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Climate Change in Iraq: A Comprehensive Analysis

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ABSTRACT

Climate change is presently the most pressing and urgent global issue. Its potential consequences, such as the drying up of rivers, the submersion of vast coastal areas, and shifts in global agricultural production patterns, are so severe that they could have catastrophic impacts on humanity. Consequently, global environmental organizations have sounded the alarm, warning of the deteriorating global climate and the grave consequences of increasing carbon emissions. The primary objective of this research is to classify the root reasons of climate change in Iraq, explore potential mitigation strategies, and assess the resulting impacts of these changes. A comprehensive literature review was performed, including environmental reports, historical climate data, and previous studies on climate change in Iraq. Data analysis focused on temperature trends, rainfall patterns, and environmental consequences over the past decades. Our findings indicate that the escalation in temperatures and the reduction in rainfall levels owing to climate change have had a significant effect on water availability, decline in agricultural production, increase in poverty, deterioration of health conditions, decline in the tourism sector and escalation in the occurrence of dust storms. Temperatures across the country have risen sharply since the 1950s, with the average temperature during the period 1901-2021 increasing by approximately 2 degrees Celsius, even higher than the global average. Additionally, rainfall has shown a substantial and continuous decline, with projections indicating a reduction of more than 30% by 2100 compared to the 1938-1978 average. Climate change poses a serious threat to Iraq's sustainability. Immediate policy interventions, international cooperation, and sustainable environmental strategies are necessary to mitigate its adverse consequences.

1. INTRODUCTION

Climate is usually defined as the average weather conditions over a long period, usually calculated over 30 years. The term encompasses patterns of temperature, humidity, precipitation, wind, and various seasons. Climatic patterns play a pivotal role in shaping natural systems, as well as human economies and cultures [1].

Climate change is a natural phenomenon occurring every few thousand years. However, due to increasing human activities, these climatic changes have accelerated. The United Nations Framework Convention on Climate Change defines it in Article 1 as 'a change of climate which is ascribed directly or indirectly to human activity that changes the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods [2].

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as 'any change in climate over time, whether due to natural variability or as a result of human activity [3]. Additionally, the IPCC defines climate change as a change in the state of the climate that can be identified by using statistical tests, such as changes in the mean, and that perseveres for an extended period, usually decades [4].

In general terms, climate change signifies to alterations in climatic conditions, such as temperature, coldness, and precipitation rates, which can have adverse impacts on various ecological, economic, and even political systems, leading to conflicts. Climate change is a fundamental factor contributing to increased global aridity. Rising temperatures can accelerate the process of water transfer from the Earth's surface to the atmosphere. Consequently, droughts can cause significant damage to water resources in the future. Additionally, they can impact population growth, pollution levels, living standards, dietary habits, agricultural practices, industrial activities, economic activities, and increase the demand for water and energy. Climate change presents an unprecedented challenge to agriculture and food security, exacerbating hunger and poverty, particularly in vulnerable regions [5-7].

Iraq is recognized as one of the most vulnerable countries in the Middle East and North Africa in terms of climate change effects. In recent years, it has encountered substantial climatic shifts, including a notable rise in temperatures, reduced rainfall, and heightened occurrences of drought, water scarcity, and desertification. Additionally, the concentration of

harmful substances, including carbon dioxide, has increased, further exacerbating the environmental crisis in the region. These severe phenomena have had repercussions on human health, key sectors such as water and agriculture, food insecurity, and have hindered efforts to reduce poverty and promote shared prosperity [8, 9].

Emissions of carbon dioxide and other greenhouse gases (nitrous oxide, methane, etc.) are a primary driver of climate change. The correlation between global temperatures and greenhouse gas concentrations, especially carbon dioxide, has been evident throughout Earth's history. The past three decades have witnessed drastic climate changes due to the accumulation of carbon dioxide emissions and their significant increase, resulting from the utilization of fossil fuels and deforestation. Climate change continues its trajectory towards a warmer future, with some of its effects being irreversible. Many parts of the world have experienced unprecedented impacts such as heat domes, wildfires, floods, rising sea levels, the collapse of ice caps, and impending famine following prolonged droughts [8, 10]. Figure 1 clearly shows that cumulative emissions increased from 1.995 billion tons in 2001 to 4.657 billion tons in 2020, with a compound yearly growth proportion of 4.3% throughout the period 2001-2020. The oil sector contributes approximately 40% of emissions due to the burning of associated gas.

Statistics indicate that global temperatures have risen by approximately 1.2 degrees Celsius above pre-industrial levels. This increase is expected to lead to serious climate changes, which in turn will undermine efforts to eradicate poverty. Without urgent actions to reduce vulnerabilities, improve access to basic services, and build resilience to crises, the impacts of climate change could push an additional 100 million people into poverty. Furthermore, extreme natural disasters result in annual losses of around 250 billion dollars in consumption and push 26 million people into poverty each year. The direct costs of health problems caused by climate change are estimated to be between 2 and 4 billion dollars by 2030, and contribute to more than 7 million premature deaths annually [8].

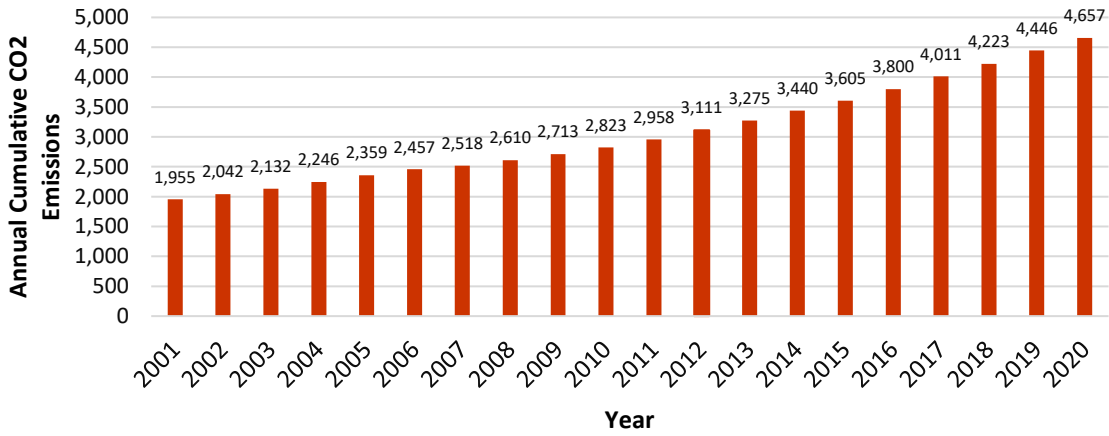

Figure 1. Annual cumulative CO_2 emissions in Iraq (2001-2020)

