Factors Influencing Global Climate Change

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Abstract:

Crop cultivation has been affected by climate changes and rising temperatures. This study aims to demonstrate the impact of these changes on crop cultivation. The researcher outlined the study's scope in understanding the suitability of climate elements affected by climate change, which include (solar radiation, temperature, rainfall, relative humidity, and wind) with the requirements of these crops for such elements. The emphasis was on temperature due to its significant impact on plant life.

The research included the theoretical framework of the study, covering the problem of the study, its importance, and its objectives. It focused on climate changes, explaining the concept of climate change and its causes, distinguishing between the concepts of change, alteration, and climate variability.

The research paid attention to studying the factors affecting the characteristics of the main climate elements, represented by stable natural factors and dynamic movement factors.

The study reached several conclusions, the most important of which is that climate changes have affected the cultivation of the studied crops by changing the planting dates of these crops during the study period. The study also

revealed differences in the length of the growing season. It was found that the growing season for winter crops has shortened, affecting their characteristics and quality. On the other hand, the growing season for summer crops has lengthened, negatively impacting the cultivation of yellow corn, as it requires a shorter growing season.

Keywords: Climate, Warming Phenomenon, Climate Change, Growing Season.

Introduction:

Climatic studies are one of the most important branches of geographical studies, not only because of the direct and indirect importance of climate in human life and various activities, but also because of the continuous development in these studies

in line with scientific advancement. This has given climatology a distinguished position among geographical sciences on the one hand—as it is a geographical science in terms of its goal, methodology, and treatment—and pure sciences (such as physics, mathematics, etc.) on the other hand. This has led some researchers to link it with meteorology, as climatologists rely on meteorological measurements, which play a role in granting the climate the ability to interpret and explain spatial and temporal variations in weather conditions.

Climate is considered one of the most important natural resources. However, this natural resource has undergone a series of changes over the last decades of the 20th century due to human activities, such as the improper use of natural resources and the increased burning of fossil fuels, which have become necessary for industrial development. This has increased the levels of greenhouse gases in the atmosphere, attracting the attention of scientists and researchers to study and understand the causes in order to find optimal solutions to mitigate or reduce their effects. The phenomenon of global

warming and the resulting climate changes can be considered one of the most pressing issues of our time, as they lead to changes in the environment, including its elements and components, which affect human life and various activities, especially economic and social ones, and particularly in the field of agriculture.

Therefore, the changes in all climate indicators, including temperature, significantly affect the cultivation of field crops. These changes determine the types of crops that can be grown in specific areas and alter the planting dates, characteristics, quality, and classification into summer and winter crops. Identifying the ideal conditions in light of climate changes affects the timing of planting, either earlier or later, as well as the changes in the nature of past, present, and future agricultural land use. The impact of climate changes on the cultivation of field crops was analyzed by determining the suitability path between the climatic requirements of the crops and the actual climate from 1963 to 2012 to identify the most suitable crops for expansion or the introduction of new crops.

First: Study Problem:

The first step in scientific research is to carefully choose and identify the study problem. One of the most challenging tasks for a researcher from the beginning is selecting the appropriate problem. Therefore, each study must have a fundamental problem that drives it.[1] The study problem can be identified by the following question: **What are the factors affecting global climate change**

Second: Importance of the Study:

Climate change is one of the most prominent issues that researchers have focused on globally due to its significant impacts on various aspects of life. This focus has driven geographers to make such studies one of their objectives, as the geographical approach relies on linking and analyzing causes and effects

[1] Al Batyhi, Abdul Razzaq. (1988). Methods of Geographical Research, Dar Al-Kutub for Printing and Publishing, Baghdad, p. 32.

associated with any environmental problem, including this one. Given the changes in weather and climate characteristics witnessed worldwide, the importance of this study emerges through its focus on agriculture. Agriculture is vital for sustaining life, and this problem is one of the most dangerous facing the world. Therefore, attention is directed toward finding different methods and means to reduce its future risks. Such a study will provide a clear picture of the factors influencing global climate change and its impact on agriculture by altering the planting dates of field crops, which naturally affects crop cultivation and production.

Third: Study Objectives:

1. Determine the extent of climate changes in the study area's elements by analyzing statistical data over a long period to understand the general trend of climate elements and phenomena and to establish their temporal trajectory.
2. Highlight the main impacts of climate change on the field crops sector.
3. Reveal the relationship between climatic characteristics and field crop cultivation.

