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The Impact of Climate Change on Fire

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Abstract

Purpose: Climate change is greatly affecting the frequency and intensity of fires around the world. The main effects of climate change on fires are rising temperatures, dry seasons and extreme droughts, changes in precipitation, increased strong winds, extended fire danger periods, and changes in natural ecosystems. Several factors due to climate change are increasing the risk of large-scale fires, such as wildfires. **Research design, data and methodology:** Rising temperatures caused by climate change will make forests and grasslands drier, make it easier for wildfires to occur in drier environments and spread quickly to wider areas, and the generated wildfires will release large amounts of greenhouse gases into the atmosphere, such as carbon dioxide (CO₂), and the released greenhouse gases will strengthen the global greenhouse effect, further raising the temperature. As temperatures rise, the risk of wildfires increases in drier environments, and this process is repeated, leading to a vicious cycle of intensifying climate change as more fires occur and more greenhouse gases are released. **Results:** In conclusion, climate change is increasing the risk of fire occurrence and this phenomenon is expected to become more frequent and severe in the future. **Conclusions:** In order to cope with the increasing fire risk caused by climate change, fire prevention and management. Fire detection and response systems need to be strengthened, supportive policies and international cooperation are needed to restore ecosystems, and these measures, along with fire prevention, management and countermeasures, should take into account long-term climate change and adaptation as well as short-term responses.

Keywords : Climate change, global surface temperature rise, Ecosystem restoration, AI, ICT

JEL Classification Code : Q54,Q56,Q57,Q58,Q59

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1. Introduction

Global warming is a phenomenon in which the global temperature increases as the concentration of greenhouse gases such as carbon dioxide in the atmosphere increases due to human activities. This phenomenon has a great influence on human life and natural ecosystems, and the frequency and intensity of natural disasters are increasing due to climate change, and heat waves and droughts are frequent due to the climate crisis, and wildfires are increasing as a result.

According to the 2022 U.N. Environmental Program (UNEP) wildfire report, the frequency of wildfires in 2040-2050 is expected to be 27% more frequent than in 2010-2020, and the figure will soar to 57% in the far future (2090-2100). Wildfires can be the greatest threat to destroying our daily lives.

Therefore, wildfires are both a result and a cause of climate change.

If the temperature of the place where the fire occurs rises, the activation energy of the combustion reaction by the ignition source decreases and the moisture content of the combustible product decreases, thereby increasing the probability of fire occurrence. With this logic, the impact of the climate crisis on fire can be estimated by delaying.

Since some time ago, wildfires, large and small, have been continuously occurring throughout the world. Since the beginning of this year, large and small wildfires have occurred in various places in Korea. What is the cause of these frequent wildfires? Global warming gradually slows the global atmospheric circulation, reducing the temperature difference between the equatorial and cold polar regions, making it difficult to extinguish wildfires.

Researchers at Columbia University said that in recent years, global warming has caused major wildfires in California to rise by one to two degrees Celsius. The damage caused by wildfires is direct to animals, plants, and people, but we need to think about how they will harm the Earth. Climate change will continue to pose new threats to nature and people. Even if we no longer emit artificial greenhouse gases, various climate change and its effects will continue to appear over the centuries to come.

Global warming can be accelerated by frequent occurrences of large-scale forest fires. Forests emit a lot of carbon dioxide as they burn. And when wildfire smoke blows through the wind to the Arctic ice sheet, the soot falls on the glacier and absorbs the sun's light, allowing the glaciers to melt faster. Additionally, abnormal high temperatures and droughts caused by climate change can lead to a vicious cycle in which climate change accelerates as well as more frequent wildfires in the future.

2. Literature Review

2.1. The Cause of a Fire

2.1.1. A fire caused by an abnormal climate

Global warming is a phenomenon in which the global temperature rises as the concentration of greenhouse gases in the atmosphere, such as carbon dioxide, increases due to human activities. This phenomenon has a great influence on human life and natural ecosystems, and the frequency and intensity of natural disasters are increasing due to climate change, and heat waves and droughts are frequent due to the climate crisis, and wildfires are increasing as a result.