Although there are many studies on climate change and its impacts, there are implications in the detailed analyses that are approaching again in Iraq among them the overlapping on water resources, agriculture, and the general cushion. Moreover, most of the previous studies are based on old data, which highlights the need for a modern analysis based on updated data to provide a clear vision on modern innovation in Iraq.

1.1 Causes of climate change

1.1.1 Natural causes of climate change

Scientists have confirmed that natural factors play an important role in climate change. These factors include:

a). Volcanic Activity: Volcanic eruptions release dust and greenhouse gases into the atmosphere, which can block a portion of solar radiation and lead to significant temperature decreases. Examples include the volcanic eruptions in Iceland and Chile [11].

b). Dust Storms: Dust storms in arid and semi-arid regions, which undergo from vegetation degradation, limited agriculture, and rainfall, contribute to climate change [12, 13].

c). Cosmic Rays: Cosmic rays, resulting from the explosion of some stars, strike the Earth's upper atmosphere and cause the formation of radioactive carbon [14, 15].

d). Sunspots: Sunspots occur approximately every 11 years due to disturbances in the sun's magnetic field, which increase the thermal energy of the emitted radiation [16, 17], as shown in Figure 2.

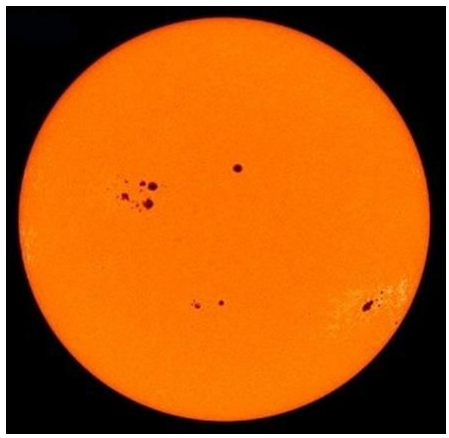

Figure 2. Sunspot activity on the Sun's surface (NASA, Environmental Protection Agency)

1.1.2 Human causes of climate change

Human activities have significantly contributed to climate

change, driven by population growth and industrialization. Scientists have concluded that human actions have a profound impact on weather patterns and climate changes. With the Industrial Revolution and increasing population, human activities requiring fossil fuels such as coal and oil have escalated, leading to a surge in greenhouse gas emissions. This has overwhelmed the Earth's natural systems, altering the composition of the atmosphere [18, 19]. The primary human-induced reasons of climate change comprise:

a) Greenhouse Gas Emissions: The burning of fossil fuels in industries like power plants, oil refineries, cement production, and battery manufacturing releases substantial amounts of greenhouse chiefly carbon dioxide, methane, gases, chlorofluorocarbons, and nitrous oxides. As societies become more complex and reliant on technology, the demand for energy and consequently, greenhouse gas emissions, increases [18, 20].

b) Vehicle and Generator Emissions: Exhaust from vehicles and generators contributes significantly to greenhouse gas emissions and air pollution [21].

c) Agricultural Activities: Agricultural practices, including the use of synthetic fertilizers, livestock farming, and deforestation, release greenhouse gases. Forests represent as carbon sinks, absorbing carbon dioxide from the atmosphere. Deforestation reduces this capacity, exacerbating climate change [12, 21].

2. METHODOLOGY

This study employs a mixed-methods approach, combining quantitative data analysis with qualitative literature review to assess the impact of climate change in Iraq.

2.1 Data collection

• Secondary data were obtained from international sources such as the Intergovernmental Panel on Climate Change (IPCC), World Bank, and World Health Organization (WHO).

• Climatic data, including temperature trends and precipitation changes from 2000 to 2023, were extracted from NASA Climate Data and Iraq's Meteorological Organization.

• Environmental reports and peer-reviewed studies published between 2015-2024 were analyzed to provide context for climate change effects.

2.2 Data analysis

• Statistical trends in temperature and rainfall were analyzed using Excel.

• A correlation analysis was conducted to examine the relationship between climate change and environmental, economic, and social variables.

• Comparative analysis was performed by comparing historical climate patterns with recent observations.

2.3 Study area and scope

• The study focuses on Iraq, particularly regions affected by desertification, water scarcity, and temperature extremes.

• The analysis covers a long time period to assess long-term trends and future projections.

3. RESULTS AND DISCUSSION

3.1 Climate change and its relation to water scarcity

Iraq is situated in the northern temperate zone, between latitudes 29°5' and 37°22' North and longitudes 38°45' and 48°45' East. Geographically, it is located in the southwest of Asia, specifically in the northeastern part of the Arabian Peninsula and the Arab world. This geographical and astronomical location qualifies Iraq to occupy the warm southern parts of the temperate zone in the Northern Hemisphere. Iraq's climate is classified as arid and semi-arid continental [22]. Iraqi climate is also characterized by a wide daily and annual temperature range due to the absence of large water bodies that could mitigate winter coldness and increase summer heat, and by the scarcity of rainfall from the northeast to the southwest, with most rainfall occurring in winter, autumn, and spring, while summer is almost rainless [23], as shown in Figure 3.

