2024年臺灣國際科學展覽會
優勝作品專輯

作品編號　180018

參展科別　地球與環境科學

作品名稱　Climate Change Brings New Novel Virus

得獎獎項　四等獎

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Climate Change Brings New Novel Virus.

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Ⅰ. Abstract

1. **Research Motivation**

Have you ever seen news stating that spring is gradually disappearing from the Korean Peninsula? The characteristics of the four seasons are disappearing due to the impact of global warming. As supporting evidence, droughts and heatwaves continue during the rainy season, and unexpected heavy rainfall occurs during autumn. These abnormal temperature phenomena are greatly affecting agriculture. Crops wither due to untimely cold spells or summer droughts, and the proliferation of bacteria and pests worsens. We need to conduct a thorough investigation and response to such weather phenomena. Carbon is known to be the main culprit behind these abnormal temperature phenomena. We want to explore how carbon affects climate change and understand the implications it has.

2. Research Objectives

The consequences of climate change, such as deforestation and rising sea levels, will cause significant damage to society as a whole. This will also have a profound impact on the survival of all living organisms on Earth. Unless industrialization is halted, global warming will continue, making it crucial to gain a proper understanding and find accurate alternatives.

The damages caused by global warming are expanding the habitats of mosquitoes, which is expected to have an impact on the spread of mosquito-borne diseases. This can also influence the emergence of novel viruses similar to COVID-19. By examining past outbreaks of diseases transmitted by mosquitoes, we aim to predict and understand such occurrences, as well as explore ways to minimize global warming.

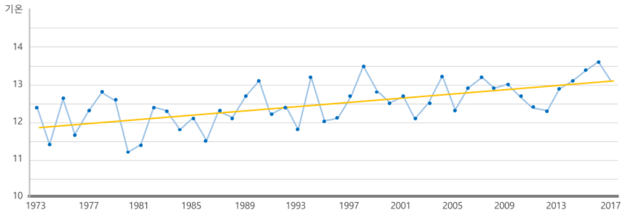
3. Expected Benefits

Based on this research, a focused exploration of the ecological impacts of global warming can provide essential data to understand the effects of climate anomalies on us and prepare for them. As these phenomena are expected to worsen over time, it will be possible to develop measures to minimize the damage caused by bacterial infections and agricultural losses.

Ⅱ. Main Body 1: Climate Change on the Korean Peninsula

According to the Korea Meteorological Administration, the average annual temperature observed at 60 locations nationwide from 2000 to 2009 increased by 0.5 degrees compared to the long-term average (1971-2000) of 12.3 degrees. As temperatures rise, spring and summer are starting earlier, while the onset of autumn and winter is being delayed. The Korea Meteorological Administration defines summer as having a daily average temperature above 20 degrees Celsius and winter as having a daily average temperature below 5 degrees Celsius. When comparing the duration of seasons in Daegu between the 1910s and the 2000s, it is observed that in the 2000s, summer extended by 20 days compared to the 1910s, but winter shortened by 30 days. If this trend continues, it is projected that by 2090, Seoul will experience an increase of 20 days in summer and a decrease of 36 days in winter compared to 1990. During the period from 1987 to 2017, the precipitation in the past 30 years increased by 124mm compared to the early 20th century.

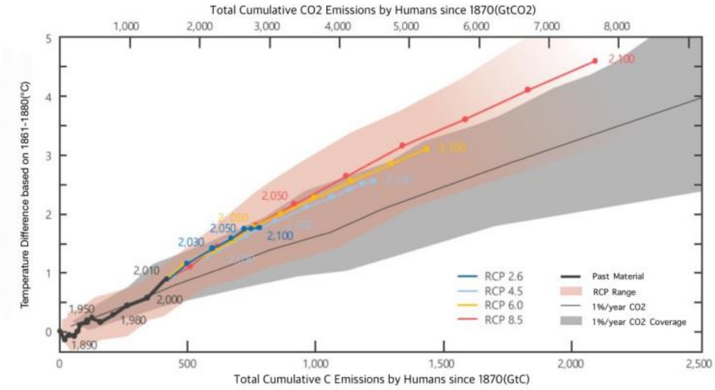
<Figure 1> Changes in the Average Annual Temperature in South Korea (1973-2017)



<Sourced from: Korea Meteorological Administration>

In 2016, while the global average temperature reached a record high, the average annual temperature in South Korea also reached its highest point since 1973, recording 13.6°C, which was 1.1°C higher than the long-term average (12.5°C).