According to the 2022 U.N. Environmental Program (UNEP) Wildfire Report, wildfires are expected to be 27% more frequent in 2040-2050 than in 2010-2020, and the figure will soar to 57% in the far future (2090-2100). Wildfires can be the greatest threat that destroys our daily lives. Wildfires are both the result and cause of climate change.

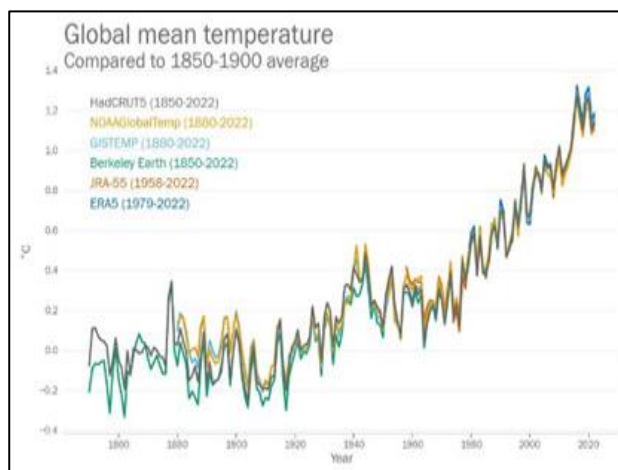


Figure 1: An increase in global average temperature

2.2. The Effects of Forest Fires

2.2.1. Carbon emissions

Wildfires emit large amounts of carbon dioxide. Carbon dioxide is a greenhouse gas that affects climate change, so carbon emissions from wildfires can accelerate climate change.

2.2.2. Air pollution

Wildfires generate large amounts of smoke and ash. Smoke contains carbon monoxide, nitrogen oxides, microparticles, etc., which can cause respiratory diseases and other health problems and weaken air quality.

2.2.3. Soil degradation, Water pollution, Ecosystem degradation

Wildfires erode soil, reduce soil drying and hydration capacity, and mix smoke and ash from wildfires can lead to water pollution and reduce biodiversity due to ecosystem destruction.

2.2.4. Casualties

Exposure to flames and smoke can cause physical damage such as burns and can lead to large-scale disasters

2.3. Cause of the Increase in Forest Fires

2.3.1. An increase in the temperature of the earth's surface

When looking at the average temperature in spring, where 65% of wildfires occur, the average temperature in spring rose 1.2°C from 11.6°C in 1973 to 12.8°C in 2021. Last year's average temperature in spring was also the fifth highest ever. 2023 was the hottest year, and it can be said that climate disasters such as heat waves, wildfires, and droughts were directly or indirectly felt.

2.3.2. Greenhouse gases and global warming produced by carbon

In order to reduce carbon emissions, the world is declaring 'carbon neutral' and eliminating fossil fuels that emit large amounts of carbon. In Korea, it is essential to close down coal power plants that emit about 26% of all greenhouse gases.

2.3.3. Natural factors

Natural factors include lightning and volcanic eruptions. Lightning is one of the main causes of wildfires, which can cause fires as they spark.



Figure 2: The dried-up Titicaca

3. Research Methods and Materials

3.1. Examples of Wildfire

3.1.1. Wildfires in Uljin, Samcheok

It is a large forest fire that occurred in Uljin, North Gyeongsang Province, and Samcheok, Gangwon Province for nine days from March 4 to March 13, 2022. The Uljin and Samcheok wildfires began at 11:17 a.m. on March 4 in Buk-myeon, Uljin-gun, and spread rapidly due to dry weather with strong winds exceeding 20m per second. The forest fires burned 20,000 ha of forest and completed extinguishing in 213 hours and 43 minutes, making them the longest-lasting forest fire since 1986, when the Korea Forest Service compiled related statistics. The cause of large-scale products that occurred simultaneously in Uljin and the East Coast area is the first fire on the side of the road, so there is a possibility of a misfire caused by cigarette flames, but the reason for the expansion of forest fires is the severe winter drought and strong winds that have come in 50 years. According to climatologists, if the temperature rises due to climate change, the evaporation of water vapor increases, which dry the soil and others, which in turn increased the damage of forest fires along with climate change.