Fourth: Study Methodology:

Geographical research relies primarily on descriptive and analytical methods, as they are fundamental to geographical studies. The systematic approach was used to identify factors of climate change and those affecting the climate. Additionally, the analytical method was utilized to collect data on the studied phenomenon, describe it precisely, and employ quantitative statistical methods in analyzing that data.

Factors Affecting Global Climate Change:

The changes in global climate are the result of civilizational development, particularly after the Industrial Revolution. The problems caused by human activities began to reflect their effects on the main components of the atmosphere, whether in the differing proportions of these components or in their characteristics, thus affecting the waves of solar radiation and terrestrial radiation. This leads to an increase in Earth's atmospheric temperature due to the exacerbation of the greenhouse effect.[2]

The current climate changes are primarily related to human activities. The largest increase in the concentration of gases resulting from human activities occurred between 1970 and 2004, with a rise of 70% compared to the beginning of the 20th century. This was mentioned in the Intergovernmental Panel on Climate Change (IPCC) report[3]. Human activities have changed the content of the atmosphere by increasing the concentration of greenhouse gases. The majority of these gases come from the energy production sector due to the burning of fossil fuels, contributing 25.9% of greenhouse gas sources. This is followed by the industrial sector at 19%, the impact of deforestation at 17.4% of total emissions, and agriculture and transportation sectors each contributing 13.5%. The housing sector contributed 7.9% and waste 2.8% of the total sources of greenhouse gas emissions in 2004. **Table (1)**

Table (1) Human Activities in Increasing Greenhouse Gas Levels Globally

Percentage %	The sector	N
25,9	Energy production sector	**1**
19	Industry sector	**2**

[2] Mousawi, Ali Sahib. (2002). Expected Global Climate Changes and Their Reflections. Journal of Geographical Research, Issue 4, College of Education for Women, University of Kufa, p. 20

[3] Al Hassan, Ahmed Jassim. (Previous Source), p. 26.

17,4	Deforestation	**3**
13,5	Agriculture sector	**4**
13,5	Transport sector	**5**
7,9	Housing sector	**6**
2,8	Waste	**7**

Source: Researcher Itimad Ali Ahmed Jassim Mohammed, Climate Change in Iraq Represented by Equation Lines, PhD Thesis, College of Arts, University of Basra, 2011, p. 26.

Before delving into the details of the human factors affecting the greenhouse effect and the resulting climate change, it is important to understand the formation process of the greenhouse effect.

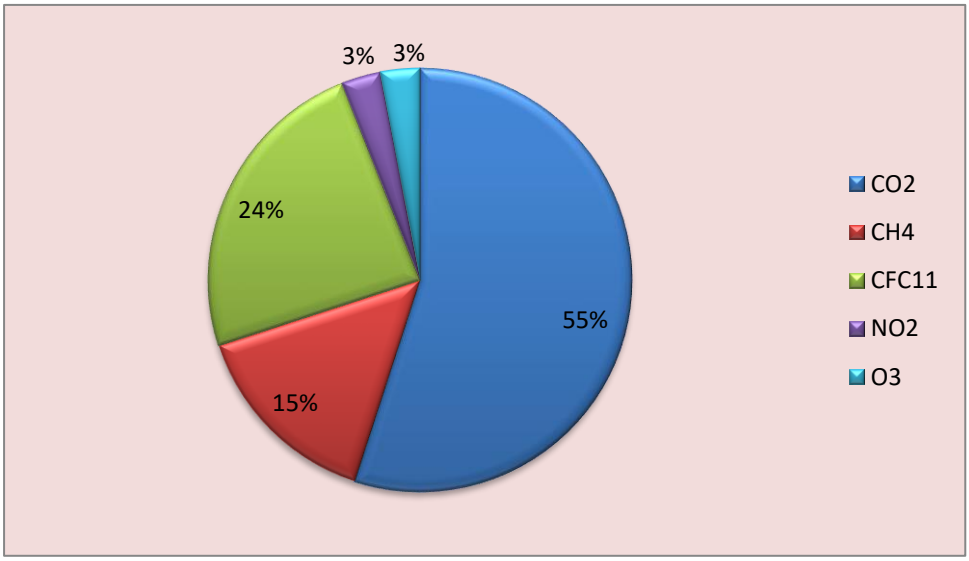
Concept of Greenhouse Effect: The greenhouse effect, also commonly referred to by terms such as the glasshouse effect, the greenhouse effect, or the warming phenomenon, is also known as global warming and climate change. Despite the varied terminology, they all refer to the same concept. The greenhouse effect is defined as the process of radiative exchange between atmospheric gases and suspended particles and the Earth's surface. These gases and particles allow solar radiation to pass through towards the Earth, while simultaneously trapping the Earth's thermal radiation, thereby increasing the atmospheric temperature.[4] The Swedish scientist Svante Arrhenius was the first to use the term "greenhouse effect" in 1896 to describe the impact of increased carbon dioxide in the atmosphere due to fossil fuel combustion.[5]