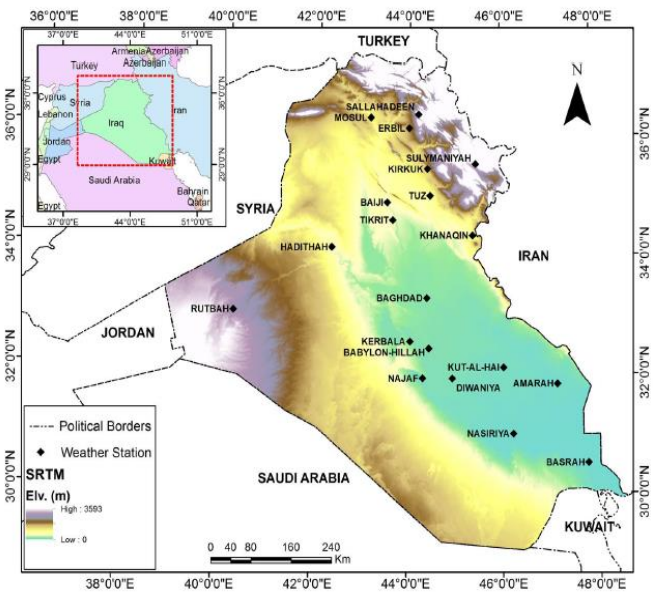

Figure 3. Location of meteorological stations in Iraq

Climate change has resulted in a decrease in the amount of water flowing into Iraq's rivers. The water sector is one of the most exposed to climate change. According to estimates by the Iraqi International Bank in 2011, there was a significant shortage of water resources compared to actual needs between 2000 and 2009. This shortage is expected to reach 37% between 2020 and 2030 and increase to 51% between 2040 and 2050 [24-26].

Understanding the trends in rainfall and temperature changes is crucial for assessing possible climate change influences on Iraq's future water resources and, consequently, its national economy. Forecasts by the Iraqi Meteorological and Seismological Organization indicate a clear decline in annual rainfall rates. Rainfall is expected to decrease significantly and continuously, reaching a decline of more than 30% by 2100 compared to the rates during the period 1938-1978 [27].

3.1.1 The rainfall

Rainfall in Iraq is generally characterized by spatial and temporal variability. The amount of precipitation recorded at meteorological stations varies significantly from one location to another, influenced by factors such as altitude and geographical position. Rainfall tends to be higher in elevated areas. Rainfall patterns can be analyzed based on spatial and temporal distribution, as well as through the calculation of averages [28, 29].

The average annual rainfall during the period (1992-2001) for most regions in Iraq was higher than the averages for both periods (2002-2011) and (2012-2021). As illustrated in Figure 4, the time period (2002-2011) exhibited a significant decrease in average rainfall compared to the other mentioned periods

3.1.2 Temperatures

Temperatures have been steadily rising across Iraq since the 1950s, with an average increase of 0.7 degrees Celsius compared to a century ago. Temperatures are projected to increase by an additional 2-3 degrees Celsius over the coming century. Between 1901 and 2021, the average temperature escalated by around 2 degrees Celsius, higher than the global average [8], as shown in Figure 5.

Climate models predict that temperatures could rise by as much as 3.5°C by 2100, worsening the situation in a country that already experiences temperatures exceeding 50°C on many summer days, according to the Iraqi Meteorological Organization and Seismology [27].

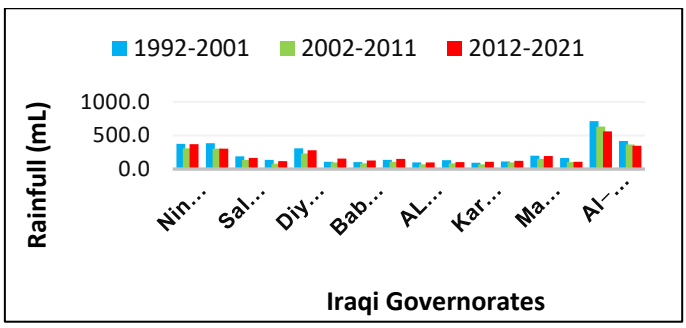

Figure 4. Average rainfall in Iraq during the periods (1992-2001), (2002-2011), and (2012-2021)

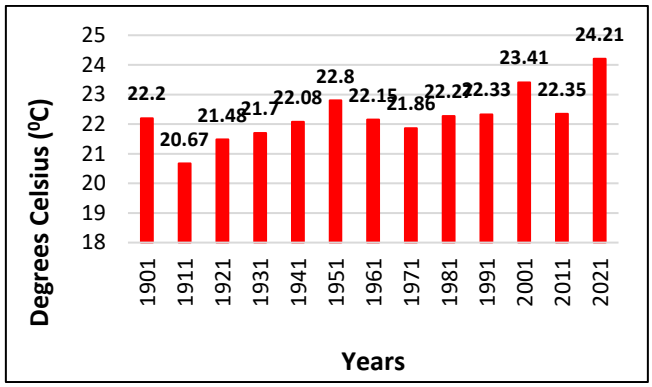

Figure 5. Average temperature in Iraq during the period (1901-2021)

3.2 Climate change and its influence on dust phenomena

Dust phenomena of various types, including dust storms, suspended dust, and raised dust, have become one of the most important environmental challenges confronting Iraq, particularly in the central and southern regions. The frequency of these dust events has increased significantly in recent decades, driven by climate change. Decreasing rainfall and increasing temperatures have resulted in the conversion of vast areas of agricultural land into deserts and the degradation of natural pastures, increasing the number of dust-generating areas within Iraq. Additionally, other natural factors have contributed to the exacerbation of these phenomena. The recurrent severe dust storms and dust events throughout the year have led to a noticeable increase in asthma cases, especially among children and the elderly, and a significant spread of diseases and cancers in recent years. International organizations and the United Nations have become increasingly concerned about this growing problem due to its health risks to humans and its detrimental effects on crops and the environment in general [30-33].

3.2.1 Suspended dust

When comparing the two periods for suspended dust, all study stations recorded a higher incidence of suspended dust in the millennium, except for Kirkuk, Al-Basra, and Dhi Qar stations, which recorded a higher incidence of suspended dust in the 1970s, as shown in Figure 6.

