are likely to be affected by floods, storm surges, erosion and other coastal hazards every year due to rising sea levels by the 2080s, particularly in the large deltas of Asia and Africa and the Small Island States.

Floods in Thailand in 2011, Hurricane Sandy in the United States in 2012, and Typhoon Haiyan in the Philippines in 2013 had devastating and wide impact in the decade of 2010's. In 2014, the Earth's warmest day is recorded in the 134 years of recorded history by NASA. It is hydrometeorological (floods, storms, heat waves) and climatological disasters (droughts, wildfires) rather than geophysical ones (earthquakes, volcanic eruptions) that are on the rise (ADB).

There is a global increase in severe floods, storms, droughts, and heat waves with a link to climate change. In the last four decades, the frequency of nature-rooted disasters recorded in the Emergency Events Database (EM-DAT) has increased almost three-fold, from over 1,300 events in 1975–1984 to over 3,900 in 2005–2014 (See Figure 1). The number of hydrological and meteorological events increased sharply during this period, with the annual number of Category 5 storms tripling between 1980 and 2008 (ADB).



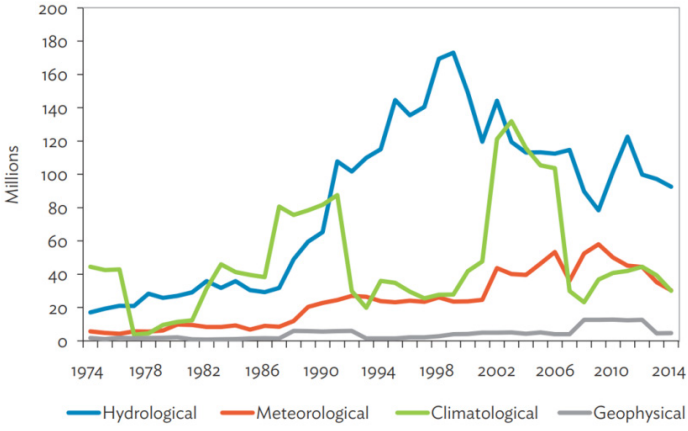
Source: Authors' estimates based on data from the Emergency Events Database (EM-DAT) of the Centre for Research on the Epidemiology of Disasters. http://www.emdat.be (accessed 5 March 2015).

Figure 1: Global Frequency of Nature-caused Disasters by Type (1970-2014)

It is estimated by the UN that between 1991 and 2005, 3,470 million people were affected by disasters, where 960,000 people died, and economic losses were sum up to US$ 1,193 billion. Based on the theoretical approach that poor is always more vulnerable with low capacities for risk reduction measures, for instance, Grenada's losses of 919 US$ million as a result of Hurricane Ivan in 2004 were equal to 2.5 times its GDP. Figures state that between 1988 and 2007, 76% of all disaster events were hydrological, meteorological or climatological in nature; these accounted for 45% of the deaths and 79% of the economic losses caused by natural hazards.

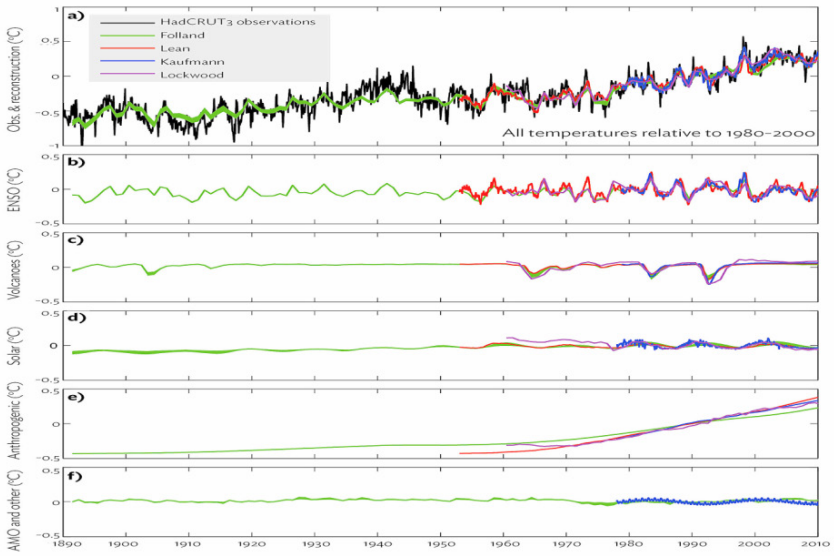
Since 2000, over 1 million people worldwide have died from nature-rooted disasters, with the cost of damage estimated at over $1.7 trillion (Guha-Sapir et. al. 2015). From 1970 to 2008, over 95% of deaths from disasters occurred in developing countries (IPCC 2012). Between 2000 and 2009, a third of global disasters and almost 80% of deaths occurred in the 40 countries that received the most humanitarian aid (Kellet and Sparks 2012). The IPCC has a rich number resources to follow the data in link with the impact of the climate change, which is available at https://www.ipcc.ch/report/ar6/syr/.