The greenhouse effect is a geophysical phenomenon resulting from a portion of solar radiation being absorbed by the atmosphere, while another portion is reflected in all directions. The remaining radiation reaches the Earth's surface, and some of it is emitted back into space as long-wave thermal radiation. A significant portion of this thermal radiation is trapped by greenhouse gases,

[4] Al-Amar, Muthanna Abdul Razzaq. (2000). Environmental Pollution, Dar Wael for Printing and Publishing, Amman, Jordan, p. 63.
[5] Shalaan, Sulafa Tariq Abdul Karim. (2003). International Protection of the Environment from the Greenhouse Effect, Master's Thesis, College of Law, University of Baghdad, p. 12.

particularly carbon dioxide, which accounts for 55% of the radiation, methane 15%, chlorofluorocarbons 24%, nitrous oxide 3%, and ozone 3%. This trapping process prevents a large amount of the radiation from escaping into space, causing it to be re-emitted towards the Earth's surface, thereby raising the Earth's surface temperature.[6]

Figure (2) The percentage of greenhouse gases' contribution to the global warming phenomenon



Source: The researcher based on: Ali Ahmed Ghanem, Applied Climate, 1st ed., Dar Al-Masirah for Publishing, Distribution and Printing, Amman, 2010, p. 324.

The greenhouse effect occurs during both day and night, that is, during the process of heat gain and loss. Here, it is important to discuss the behavior of Earth's atmosphere in both the solar and thermal spectra, where the natural properties of the atmosphere (such as absorption, transmission, or reflection of radiation) play a crucial role. Solar radiation, also known as short-wave radiation, is emitted from the sun's disk with a wavelength ranging between 0.1 and 4 microns. In contrast, terrestrial thermal radiation, which ranges between 4 and 100 microns, is emitted from earthly objects such as plants, water, and land surfaces, as well as various gases in Earth's atmosphere like water vapor, ozone, and carbon dioxide.

[6] Al-Mousawi, Ali Sahib Talib. (2009). Geography of Weather and Climate, 1st Edition, Ministry of Higher Education and Scientific Research, p. 83.

A distinguishing property of the atmosphere is that it allows most solar radiation to pass through while absorbing most of the thermal radiation emitted from the Earth's surface. Without these gases, Earth's energy would radiate into space, leading to an average temperature of around -18°C, a condition under which life would not exist due to freezing temperatures. Therefore, warmth is a natural phenomenon that supports life on Earth.[7]

The ability of terrestrial radiation to penetrate space depends on the concentration of certain gases in the atmosphere, such as carbon dioxide and methane, which are capable of absorbing terrestrial radiation and re-emitting it back towards Earth, thereby maintaining radiative balance. However, an increase in these gases in the atmosphere disrupts this balance, causing the greenhouse effect.[8]

The danger posed by the greenhouse effect has led to increased awareness of its long-term consequences, including changes in temperature patterns, rainfall, destructive hurricanes, and droughts. As the impacts of global warming intensify, it will become increasingly difficult for humanity to halt climate deterioration and the accompanying natural disasters and changes in climate systems.[9] Key factors contributing to the increase in greenhouse gases in the atmosphere include:

Population Growth:

Human impacts have increased with the massive rise in population numbers. The 20th century witnessed unprecedented population growth. Over a span of 100 years, from 1900 to 2005, the global population increased from 1.6 billion to 6.1 billion people. The world's population nearly quadrupled, and the real

[7] Al-Budairi, Ahmed Lefteh Hamd. (Previous Source), pp. 13-14.
[8] Khooli, Mohammed Radwan. (1999). Desertification in the Arab World, Center for Arab Unity Studies, 2nd Edition, Beirut, p. 30.
[9] Baty, Munir. (2001). Environmental Risks and Impacts of Forest Fires and Tree Cutting, Journal of Sciences, Baghdad, Issue 113, p. 11.