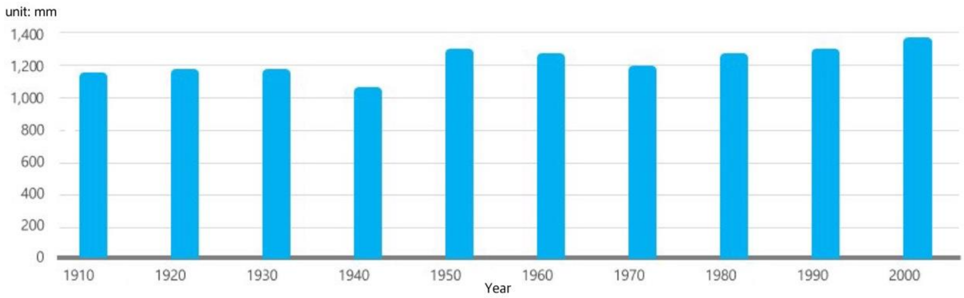
<Figure 2> Global Temperature Increase Projections Based on Carbon Dioxide (CO2) Emissions



<Sourced from: Working Group I Fifth Assessment Report: Summary for Policymakers, IPCC(2013) translated version, Korea Meteorological Administration (2013)>

According to the IPCC AR5 report, the global average temperature in the late 21st century and beyond is projected to rise in proportion to the cumulative emissions of carbon dioxide (CO_2). Under the RCP 8.5 scenario (which represents the current trend of greenhouse gas emissions), it is projected that by the year 2100, the global average temperature will increase by approximately 4.7°C compared to the past (1861-1880). On the other hand, under the RCP 2.6 scenario (which assumes that the Earth is capable of self-recovery from human-induced impacts), it is projected that by 2100, the global average temperature will increase by 1.8°C.

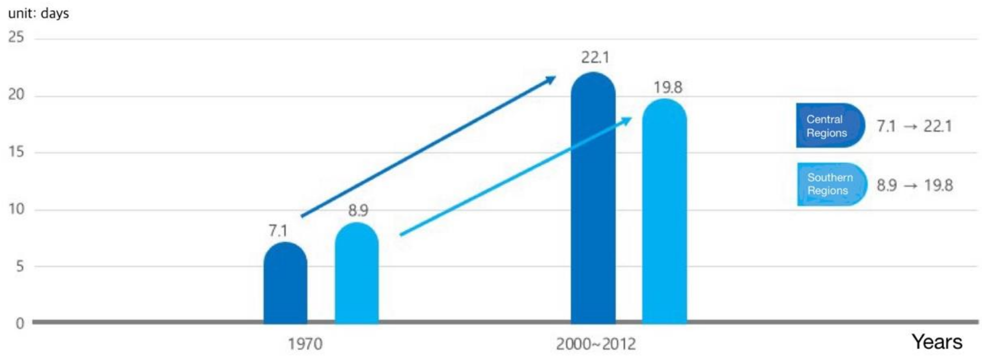
<Figure 3> Urban Precipitation Changes (Decadal Average Precipitation)



<Sourced from: Understanding Climate Change II - Climate Change on the Korean Peninsula: Present and Future, National Institute of Meteorological Research (2009)>

Regarding rainfall data over the past 100 years (1912-2008), when examining the decadal average precipitation as a time series in six observation points with long-term data (Seoul, Incheon, Gangneung, Daegu, Mokpo, Busan), it shows a generally increasing trend compared to 1910, with the exception of the 1940s and 1970s.