The number of people affected by disasters, mainly that of hydrological hazards, has also been increasing. Before the 1990s, 5-year averages did not reach 50 million people. This figure doubled after the 1990s, and was mostly over 100 million until 2014 (See Figure 2). Figure 3 also shows the fluctuations in the global mean temperature as part of the El Nino.



Note: The number of people affected is based on a 5-year moving average.
Source: Centre for Research on the Epidemiology of Disasters. Emergency Events Database (EM-DAT). http://www.emdat.be (accessed 5 March 2015).

Figure 2: The number of people affected by nature-caused disasters: Global Trends (1970-2014)



°C = degrees Celsius, AMO = Atlantic Multi-decadal Oscillation, ENSO = El Niño-Southern Oscillation.
Source: IPCC 2013.

Figure 3: Contributions to Global Mean Temperature Change (1890–2010)

Some recommendations are made by using the scientific evidence to support climate change adaptation for a safer World (Counting the Cost, 2022)

- Countries must urgently cut greenhouse gas emissions.
- Economically strong countries need to provide more funding to support vulnerable communities living in poorer countries to help

them adapt and build resilience to the impacts of climate change.

- Following COP27 to establish a Loss and Damage fund, governments need to work out how the fund will be governed and who will contribute funding and at what levels. It is recommended that the 'polluter pays' principle should be the cornerstone.
- The new Loss and Damage fund needs to provide money to those affected by climate impacts. Governments need to recognise that insurance approaches - including the Global Shield - will never represent a holistic approach to dealing with Loss and Damage.
- All governments must invest in the energy transition to renewables.

2. Climate Change Adaptation and Disaster Risk Reduction

Climate change can affect disaster risks in twofold. First, through the likely increase in weather and climate hazards and second through increases in the

vulnerability of communities to natural hazards. Challenge of increasing risks due to climate change makes it harder to implement and achieve Sustainable Development Goals (SDGs). Post 2015, the declaration of the Sendai Framework for Disaster Risk Reduction (SFDRR), the Paris Agreement on climate change and 2030 Sustainable Development Agenda, became inseparable documents and resource for scientists and policy makers. Figure 4 below picturises the integration and coherence of the Sendai targets, SDGs and climate action.

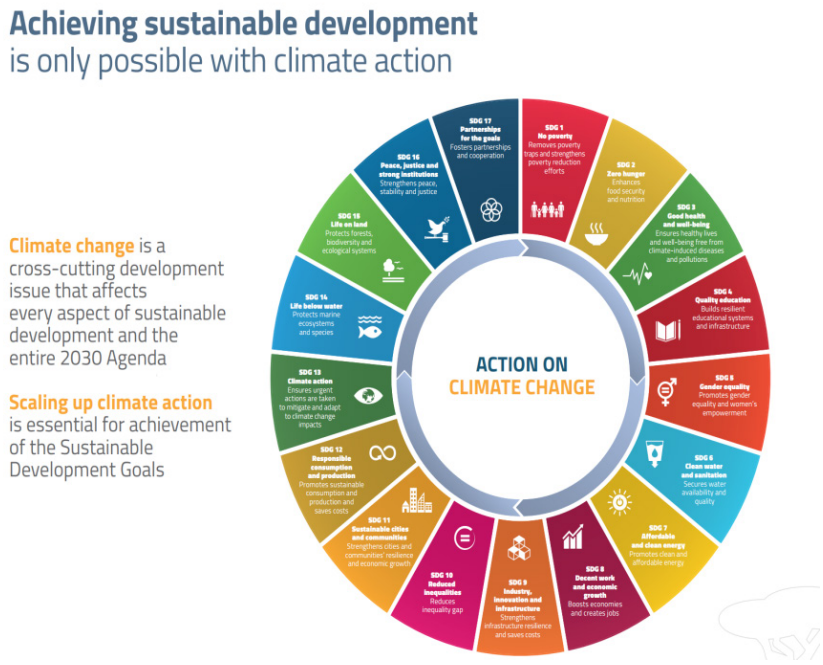


Figure 4: The link between sustainable development goals and climate change

Source: UNDP (2016)

Stakeholders, mainly national and local governments, define three main areas of coherence between the climate change adaptation (CCA) and disaster risk reduction (DRR). These can be listed as:

- Strategic: Goals and priorities in CCA and DRR in local and national development plans,
- Operational: Policy frameworks and institutional arrangements to support CCA and DRR,
- Technical: To strengthen technical capacities to assess risk and opportunities, to identify and to prioritise DRR and CCA measures and to finance them.