3.1.2. A large forest fire in Gangwon-do in 2019

The start of the large forest fire that hit Goseong, Sokcho, Gangneung, Donghae, and Inje in Gangwon-do from April 4 to 5, 2019 was the telegraph pole of Goseong-gun. At that time, the electric wire connected to the switchboard on the telephone pole is believed to have been shaken badly by strong winds and then caught fire. The flame spread rapidly as it spread to nearby hills by strong winds that reached 35.6 meters per second, spreading into two branches of Saturn-myeon and Sokcho-si, and the area affected rapidly increased as the fire spread by hundreds of meters. The forest fire spread rapidly due to strong winds, failing to extinguish the initial fire and spreading to the downtown of Sokcho and the coast less than an hour after the fire broke out, and local governments even ordered residents to evacuate.

Another cause was a strong wind called the Yangganji Wind. The Yangganji Wind is a local strong wind blowing between Yangyang and Ganseong, and the mobile high pressure in the south of the Korean Peninsula in spring occurs in the high-and-north low-pressure system, where the low pressure is located in the north. In this atmospheric pressure arrangement situation, the moment the wind blowing from the west crosses Taebaek Mountain, which is a high altitude, the pressure increases and turns into a high-temperature and dry strong wind.

3.1.3. Australian forest fires

It is a large-scale forest fire that occurred on September 2, 2019, in southeastern Australia and extinguished on February 13, 2020. The haze spread not only to Australia, but also to neighboring countries and continents, causing problems in several countries, such as abnormal high temperatures and spreading to New Zealand and South America, the Pacific coast, and the Bay of Tokyo. A large forest fire damaged 500 million animals, destroyed 28% of the Korean Peninsula, and killed 340,000 people, including firefighters. Furthermore, nearly 450 people died, including suffocation from smoke.

The main causes of wildfires are various, and one of them was the climate change caused by global warming. Analysts say that climate change has created an environment that can occur due to forest fires, which has led to rising average temperatures and decreased precipitation. In particular, Australia is one of the dry continents, and it was said that it was difficult to extinguish fires due to continuous high temperatures and drought. The forest fires caused huge economic losses to Australia as a whole, and the destruction of the ecosystem due to the death of wildlife such as koala kangaroos was also serious. And there are concerns that drinking water could also be problematic due to fine dust generated from forest fires.

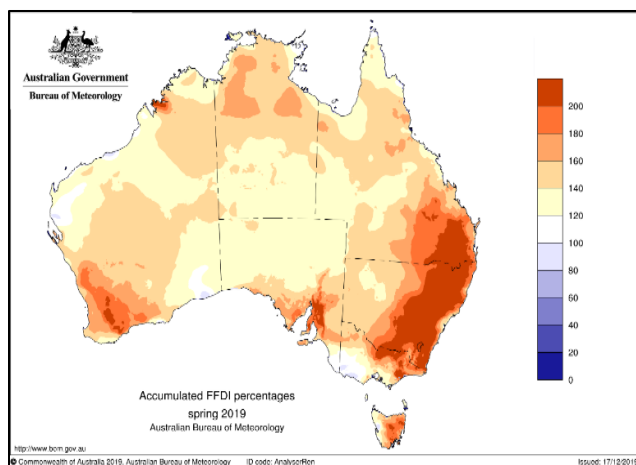


Figure 3: Accumulated FFDI percentages spring 2019

3.1.4. Greek forest fires

In 2021, Greece saw its worst wildfire since 2007. Thousands of people were evacuated as wildfires spread out of control on the Greek island of Evia, the second largest. Heat waves and strong winds caused a series of fires, burning many homes and crops, and causing casualties. The World Meteorological Organization blamed global warming.



Figure 7: August 3, 2021 at the scene of the Evia Island fire

4. Results and Discussion

Fire response measures are as follows.

4.1. Fire Prevention and Management

4.1.1. Strengthen forest fire and prevention policies

To prepare legal regulations and management measures to reduce the occurrence of forest fires in dangerous areas. For example, management of flammable substances and strengthening regulations on the use of firearms in densely populated areas such as campsites.