GDP increased by about 20 to 40 times. However, this rapid growth in both population and economy varied across the world, and not all regions benefited equally from economic growth.

Population growth and economic development occurred simultaneously with the increased unsustainable use of Earth's physical environment. Demographers estimate that the world's population could rise to about 10 to 12 billion people by the mid-21st century, causing greater pressure on air, land, and water. Most of the population increase in the 20th century and the future will occur in developing countries, which constituted 62% of the world's population in 1950 and 72% in 1995.[10] **Table (3)**

Table (3) World population for the period (1965-2012)

Population (billion people)	Year
3,2	1965
4,0	1975
4,8	1984
5,6	1994
6,1	2005
6,6	2008
7,0	2012

Source: The researcher based on: Qusay Fadhel Al-Hasani, Indicators of Climate Change and Some of Its Environmental Impacts in Iraq, PhD Thesis, College of Arts, University of Baghdad, 2012, p. 95.

With the industrial revolution in the early 19th century, humans became a new factor in climate balance as their activities led to the release of massive amounts of CO2 into the atmosphere.[11] Machines replaced humans, and steam engines, which required fuel like coal, oil, and nuclear energy, were used. This

[10] U.N ,Wold Urbanization prspects New York, 1995, p112
[11] Al-Mashhadani, Ghazwan Abdul Aziz. (Previous Source), p. 13.

resulted in the burning of carbon materials, increasing some gases and pollutants in the atmosphere beyond the ecosystem's capacity to absorb them.[12]

2. Deforestation: With the advent of the industrial revolution, global population growth increased, accompanied by environmental destruction, including deforestation by burning or cutting to convert land into agricultural spaces or to use timber for industrial purposes or as a fuel source. The areas deforested increased in the 19th and 20th centuries.[13]

Forests cover about one-third of the world's area, playing a crucial role in environmental processes and gas exchange[14]. They act as a factor in mitigating the severity of climate changes by absorbing greenhouse gases, especially CO2, and producing oxygen.[15] However, the reduction of forest areas diminishes their role in maintaining thermal balance on Earth. Trees help reduce temperature through transpiration during their growth, typically between 10 to 15 years. The air temperature above plants at 5 cm is lower than the air temperature at 20 meters, with an average difference of 2.5°C, which can reach up to 6.5°C in extreme cases.

The effect of forests in reducing air temperature is similar to that of water bodies due to their moisture content and evaporation. Forests moderate temperature because a significant part of air heat is used in evaporation and transpiration from plants, reducing the energy available to heat the air[16]. Other climate impacts of deforestation include increasing the Earth's ability to absorb solar radiation, thereby raising temperature.[17]

[12] Al-Samak, Mohammed Azher Said, and Al-Saati, Basim Abdul Aziz. (1988). Geography of Natural Resources, Directorate of Dar Al-Kutub for Printing and Publishing, University of Mosul, p. 216
[13] Hussaini, Qusay Fadhil. (Previous Source), p. 106.
[14] Hatout, Alia and Hamdan, Mohammed. (2003). Environmental Science, 1st Edition, Dar Al-Shorouk for Publishing and Distribution, Amman, p. 248.
[15] Food and Agriculture Organization Report, State of the World's Forests, 2007, p. 74.
[16] Mousa, Salah Bashir. (2005). Natural Climate, Modern University Office, Alexandria, p. 113.
[17] Mousa, Ali Hassan. (Previous Source), p. 66.

Four-fifths of the forests that once covered the Earth have been cleared or degraded for various commercial, agricultural, and urban purposes. The deforestation rate has increased to about 11 million hectares annually, surpassing the rate of reforestation tenfold. Consequently, one-third of the original forests have disappeared. Estimates indicate that forest areas worldwide declined by about 180 million hectares between 1980 and 1995 and by 8 million hectares between 1990 and 2005. Tropical forests, which constitute 56% of the world's forests, have been most affected by deforestation, while temperate forests in most industrial countries cover about 42%.