3.2.2 Raised dust

Figure 7 clearly demonstrates a significant variation in the frequency of raised dust events among the studied stations across the two periods. Most stations recorded higher occurrences of raised dust during the 1970s, while Maysan and Al-Mosul stations exhibited the highest frequencies during the millennium.

3.2.3 Dust storms

Figure 8 clearly illustrates a notable variation in the frequency of dust storm occurrences among the studied stations across the two periods. While some stations, such as Al-Basra, Maysan, Dhi Qar, Wasit, Salahaldin, and Kirkuk, recorded higher frequencies of dust storms during the 1970s, other stations including Baghdad, Karbala, Diyala, Al-Anbar, and Al-Mosul exhibited higher frequencies during the millennium.

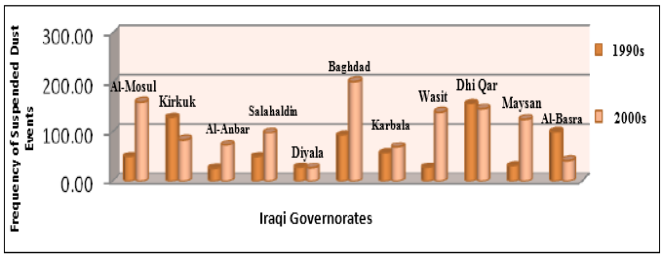

Figure 6. Comparison of suspended dust for the 1970s and 2000s

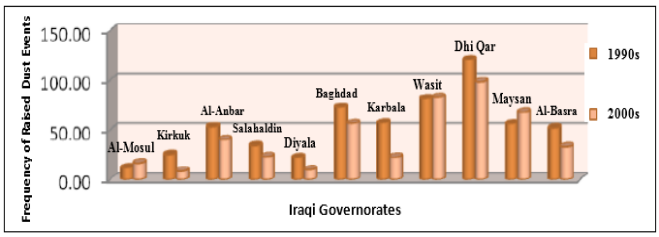

Figure 7. Comparison of raised dust between the 1970s and 2000s

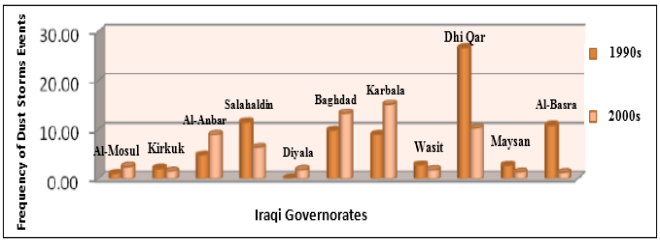

Figure 8. Comparison of dust storm frequency between the 1970s and 2000s

3.3 Climate change and its influence on agriculture

Agricultural production in many regions is already suffering from the adverse effects of rising temperatures, increased droughts and floods, and more extreme weather events. Salinization of arable land, scarcity of freshwater, and desertification have exacerbated these challenges. It is worth noting that desertification affects 39% of Iraq's land, and with the salinization of approximately 54% of cultivated land, the intensified impacts of climate change on agriculture will make it progressively challenging to cultivate crops, raise livestock, and manage forests in the same methods and places as in the past. Managing drought could become a significant challenge in agricultural areas [34, 35].

Numerous investigations on the specific effect of climate change on the agricultural sector suggest the following direct effects:

a) Decreased crop yields: Crops cultivated for food, fiber, and energy require specific conditions, including optimal temperature and sufficient water. The increasing frequency of dangerous occurrences, particularly floods and droughts, also decreases production and damages crops [12, 36].

b) Increased prevalence of plant diseases and insect infestations: Many weeds, pests, and insect-borne diseases thrive in high temperatures, more humid climates, and higher levels of atmospheric carbon dioxide [37].

c) Animal diseases: Livestock productivity in terms of meat and dairy is reduced due to increased disease prevalence and parasites. The quality and quantity of fodder will also decrease due to reduced forage crop yields [34].

d) Impact on fisheries: Fish migration to deeper waters and the subsequent negative impact on fish farm productivity due to rising water temperatures and reduced freshwater supplies. Additionally, the quality and type of fish will change due to increased salinity [12, 38].

e) Indirect impacts: Climate change also has indirect effects on the agricultural sector, such as reduced natural flow in the Tigris and Euphrates rivers, increased salinity, evaporation rates, and light intensity [39].

The results of a report by the Central Statistical Organization of Iraq showed a significant decrease in the area and production of crops and vegetables due to the reduced water allocation for irrigation during the summer season of 2021 in some governorates [40], as shown in Figure 9.

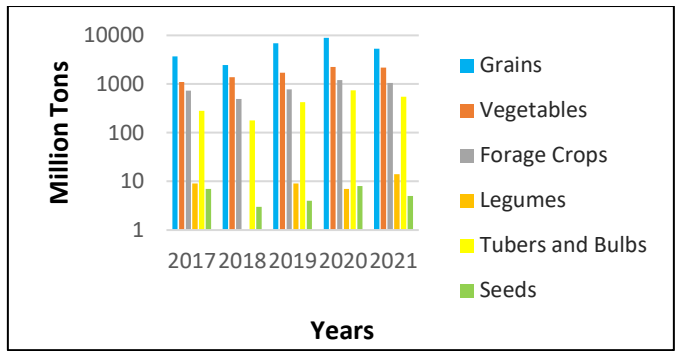

Figure 9. Production quantity of vegetables, fodder crops, tubers and bulbs, cereals, legumes, and seeds for the period 2017-2021

3.4 Climate change and its influence on poverty

Climate change and poverty are two sides of the same coin, as failure in one inevitably leads to failure in the other. We can never eradicate poverty without addressing the issue of climate change, as it could push 100 million people into extreme poverty within the next decade. Natural disasters such as droughts, temperature fluctuations, floods, and storms threaten food security and pose risks to agriculture, people, and economies, disproportionately affecting poor communities. Given that most of the world's poor depend on agriculture and fishing, and often have only enough resources to sustain themselves for one season, they lack the financial reserves to cope with natural disasters. In the confront of severe climate change, millions of people lose their food reserves and become even poorer, making it difficult for them to regain their previous level of subsistence [41].