4.1.2. Vegetation management

In forest areas, substances that can be used as fuel should be removed through regular management activities such as removing leaves from vegetation and cleaning branches. It is also an important way to prevent the spread of fire by building fire lines.

4.1.3. Community education

No illegal incineration through education and campaigns for fire prevention. It can be effective to educate such as how to manage embers.

4.2. Strengthen fire detection and response systems

4.2.1. An early warning system

We need to build a system that can detect wildfires early and respond quickly by using satellites, drones, surveillance cameras, and sensors. It is important to extinguish fires when they are small through early warning systems.

4.2.2. Strengthening Fire Resources

Strengthen firefighting personnel and equipment in areas where wildfires occur frequently so that they can respond quickly in the event of a fire. In particular, it is essential to extinguish the fire in the air by using helicopters or airplanes.

4.2.3. An efficient fire control strategy

In the event of a fire, effective extinguishing strategies should be established in consideration of wind and climate conditions, and studies ways to block the fire should be conducted.

4.3. Climate Change Mitigation

4.3.1. A reduction in greenhouse gases

Reducing greenhouse gases is the best way to curb climate change. Policies that reduce the use of fossil fuels, expand the use of renewable energy, and increase energy efficiency are needed, especially in line with the goals of the Paris Agreement.

4.3.2. Protection of carbon sinks

Forests play an important role in absorbing carbon dioxide in the atmosphere. Forest protection and tree planting can increase carbon sinks and reduce carbon emissions from wildfires.

4.4. Climate Change Adaptation Strategy

4.4.1. Fire Protection Design of Buildings

In areas with high fire risk, it is important to design fire-resistant structures and use building materials and structures as fire-resistant materials. This will protect your dwelling place from fire.

4.4.2. Strengthening the Resilience of the Community

It is necessary to strengthen the capacity of communities to minimize damage after fires and increase resilience. This includes disaster evacuation drills, emergency evacuation plans, and rapid reconstruction plans.

4.5. Ecosystem Restoration

4.5.1. Restoring Ecosystems After Fire

In areas where fires have occurred, the process of restoring ecosystems is important. In particular, forest fire prevention technology.

It is necessary to share monitoring and response strategies, and to establish an international support system for fighting fires.

4.5.2. Introduction of Fire-Resistant Plants

It is possible to study and apply ways to reduce damage in the event of a fire by introducing fire-resistant plant species in areas with a high risk of fire.

4.6. International Cooperation

International agreements and joint action aimed at mitigating and adapting to climate change are essential to address the fire problem. Cooperation and responsible action between countries should be emphasized through international agreements such as the Paris Agreement.

5. Conclusions

According to a study by the Korea Forest Service, wildfires are becoming more frequent and spreading to large-scale fires due to accelerating global warming. It is pointed out that it is urgent to come up with measures to reduce forest fire damage, given that high-temperature drying phenomenon intensifies in spring and summer, and climate change such as small precipitation is likely to occur more often and spread to large fires in winter.

Over the past 30 years, Korea's temperature has risen by 1.4°C from 1921 to 2017 and the precipitation in the last three years has been 107.5mm. The amount of precipitation in the winter of 2021 was 13.3mm, the lowest winter measure ever recorded after weather observation. From February to April 2023, the precipitation was very small, so the southern and central regions suffered from drought, and during this period, many large-scale forest fires occurred nationwide. The smoke and carbon dioxide generated by the forest fires further accelerate global warming.

Therefore, as global warming progresses, the frequency and intensity of forest fires increase, and it takes a lot of time to restore forests lost by forest fires. Global warming will be repeatedly aggravated by the disappearance of forests, which will harm human health ecosystems.

Climate change caused by global warming is closely related to an increase in the risk of wildfires. To solve this problem, it is important to prevent global temperature rise and maintain a healthy ecosystem. Policy responses such as air pollution regulation and energy policy improvement are also needed.

All countries in the world, including Korea, are directly affected by climate change and fires, and this is limited by government responses alone, requiring national attention and participation. These measures should consider both long-term climate change mitigation and adaptation as well as short-term responses.

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