	Sustainable Development Goals	Paris Agreement on climate change	Sendai Framework for Disaster Risk Reduction
Background	Global agenda for action towards sustainable development	Agreement on the global response to climate change; adaptation, mitigation and finance	Global framework to guide multi-hazard management of disaster risk
Climate change adaptation and disaster risk reduction	Climate action and disaster risk reduction are cross-cutting issues, but explicitly mentioned in: – Goal 13 to combat climate change and its impacts, – Goal 11 to make cities inclusive, safe, resilient and sustainable. Climate action also contributes to the achievement of many of the other goals	Articles 7 and 8 explicitly focus on CCA and DRR: – Article 7.1, on enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change – Article 8.1, on averting, minimising and addressing loss and damage associated with the adverse effects of climate change	Paragraph 13 recognises climate change as a driver of disaster risk, and points to the opportunity to reduce disaster risk in a meaningful and coherent manner

Figure 5: Overview of the Sustainable Development Goals, the Paris Agreement and the Sendai Framework

Source: OECD, 2019.

Below Figure 6, briefly summarises and links the 7 Sendai targets with the SDGs. There is social, economic and governance strategies to take place by 2023.

Source: Prevention Web, *Integrated monitoring of the global targets of the Sendai Framework and the Sustainable Development Goals*

Figure 6: Sendai Targets and SDGs

Countries are trying to find was to deal with the climate change problem in line with the DRR. The first thing to address the root cause is generally to suggest to try to reduce down the greenhouse gas emissions resulting from

human activities. This is the mitigation phase of disaster risk management cycle, where action is taken in the ex-ante period. IPCC defines mitigation as "*an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks*" in the context of climate change. Examples of mitigation actions include developing new low-energy technologies for industry and transport, reducing consumption of energy-intensive products, and switching to renewable forms of energy, such as solar and wind power. IPCC also defines the adaptation as "*the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities*", where examples of it may include preparing risk assessments, protecting ecosystems, improving agricultural methods, managing water resources, building settlements in safe zones, developing early warning systems, instituting better building designs, improving insurance coverage and developing social safety nets. These are naturally are linked to SDGs.

Disaster risk reduction takes place in the Hyogo Framework for Action (HFA) 2005-2015. Then in the Sendai Framework 2015-2030, the idea is supported by building resilient communities and nations considering the full disaster risk management cycle; before, during and after phases. Climate-related hazards and disasters can hit the vulnerable parts of the communities as anticipated. These can be people with disabilities, elderly, children and other vulnerable groups. Response to climate-related hazards and disasters, and mitigation of their impact, requires cross sector engagement. The way to achieve SDGs require interventions beyond emergency response, to improve resilience among communities, including poverty reduction strategies, economic development measures to promote sustainable communities, infrastructure to reduce risk in cities, and the active involvement of persons with disabilities to address existing barriers. Moreover, in the recovery phase, build back better principle should guide the process, the work to improve existing conditions without creating new barriers to any vulnerabilities. By 2030 and beyond until 2050, climate change adaptation actions and disaster risk reduction strategies go hand in hand to achieve resilience at all levels in multi-sectoral approach. Perhaps, in terms of disaster science and studies, the pivotal SDG can be outlined as Goal 17, where international cooperation and coordination is required for good governance and process.

3. Conclusion

Climate change is not a disaster itself but it is a very important triggering impact to cause the change in the frequency and severity of disasters around the World. Some of these disasters can occur as sudden (rapid) onset whereas some can happen as slow onset. Our roles as disaster scientists, climatologists, policymakers and individuals are to be aware of the changing and surrounding risks, prepare for them, respond to them when and if they occur, and recover and rehabilitate as quick as possible afterwards. Climate change adaptation, disaster risk reduction, disaster risk governance and development are inseparable components, actors of the way paved to reach resilient communities and countries.

Data plays a crucial role in achieving targets and goals, which are set to reduce risks and impacts of disasters including climate change effect. If we have quality and sustainable climatic and disaster-related data, decision making process before, during and after a disaster event will be eased smoothly and safely. We should all aim to collaborate, cooperate and coordinate to prepare for safer and better future for all of us.

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