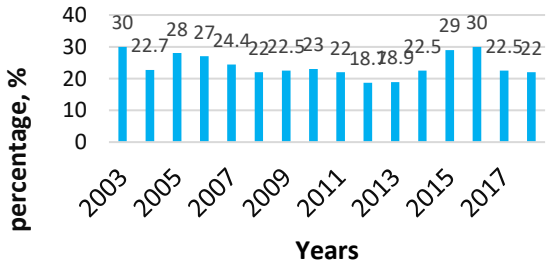

Figure 10. Poverty indicators in Iraq, 2003-2018

Over 800 million people worldwide suffer from hunger and poverty, and many lack access to safe drinking water at home. Hunger and water insecurity are among the primary causes of poverty, which is rooted in economic, social, political, and cultural factors [42].

Undoubtedly, poverty is a multifaceted phenomenon with numerous causes, including economic, social, and political factors. A report by the Central Statistical Organization of Iraq revealed disparities in poverty rates between 2003 and 2018 [43], as shown in Figure 10.

3.5 Climate change and its influence on public health

Recent climate changes have had harmful impacts on human health. The increasing frequency of heat waves, cold spells, floods, droughts, and air pollution pose significant threats to the health of millions of people. These impacts include [44-49]:

a) Increased malnutrition and its associated complications, as well as impacts on child growth and development.

b) Increased mortality, morbidity, and injury due to heat waves, floods, storms, fires, and droughts.

c) Increased incidence of diarrheal diseases and respiratory and cardiovascular diseases due to elevated ground-level ozone concentrations associated with climate change.

d) Spread of insect-borne diseases.

e) Contact with elevated temperatures can lead to many health problems, for example, heatstroke, heat exhaustion, and muscle cramps.

Increased respiratory diseases including bronchitis, pneumonia, and influenza due to airborne allergens. More than 400 million people are estimated to be exposed annually to heat stress levels that exceed the working heat limit (inability to work outdoors), and more than 10 million people are estimated to be exposed annually to heat stress levels that exceed the survival threshold (risk of death outdoors) [50], as shown in Figure 11.

By 2040, approximately 700 million people are projected to be exposed to severe and prolonged droughts lasting at least six months each year. The intensity and duration of these future droughts are expected to be at least as severe as the 1930s "Dust Bowl" drought in the U.S. Midwest [3], as illustrated in Figure 12.

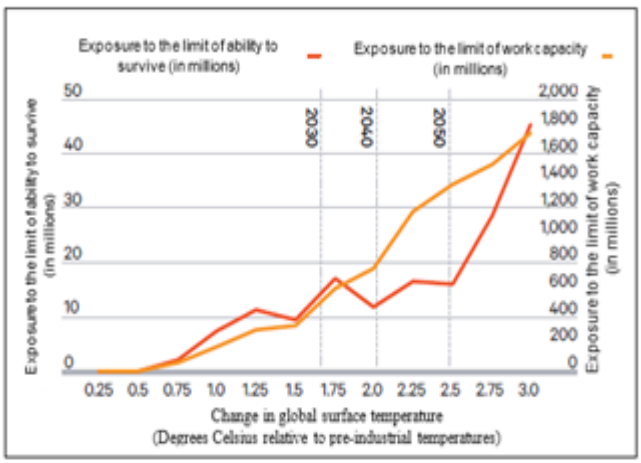

Figure 11. The impact of temperature on human health

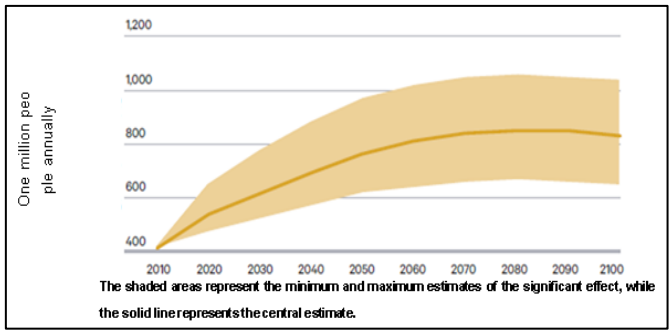

Figure 12. Annual number of people exposed to drought

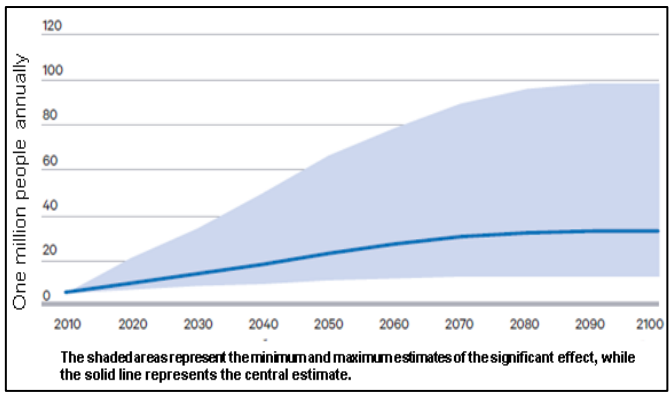

Figure 13. Annual number of people affected by floods

In 2020, there was a 23% increase in floods compared to the annual average of 163 events from 2000 to 2019, and an 18% increase in flood-related deaths compared to the annual average of 5,233 fatalities. By 2100, river floods are projected to affect approximately 60 million people annually worldwide, with South Asia experiencing the most significant impact, affecting 33 million people each year [50], as shown in Figure 13.

3.6 Climate change and its influence on tourism

The tourism sector in Iraq is considered one of the main and important economic sectors due to its qualitative leap in social and economic growth and its influence to the development process, especially since there are many archaeological, cultural, religious, and recreational sites spread across all Iraqi governorates [51]. The tourism industry is highly vulnerable to climate change due to its dependence on natural resources, environmental features, and cultural aspects that are sensitive to climate variations. The two most important climatic elements that have a direct and effective impact on tourist comfort and the activities they engage in are temperature and relative humidity due to the strong relationship between them. Tourists often prefer a moderate temperature between 18-25 degrees Celsius [52].