<Figure 4> Number of Concentrated Heavy Rainfall Days on the Korean Peninsula



<Sourced from: Abnormal Climate Report>

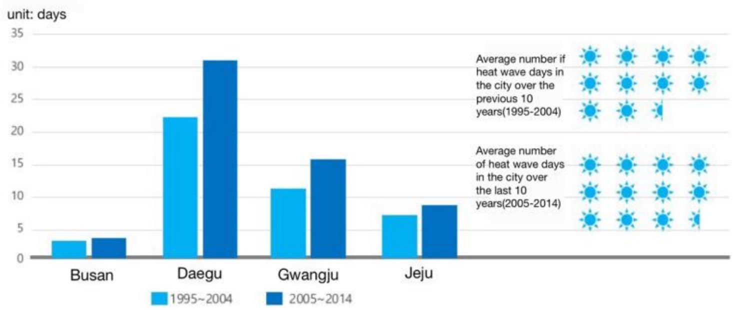
In the southern regions such as Jeolla, Gyeongsang, and Jeju, the number of concentrated heavy rainfall days (daily precipitation exceeding 80mm) increased by 2.2 times from 8.9 days in the 1970s to 19.8 days in the 2000s. In the central regions such as Gyeonggi, Gangwon, and Chungcheong, the number of concentrated heavy rainfall days increased by 3.1 times from 7.1 days in the 1970s to 22.1 days in the 2000s.

Main Body 2: Impacts of Climate Change on Humans

Climate change can lead to decreased crop yields and livestock losses, and it has a critical impact on regional food security. Climate change affects not only household purchasing power, food markets, and food security but also human health and livelihoods.

For the well-being of humans, ensuring an adequate water supply is essential. Rivers and lakes supply water to humans and animals, and they are essential for agriculture and industries. Globally, climate change will have unpredictable and significant impacts on freshwater systems. There will be increased occurrences of floods and droughts, leading to conflicts and tensions over water resources, as well as potential displacement of local communities. Water scarcity will have implications for agriculture, food security, and income.

<Figure 5> Changes in the Annual Average Number of Heatwave Days in Major Cities



<Sourced from: Korea Meteorological Administration, National Climate Data Center>

In the recent 10 years, the annual average number of heatwave days in 7 major cities was recorded as 11.3 days. This shows an increase of 0.9 days compared to the previous 10-year average of heatwave days (10.4 days).

2-1-1 Increase in Infectious Diseases

Climate change can potentially alter the distribution of certain diseases. Disease vectors that carry pathogens can respond sensitively to temperature, humidity, and rainfall, spreading diseases to new areas. Examples of such vectors include mosquitoes that spread malaria, dengue fever, and yellow fever, sand flies that transmit leishmaniasis, and ticks that carry Lyme disease and tick-borne encephalitis.

Climate change can lead to more frequent occurrences of extreme weather events such as wildfires, droughts, and flooding. Displaced wildlife seeking new habitats may come into contact with human-populated areas or livestock farms, increasing the likelihood of viral infections in humans. The Nipah virus, a novel virus causing encephalitis, emerged in Malaysia in 1998-1999 and resulted in over 100 deaths. According to research published in the Malaysian Journal of Pathology, the virus, known to have fruit bats as its reservoir, infected pigs when bats were displaced from their habitats due to wildfires and droughts, and subsequently spread to humans.

Notably, blood-sucking insects like mosquitoes play a significant role in transmitting vector-borne diseases. Over 4 billion people reside in areas heavily affected by dengue fever worldwide. As the habitats of mosquitoes that primarily live in hot regions expand due to global warming, the viruses they carry also spread globally. For instance, the chikungunya virus spread from Africa and Southeast Asia to the subtropics and the Zika virus spread from Africa to the Americas. The West Nile virus was transmitted from Uganda to Canada.

The current climate change-induced conditions such as rising temperatures, increasing sea temperatures, changes in rainfall patterns, and higher humidity have created suitable environments for disease-spreading mosquitoes, including those carrying malaria and dengue fever. The most severe outbreaks of dengue fever occurred in the past decade, primarily between 2009 and 2019. With the current rise in global average temperature by 1.1 degrees compared to pre-industrial levels, the expectation is that infectious diseases caused by viruses and other pathogens will continue to increase.