Notably, more than 5,000 forest fires annually consume about 1 million hectares of Mediterranean shrublands, and over 2.3 million hectares of forests and shrublands burn each year in South America.[18] Some studies suggest that about half of the CO2 emitted into the atmosphere comes from developing countries' annual burning of tropical and subtropical forests. Whether trees are cut or burned, they release their stored CO2, leading to two negative climatic outcomes:

1. **Deprivation of the environment from a natural producer of oxygen and absorber of carbon dioxide from the atmosphere:** The reduction of vegetation cover leads to a large proportion of this gas remaining in the atmosphere for a long time, increasing its concentration and exacerbating the greenhouse effect.
2. **Release of stored carbon dioxide:** Cut trees release their stored carbon dioxide into the atmosphere either through burning or slow decomposition over time. It is estimated that about 50% of the carbon dioxide emitted into the atmosphere remains for approximately 2-5 years, allowing it to spread uniformly throughout the Earth's atmosphere, impacting not just the producing area. The other half of the carbon dioxide will enter the oceanic system as organic carbon concentrated in plants and aquatic life that feed on them, and as

[18] Food and Agriculture Organization Report, (Previous Source), p. 74.

inorganic carbon concentrated in sediment deposits. Some will also concentrate in the terrestrial biosphere as wood and humus.[19]

In the study area, the natural or planted forest areas are very small. However, there are wide areas of palm groves. The population distribution in this region is linear, along rivers and their branches, with dense areas of palm groves along these rivers. Therefore, as cities along the rivers expand, it must be at the expense of the adjacent palm groves and agricultural lands because urban expansion is horizontal, not vertical. Due to the increasing population growth, urgent need for housing units, and rising real estate prices for houses and residential lands within municipal boundaries, coupled with the absence of law or weak enforcement and lack of accountability for those who destroy agricultural lands by clearing trees and palm groves, large areas have been converted into informal residential areas. This phenomenon has increased since 2003, with about 300 dunums of groves and forests cleared from a total area of 910,166 dunums.[20]

. Increased Greenhouse Gas Emissions:

The term "greenhouse gases," as defined by the Intergovernmental Panel on Climate Change (IPCC), refers to the gaseous components of the atmosphere, whether natural or human-made, that absorb and emit radiation at specific wavelengths within the thermal infrared range emitted by the Earth's surface and atmosphere.[21]

[19] Meqbali, Mohammed Ayad. (2003). Weather and Climate Extremes, 2nd Edition, Dar Shomoa Al-Thaqafa for Printing and Publishing, Libya, p. 51.
[20] Ministry of Planning, Central Organization for Statistics and Information Technology, Directorate of Environmental Statistics, Environmental Statistics Report of Iraq for the Year 2007, pp. 37-40.
[21] Intergovernmental Panel on Climate Change, (2007). Adaptation and Impact Speed, (Previous Source), p. 111.

Summary and Results:

The study revealed the following:

1. **Climate change is caused by human activities:** Human activities, particularly the burning of fossil fuels, have increased the levels of carbon dioxide and other greenhouse gases in the atmosphere, leading to higher temperatures. Changes that occurred during the third and fourth geological periods were due to various natural cosmic factors, such as changes in the Earth's axial tilt, solar spots, volcanic ash, etc. Changes that happened 500 million years ago were caused by continental drift and plate tectonics.
2. **Impact of global warming due to increased greenhouse gases:** These gases, released by industries worldwide, necessitate reducing local environmental pollutants to prevent future temperature increases.
3. **Effects on key climate elements:** The study found that the general trend for both annual and monthly temperature is an increase, while rainfall and relative humidity are decreasing.
4. **Changes in planting schedules for summer and winter crops:** These changes have led to variations in the length of the growing season, either shortening or lengthening it.
5. **Variation in temperature suitability for crop growth:** The study noted differences in temperature suitability for the germination, growth, and maturation of agricultural crops over the study period.
6. **Changes in wheat planting dates:** During the first decade of the study, the optimal time for planting wheat was at the end of October, with maturation in early May. In the third decade, planting shifted to early November, and in the last decade, it moved to the end of November, with maturation at the end of April. These changes in planting dates are attributed to increased temperatures resulting from climate change.