4. LACK OF UNCERTAINTY AND LIMITATIONS DISCUSSION

While this study provides valuable insights into the effects of climate change, several limitations should be acknowledged:

1). Data Limitations: The availability of data was a significant constraint, with limited datasets accessible for

certain regions. This lack of comprehensive data may impact the overall findings.

2). Difficulty in Data Acquisition: Obtaining reliable data was challenging due to logistical issues and restrictions, which may have affected the quality of the analysis.

3). Limited Resources: The study faced limitations in terms of resources, which restricted the extent of the research and the methods that could be employed.

4). Equipment Malfunctions: Some weather stations and measurement devices experienced malfunctions, leading to gaps in the data collected. This could introduce inaccuracies in the results.

5). Data Preservation Issues: Certain datasets were not adequately preserved, limiting their accessibility for analysis and potentially impacting the study's conclusions.

6). Potential Biases:

• Selection Bias: Some data sources may not fully represent all regions equally, affecting the generalizability of the findings.

• Measurement Bias: Malfunctions in measurement devices or inconsistencies in data collection methods may lead to variations in reported climate trends.

• Interpretation Bias: The study relies on available datasets, which may introduce biases due to missing or incomplete records.

7). Future Research Directions: Future research should focus on improving data collection methods, enhancing the reliability of measurement instruments, and addressing data preservation challenges to ensure more accurate assessments of climate change impacts.

5. CONCLUSIONS AND RECOMMENDATION

The phenomenon of climate change is one of the biggest challenges confronting humanity nowadays, and it poses a huge long-term challenge, raising difficult questions about issues of justice and human rights, both among members of the same generation and between members of different generations. Humanity's ability to find satisfactory answers to these questions will be a test of our ability to make the necessary efforts to bear the consequences of our actions. Climate change is one of the threats that fate has destined us to face, and therefore we must confront this threat before it turns into a full-blown crisis affecting future generations. Among the findings of this study are the following:

1). Climate change signifies a great global difficulty facing humanity in the 21st century due to its impacts and consequences.

2). Climate change is a top priority on the international policy agenda, requiring action to resist its negative impacts.

3). Drastic mitigation of the effects of climate change requires fundamental changes in international policies and the need for international cooperation.

4). The importance of supporting efforts to mobilize all scientific and institutional capacities to find solutions that can mitigate the negative impacts of climate change.

5). Despite the international efforts made in holding conferences and the resulting agreements and treaties, they have not led to concrete actions, which means the absence of a real political will to confront this problem, and the overriding of the private interests of rich countries.

In view of the study's findings, the following recommendations can be made:

1). Renewable Energy Policies

• Government Incentives for Solar and Wind Energy: The Iraqi government should introduce tax exemptions and subsidies for businesses and individuals investing in solar panels and wind turbines. This can reduce reliance on fossil fuels and decrease CO_2 emissions.

• Mandatory Renewable Energy Targets: Implementing a policy that mandates a minimum of 20% renewable energy generation by 2035 can accelerate Iraq's transition to a low-carbon economy.

• Investment in Green Technology: Establishing public-private partnerships (PPPs) to finance clean energy projects can attract international funding and expertise.

2). Water Management Strategies

• Modernizing Irrigation Systems: The government should promote drip and sprinkler irrigation to reduce water wastage in agriculture, which consumes over 70% of Iraq's freshwater resources.

• Rainwater Harvesting and Desalination: Large-scale investment in rainwater harvesting projects and desalination plants (especially in Basra) can help counteract declining water availability.

• Regional Water Agreements: Strengthening diplomatic negotiations with upstream countries (Turkey and Iran) to ensure a fair distribution of water from the Tigris and Euphrates rivers is crucial for Iraq's water security.

3). Climate Adaptation Strategies

• Urban Greening Initiatives: Implementing mandatory afforestation programs in cities (e.g., Baghdad, Basra) can reduce the urban heat island effect and improve air quality.

• Early Warning Systems for Extreme Weather: Establishing a national early warning system for dust storms, heatwaves, and floods can minimize economic losses and protect vulnerable communities.

• Climate-Resilient Agriculture: Encouraging farmers to adopt drought-resistant crops and climate-smart agricultural techniques can enhance food security and reduce dependency on climate-sensitive crops.

6. ETHICAL CONSIDERATIONS

This study relied solely on secondary data sources, including peer-reviewed research articles, government reports, and statistical data from the Iraqi Ministry of Planning and Statistics. No primary data collection involving human participants was conducted. Therefore, ethical approval was not required for this study. However, all referenced data sources were properly cited to ensure academic integrity and compliance with ethical research standards.

REFERENCES

[1] NASA. (2023). What's the difference between weather and climate? NASA Climate Change. https://climate.nasa.gov/resources/global-warming-vs-climate-change/, accessed on Feb. 20, 2025.

[2] SIS. (2023). Egypt's role in promoting the concept of climate justice and enforcing the principles of equity in COP27. The Egyptian Center for Human Rights Studies. https://hrightsstudies.sis.gov.eg/en/more/cop27-human-rights/studies/egypt-s-role-in-promoting-the-concept-of-