The World Health Organization (WHO) expresses concerns about the potential explosive spread of the Zika virus in various regions due to the influence of El Niño. As the Zika virus is primarily transmitted by the Aedes mosquito, which inhabits tropical regions, the population of mosquitoes is directly related to the spread of the virus. CNN also explains that during El Niño events, temperatures rise, and precipitation patterns change in South American regions, leading to an increase in mosquito populations and creating an environment conducive to the outbreak of mosquito-borne diseases.

2-1-2. Relation Between Rising Temperatures and Mosquitoes in Infectious Diseases

When the monthly average maximum temperature exceeds 22.6°C, it is optimal for the development of mosquito larvae and the survival of adult mosquitoes. This finding aligns with previous studies that confirmed the favorable ecological conditions for mosquitoes, which found that the optimal temperature for the Japanese Encephalitis Virus (JEV) vector mosquitoes is between 22.8°C and 34.5°C. Viruses are incomplete organisms that cannot survive without a host. They are transmitted through host cells, with mammals such as humans and animals acting as hosts. Therefore, mosquitoes can transmit viruses for which there is a suitable host, such as dengue fever, Zika virus, malaria, West Nile fever, Japanese encephalitis, and yellow fever.

Recently, the World Health Organization (WHO) stated in its "Mythbusters" corner regarding COVID-19 that there is no evidence or information suggesting transmission through mosquitoes. This viewpoint is also echoed by authoritative figures both domestically and internationally.

2-1-3. Association Between Climate Change and Changes in Mosquito Habitats

The Zika virus, first discovered in Central Africa in 1947, initially remained dormant only in primates. It wasn't until seven years later, in 1954, that it started infecting humans. However, as the symptoms such as fever, headache, rash, and joint pain were mild, Zika was considered less harmful compared to the closely related dengue fever virus. However, after its initial discovery and a long period of time, Zika started showing destructive and devastating consequences. Until its global spread began around 2007, Zika outbreaks mostly occurred in Central Africa and French Polynesia (an overseas territory of France located in the South Pacific). This was primarily due to the large populations of mosquitoes carrying the Zika virus in the regions classified as the most humid and tropical on Earth.

Mosquitoes are considered the primary vectors for the Zika virus. It has been identified that a total of seven different mosquito species can carry the Zika virus. Under normal climatic conditions, the activity range of disease vectors such as insects remains relatively stable. However, the current global climate is not stable. Since 1880, the Earth has been warming, and the activity range of mosquito vectors has been expanding. Over the past 136 years, as the Earth has become 1°C warmer, the activity range of the Egyptian mosquito, which is one of the most important vectors for the Zika virus, has been expanding from tropical regions towards higher latitudes.

Not only has the activity range of these disease vectors increased, but their activity periods have also lengthened. Areas where mosquitoes carrying the Zika virus were observed for 1-2 weeks per year are now experiencing observations for 1-2 months, and areas where observations lasted for 1-2 months are now experiencing observations for over 6 months. The expanded geographical and temporal exposure to the Egyptian mosquito is one of the dangerous epidemiological shocks resulting from climate change. Diseases have emerged from distant wetlands due to climate change, and as the regions where disease vectors can survive have rapidly expanded, humans have been exposed to disease vectors more frequently. Essentially, this is a consequence of global warming caused by climate change. Many vectors, including mosquitoes, are spreading previously unknown diseases globally.

Between 2007 and 2016, variants of forest mosquitoes moved away from regions where they traditionally resided during the 20th century and spread along hot and humid climates. In 2007, the variants of forest mosquitoes first spread from Central Africa and the Federated States of Micronesia, specifically in Yap. By 2014, they had expanded their range to Easter Island, a wide area in Polynesia, the Cook Islands, and New Caledonia. In 2015, with the record-setting highest global temperatures, Zika spread again from Pacific islands to Brazil and the Caribbean. It then further spread to extensive areas in Central and South America.

The increase in global average temperature due to global warming creates a highly favorable environment for bacterial habitats and affects the survival, hatching, growth rate, and activity range of insects. In particular, insects like mosquitoes and ticks, which lack temperature regulation mechanisms, experience faster growth rates as temperatures rise. This means that the lifespan of each individual may decrease, but the overall population of vectors is increasing.

<Table-1> Mosquitoes Transmitting Infectious Diseases

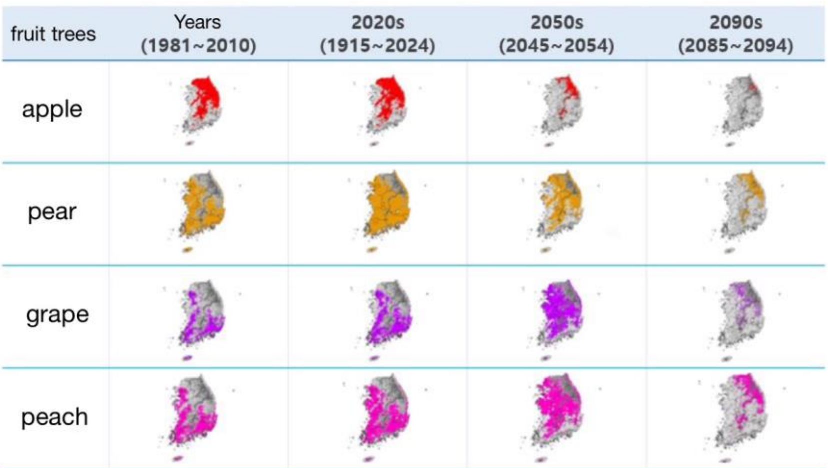
	Habitat	Infectious Disease	Habitat Changes	Symptoms
Asian tiger mosquito, Aedes aegypti 	Nationwide in Korea, Japan, Taiwan, France, Australia, Hawaii, etc., inhabiting forests or residential areas near forests.	Yellow fever, dengue fever, chikungunya fever, Zika virus infection	While originally found in Southeast Asia and West Africa, it can now be found worldwide due to habitat changes. It has spread to many countries globally through the transportation of goods and increasing international travel.	1. Zika virus incubation period: 2-14 days. 2. Major symptoms: Fever, rash, joint pain, conjunctivitis, and eye redness.

Culex mosquito species 	They inhabit rice fields, animal sheds, puddles, and similar environments in the southeastern Asia region where Korea is located.	Malaria	Recently, due to climate change, specifically global warming, they are occurring in wider areas. As temperatures rise, their habitats are expanding to more northern and higher-altitude regions.	1. Malaria incubation period: 8-25 days 2. Malaria symptoms: Flu-like symptoms, inflammation, gastrointestinal disorders, headache, fever, joint pain, recurring episodes
Aedes mosquito species 	Throughout the country	Japanese Encephalitis	Recently, with the increase in average temperatures in Jeju Island, the activity period of the small red house mosquito is becoming earlier, and the density of this mosquito species observed throughout South Korea is increasing.	1. Japanese Encephalitis symptoms: 95% of cases are asymptomatic, occasionally accompanied by fever. 2. Early symptoms: High fever, headache, vomiting. 3. Acute phase: Impaired consciousness, seizures, coma, death. 4. Recovery phase: Language disorders, impaired judgment, respiratory failure.
Asian tiger mosquito 	Throughout the country	West Nile Fever	Since 1999, it has been occurring in most tropical regions of the United States and southern regions of Canada. However, due to global warming, its occurrence has increased worldwide.	1. West Nile Fever incubation period: 2 weeks 2. West Nile Fever symptoms: Fever, headache, muscle pain, gastrointestinal symptoms.

2-1-4 Changes in Fruit Tree Habitats

Global warming is also causing changes in the habitats of fruit trees. This can result in significant damage to farmers, especially in agriculture that requires new irrigation facilities. Additionally, the emergence of new fungi and viruses can cause significant harm to farms.

<Table-2> Changes in Fruit Tree Habitats



<Source: Rural Development Administration>

It can be observed that due to global warming, fruit tree habitats are shifting towards the northeast.

2.2 Experiment on the Impact of Carbon Dioxide (CO_2) on Temperature Changes

2.2.1 Hypothesis

Carbon dioxide is the main driver of global warming. Therefore, it is expected that carbon dioxide will have an impact on increasing temperatures.