climate-justice-and-enforcing-the-principles-of-equity-in-cop27/.
[3] Shukla, P.R., Skea, J., Slade, R., Al Khourdajie, A., et al. (2022). Climate change 2022: Mitigation of climate change. Contribution of Working Group III to The Sixth Assessment Report of The Intergovernmental Panel on Climate Change, 10: 9781009157926. https://doi.org/10.1017/9781009157926
[4] Al-Kani, N.A. (2021). Climate change and its impact on the general trends of temperature during the summer solstice days in Iraq. Journal of Education College Wasit University, 2(44): 181-198. https://doi.org/10.31185/eduj.vol2.iss44.2360
[5] World Health Organization. (2023). Climate Change and Health. https://www.who.int/ar/news-room/fact-sheets/detail/climate-change-and-health.
[6] United Nations Environment Programme. (2021). Increasing Climate Change Impacts Require Enhanced Adaptation Efforts. https://www.unep.org/ar/alakhbar-walqss/alqst/m-tzayd-tathyrat-tghyr-almnakh-yjb-ly-alalm-ydaf-jhwdh-almnyt-baltkyf.
[7] World Bank. (2024). Climate change and its impact on economic and social development in the Arab world.
[8] Al-Nasrawi, S.J. (2022). Climate change in Iraq: A complex problem in need of a solution. College of Administration and Economics, University of Karbala. https://business.uokerbala.edu.iq/wp/archives/22409.
[9] Salim, A.M., Al-Hameedawi, S.M., Al-Mukhtar, A.A. (2021). The impact of climate change on seasonal temperature rates in Iraq for the period 1980-2019. Sirte University Journal for Humanities, 11(1): 410-458, https://doi.org/10.37375/sujh.v11i1.297
[10] Al-Tamimi, K.H.A., Mohammed, H.J. (2023). Climate and its impact on sustainability in Iraq. The International Journal of Humanities and Social Sciences, 51: 186-200. https://doi.org/10.33193/IJoHSS.51.2023.669
[11] Németh, K., John P., Lockwood, R.W. (2022). Hazlett: Volcanoes — Global Perspectives. Bull Volcanol, 73: 631-632. https://doi.org/10.1007/s00445-011-0479-7
[12] Sayed, H.A. (2019). Climate change: Its causes and consequences. The Academic Journal of Research and Scientific Publication, 1(5): 3-12. https://www.ajrsp.com/vol/issue5/.
[13] Abdullahi, M.B., Elnaggar, A.A., Omar, M.M., Murtala, A., Lawal, M., Mosa, A.A. (2023). Land degradation, causes, implications and sustainable management in arid and semi arid regions: A case study of Egypt. Egyptian Journal of Soil Science, 63(4): 659-676. https://doi.org/10.21608/ejss.2023.230986.1647
[14] Hammada, Emily, E. (2017). Climate change and sustainable environmental development in Egypt. Journal of Environmental and Energy Research, 6(8): 1-3. https://doi.org/10.21608/jbet.2017.135429
[15] Giacalone, J., Fahr, H., Fichtner, H., Florinski, V., Heber, B., Hill, M.E., Kóta, J., Leske, R.A., Potgieter, M.S. Rankin, J.S. (2022). Anomalous cosmic rays and heliospheric energetic particles. Space Science Reviews, 218(4): 22. https://doi.org/10.1007/s11214-022-00890-7
[16] Abdulkareem, I.H., Nemah, H.A. (2021). Variation of weather elements during different seasons in Iraq. Journal of Engineering Science and Technology, 16(6): 5000-5012. https://jestec.taylors.edu.my/Vol%2016%20Issue%206%20December%20%202021/16_6_43.pdf.
[17] Filippov, B. (2024). Magnetic fields on the Sun. In Eruptions on the Sun. Astrophysics and Space Science Library. Springer, Cham. https://doi.org/10.1007/978-3-031-58177-9_3
[18] Udochukwu, I.S., Innocent, A.E., Enthusiasts, S. (2024). The interplay between population growth and climate change: A critical analysis. International Journal of Innovative Science and Research Technology, 9(10): 986-993. https://doi.org/10.38124/ijisrt/ijisrt24oct644
[19] Edo, G.I., Itoje-akpokiniovo, L.O., Obasohan, P., Ikpekoro, V.O., et al. (2024). Impact of environmental pollution from human activities on water, air quality and climate change. Ecological Frontiers, 44(5): 874-889. https://doi.org/10.1016/j.ecofro.2024.02.014
[20] Al-Masoudi, F.U.K. (2024). Monitoring the change in annual drought conditions in Iraq for the period (1981-2022), using statistical methods and modern technologies. International Journal for Humanities & Social Sciences (IJHS), 1(2): 42-54. https://doi.org/10.69792/IJHS.24.2.5
[21] Rahmani , Z., Ahmadi, J. (2024). The impact of human activities on climate change. Sprin Journal of Arts, Humanities and Social Sciences, 3(6): 24-27. https://doi.org/10.55559/sjahss.v3i6.362
[22] Al-Asadi, S.A. (2002). The impact of the shape of the Shatt Al-Arab basin and the course on the drainage system. Iraqi Geographical Society Journal, (52).
[23] Al-Hadidi, N.A.H., Al-Saedi, M.A. (2022). Water Scarcity in Iraq: Causes, problems, and solutions. Journal of the Iraqi University, 55(1): 623-637. https://www.researchgate.net/publication/363582387_Water_scarcity_in_Iraq_causes_problems_solutions_sht_almyah_fy_alraq_alasbab_walmshakl_walhlwl.
[24] Central Bank of Iraq. (2011). Monetary policy report 2011. Central Bank of Iraq, Baghdad, Iraq, https://www.cbi.iq/documents/monetary_policy_report2011.pdf.
[25] Central Bank of Iraq. (2022). Financial stability report 2021. Baghdad, Issue 12, https://cbi.iq/static/uploads/up/file-167074229317374.pdf.
[26] Muhammed, M., Al-Dabbas, M. (2022). Impact of climatic change and shortage of water flow on the Euphrates River water salinity between Al-Hindyia and Al-Nasiriya, Southern Iraq. The Iraqi Geological Journal, 55(2A): 139-152. https://doi.org/10.46717/igj.55.2A.10Ms-2022-07-26
[27] The General Authority for Meteorology and Seismology, Iraq, Annual Climate Report, Baghdad, Iraq, 2011.
[28] Al-Lami, A.M., Al-Timimi, Y.K., Al-Shamarti, H.K. (2021). Spatiotemporal analysis of some extreme rainfall indices over Iraq (1981-2017). Scientific Review Engineering and Environmental Sciences, 30(2): 221-235. https://doi.org/10.22630/pniks.2021.30.2.19
[29] Hassan, W.H., Nile, B.K., Kadhim, Z.K., Mahdi, K., Riksen, M., Thiab, R.F. (2023). Trends, forecasting and adaptation strategies of climate change in the middle and west regions of Iraq. SN Applied Sciences, 5(12): 312. https://doi.org/10.1007/s42452-023-05544-z
[30] Al-Salihi, A., Mohammed T.H. (2015). The effect of dust storms on some meteorological elements over Baghdad, Iraq: Study cases. Journal of Applied Physics, 7(2): 1-7. http://doi.org/10.9790/4861-07220107
[31] Al-Husseini, C.F. (2015). Analysis of the fluctuation and

trend of dust phenomena in Al-Qadisiyah Governorate for the Period 1971-2010. Journal of Basic Education College for Educational and Human Sciences, University of Babylon, no. 20. https://jbehs.uobabylon.edu.iq/index.php/behs/article/view/20.