2.2.2 Materials

Dry ice (carbon dioxide), 4 tanks, 4 incandescent lamps, wrap, 4 thermometers, black paper, stopwatch

2.2.3 Experimental Procedure

1. Place black paper in each of the 4 tanks.
2. Add 0g, 200g, 500g, and 1000g of dry ice to each tank, respectively.
3. Place a thermometer in each tank and adjust the incandescent lamps to approximately 800W for heating.
4. Seal the entrance of each tank with wrap.
5. Record the temperature changes at 1-minute intervals throughout the experiment.

2.2.4 Experimental Results

<Table-3> Experimental Results of Temperature Changes according to Carbon Dioxide

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Dry ice refers to a substance that converts carbon dioxide into a solid state under high pressure and low temperature. From the experimental results, it can be observed that dry ice gradually sublimates, releasing gaseous carbon dioxide, due to the heat from the high-wattage incandescent bulb. Additionally, as the amount of dry ice increases, the amount of carbon dioxide also increases, resulting in a higher internal temperature. This is because an increased amount of carbon dioxide enhances the greenhouse effect, which refers to the trapping of solar energy in the Earth's atmosphere, preventing it from escaping. The increased carbon dioxide in the container traps more heat energy, leading to a rise in temperature.

Through this experiment, it has been discovered that an increase in the amount of carbon dioxide accelerates the increase in temperature.

Ⅲ. Conclusion

3.1 Conclusion and Recommendations

Industrialization cannot be stopped, and as a result, carbon emissions will continue to accelerate. This will lead to a rise in global temperatures, increasing the likelihood of Korea becoming a tropical region. This implies changes in the habitats of insects and animals, as well as the ecological environment of plants. The increase in temperature not only expands the habitats of mosquitoes that transmit infectious diseases but also predicts an increase in insect-borne infectious diseases as summers become longer throughout the year, according to the Ministry of Environment and the Korea Meteorological Administration. This not only applies to mosquitoes but also creates favorable conditions for the proliferation of bacteria and viruses. Emerging viruses can use common mosquitoes found in our surroundings as vectors to transmit diseases to humans, potentially resulting in consequences similar to the Zika virus that claimed many lives.

In search of solutions, we have explored the CRISPR gene-editing technology. Specifically, we have looked into the technology of genetically modifying malaria-carrying mosquitoes into non-malaria vectors, inducing male mosquito infertility by removing specific genetic material associated with reproductive capabilities using this gene-editing tool.

In fact, a field trial conducted in Jacobina, Bahia, Brazil, for one year from June 2013 to June 2014, resulted in a 96% reduction in mosquitoes. In April 2014, it was approved for commercial production by CTNBio (National Technical Commission for Biosecurity). Following this, Oxitec established a GM mosquito production facility in Campinas in July and released them in Bahia. The evaluation was conducted based on Federal Law # 11.105 (2005) by the evaluation committee composed of the University of Sao Paulo and Moscamed. In July 2015, mosquito populations were reduced by 95%, making it one of the most successful experiments conducted to date.

As part of global efforts for decarbonization policies, countries around the world are implementing Green New Deal policies. In preparation for the post-COVID era, these policies aim to promote environmentally friendly and sustainable growth, and transition to a low-carbon economy by reducing carbon emissions through energy conversion, in order to mitigate global warming. Addressing global warming, which can endanger our future lives, is a task that must be resolved, and thorough preparations are necessary for this purpose.

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【評語】180018

Qualitative discussion,lacking quantitative investigation! The conclusions are clear but incomplete!

Strength:

(1) The study included human and agricultural production diseases.

(2) The Literature review highlights infectious diseases, presenting compelling evidence of the rise in cases across various global regions.

Weakness:

(1) The simplicity of the experimental design, aiming to establish a positive relationship between carbon dioxide concentration levels and temperature, does not strongly correspond with the overarching topic of illustrating how a ""new novel virus"" may emerge.

(2) The weakness could be addressed by enhancing the literature review, which currently predominantly covers well-established infectious diseases. This can better clarify which statements are

paraphrased from previous studies and which ones are original points from the authors to avoid the possibility of plagiarism.

(3) The discussions should be considered an increased probability of new viruses, fungi, or antibiotic/antimicrobial resistance in both human and crop populations.