[32] Halos, S.H., Mahdi, S. (2021). Effect of climate change on spring massive sand/dust storms in Iraq. Al-Mustansiriyah Journal of Science, 32(4): 13-20. http://doi.org/10.23851/mjs.v32i4.1105

[33] Awadh, S.M. (2023). Impact of North African sand and dust storms on the Middle East using Iraq as an example: Causes, sources, and mitigation. Atmosphere, 14(1): 180. https://doi.org/10.3390/atmos14010180

[34] AlEnezia, A.F., Alalwanya, A.A., Al-Falahi, M.N.A., Salima, S.A. (2022). Study the variations of agricultural land degradation in Zawiyat Al-Dhban District (Abu Falis) within the arid environment of anbar governorate. IOP Conference Series: Earth and Environmental Science, 1060(1): 012130. http://doi.org/10.1088/1755-1315/1060/1/012130

[35] Ali, S.H., Qubaa, A.R., Al-Khayat, A.B.M. (2024). Climate change and its potential impacts on Iraqi Environment: Overview. IOP Conference Series: Earth and Environmental Science, 1300(1): 012010. https://doi.org/10.1088/1755-1315/1300/1/012010

[36] Salman, S.A., Shahid, S., Sharafati, A., Salem, G.S.A., Bakar, A.A., Farooque, A.A., Chung, E.S., Ahmed, Y.A., Mikhail, B., Yaseen, Z.M. (2021). Projection of agricultural water stress for climate change scenarios: A regional case study of Iraq. Agriculture, 11(12): 1288. https://doi.org/10.3390/agriculture11121288

[37] Makki, M.M. (2022). The effect of climatic characteristics on agricultural pests that infect the wheat crop in Najaf Governorate. Journal of Positive School Psychology, 6(6): 8239-8264.

[38] Murthy, H.S. (2022). Impact of climate change and global warming on aquaculture and fisheries: An insight. In Impact of Climate Change on Hydrological Cycle, Ecosystem, Fisheries and Food Security. CRC Press, pp. 163-170. https://doi.org/10.1201/9781003299769-16

[39] Al-Ansari, N., Abed, S.A., Ewaid, S.H. (2021). Agriculture in Iraq. Journal of Earth Sciences and Geotechnical Engineering, 11(2): 223-241. https://doi.org/10.47260/jesge/1126

[40] Agricultural Statistics Directorate-Central Statistical Organization / Iraq, April 2021.

[41] Ayoo, C. (2022). Poverty reduction strategies in developing countries. Rural Development-Education, Sustainability, Multifunctionality, 19. https://doi.org/10.5772/intechopen.101472

[42] Tackie, D.N.O. (2021). An examination of poverty: Dimensions, causes, and solutions. Journal of Rural Social Sciences, 36(2): 2. https://egrove.olemiss.edu/jrss/vol36/iss2/2.

[43] Republic of Iraq. (2018). Ministry of planning and development cooperation, central statistical organization, annual statistical bulletin (2003-2018), Baghdad, Iraq. https://www.cosit.gov.iq/ar/2018-2019?utm_source=chatgpt.com.

[44] Rabie, M.S., Timman, Z.L., Jasim, L.Q.H. (2024). The impact of climate change on air pollution in Baghdad and its health implications. Web of Humanities: Journal of Social Science and Humanitarian Research, 2(6): 1-15. http://webofjournals.com/index.php/9/article/view/1477.

[45] Aziz, H.W., Abdullah, A.J. (2015). Climate change and its effects on human health and comfort. Journal of Basic Education College for Educational and Human Sciences, 21. https://jbehs.uobabylon.edu.iq/index.php/behs/article/view/21.

[46] Siyama, I. (2015). Climate Change. Arab Journal. https://is.gd/wFXQyQ.

[47] Hoffmann, R., Andriano, L., Striessnig, E., Rüttenauer, T., Borderon, M., Grace, K. (2024). Climate change and population: Demographic perspectives on the 21st century's defining challenge. Vienna Yearbook of Population Research, 22. https://doi.org/10.1553/p-nfjc-z82h

[48] Arselan, C.A. (2010). Climatic change scenario (2007-2037) for Tuzkhormatoo region. Engineering and Technology Journal, 28(22).

[49] Arslan, C.A., Kayis, E. (2018). Weather forecasting models using neural networks and adaptive neuro fuzzy inference for two case studies at Houston, Texas and Dallas states. Journal of Asian Scientific Research, 8(1): 1-12. https://doi.org/10.18488/journal.2.2018.81.1.12

[50] Quiggin, D., De Meyer, K., Hubble-Rose, L., Froggatt, A. (2021). Climate change risk assessment 2021. The Royal Institute of International Affairs: London, UK. https://is.gd/DWiAGI.

[51] Nashour, I.K. (2017). Performance indicators of the tourism sector in Iraq and ways to develop it. Journal of Administration and Economics, 113: 382-401. https://admics.uomustansiriyah.edu.iq/index.php/admeco/article/view/746.

[52] Arslan, C.A., Ali, S.M., Amin, Y.A.H. (2021). Evaluation the water quality of Kirkuk irrigation project within Tuz district for different purposes. https://www.researchgate.net/publication/353573392_Evaluation_The_Water_Quality_Of_Kirkuk_Irrigation_Project_Within_Tuz_District_For_Different_Purpose.