International Journal of Studies in Business Management, Economics and Strategies
Volume 3, Issue 3, March - 2024
ISSN (E): 2949-883X
Scholarsdigest.org

MEASURING AND ANALYZING THE RELATIONSHIP BETWEEN CLIMATE CHANGES AND GROSS DOMESTIC PRODUCT GROWTH USING SIMULTANEOUS INTEGRATION TEST ACCORDING TO ARDL METHODOLOGY-IRAQ CASE STUDY

Asst. Prof. Dr. Ahmed.Hamdi Al-Husayny
Mustansiriyah University / Management and Economics
College/Department of Finance and Banking Sciences
dr.ahmad_hamdy@uomustansiriyah.edu.iq

Abstract
Extreme climate changes and their negative economic and financial repercussions are the main concerns of all developed and developing countries. Fluctuations in climate indicators directly impact the composition of GDP and thus their impact on economic growth rates, the current study focuses on measuring and analyzing the effects of climate variability on different indicators of economic growth rates. The study will draw on the nature of the relationships between climate change indicators as influential variables and GDP composition as an independent variable. This reflects economic growth rates on GDP time series data and climate change indicators for 2000-2022, the application of an econometrics study adopting the simultaneous integration test according to the self-regression methodology of distributed time gaps (ARDL), the stable study of time chains and the application of joint integration using the (ARDL) methodology, the study found a long-term complementary relationship between rainfall rates and economic growth rates, and a correlation between water revenue indicators, rainfall rates, greenhouse gas emissions, and short-term economic growth rates.
Accordingly, given the direct impact relationship between climate change and economic growth rates, the Iraqi Government is obliged to explore and investigate those potential impacts and develop government plans to reduce the negative impacts of climate variability.

Keywords: Extreme climate changes, economic growth rates, time chains, simultaneous integration test, ARDL.

Introduction

The world's countries are witnessing unprecedented mobility to cope with the dangers of climate change, which are far more serious than changes affecting the lives of biological organisms, these risks pose a challenge to the financial and economic systems and to the various countries of the world. Sudden changes in temperatures and fluctuations in rainfall rates in different parts of the globe rising sea levels from normal rates, increasing salinity and decommissioning of agricultural land, and other climate imbalances have affected directly or indirectly States' economies through their impact on economic growth rates, in addition to the

climate challenges, traditional challenges that have been and continue to be experienced by diverse economies are financial and economic challenges. Large financial institutions such as Leaman Brother's Corporation and other financial institutions are still not fully recovering from the mortgage crisis that hit the pillars of capital systems in 2008, the general lockdown was followed by the COVID-19 events, which led to the loss of significant figures in the financial and non-financial assets of those institutions. Recently, the world experienced a political and military crisis marked by the Russian-Ukrainian war followed by the Gaza War in October 2023, all those variables have directly or indirectly affected the financial and economic systems of the world's countries. Iraq is one of the countries directly affected by the above-mentioned challenges. The climate, financial, and economic challenges constitute a stumbling block to the advancement of GDP growth levels. These challenges are added to a number of challenges that the Iraqi economy has suffered and continues to suffer through structural imbalances in the composition of GDP owing to the legitimacy of Iraq's economy by relying on a single source of financing for economic activities, namely crude, its productive and banking apparatus is weak, labor market problems are exacerbated and unemployment rates are high, especially among young people, and other problems constitute a financial and economic burden on the government's budget.

1- Chapter I

Study methodology

1-1: First requirement: study plan:

1- objective of the study:

The current study aims to measure and analyze climate risks and their impact on GDP growth rates through their impact on Iraq's financial and economic variables. By analyzing what financial, economic, and climate data are available from local, regional, and international official sources, The use of such data to build a standard model to illustrate the extent to which the above-mentioned risks affect GDP growth rates.

2- The Importance of Study:

The importance of the current study stems from the fact that it introduced an important variable to a number of variables that directly affect the growth rate of the gross domestic product (GDP), the ecological variable (climate), which in one way or another affects GDP growth rates and thus the overall economic growth rate.

3- Study hypothesis:

The study is based on the premise that (***climate changes directly affect economic growth rates by influencing GDP components***).

4- Study Problem:

This study attempts to respond to the following questions through analytical and quantitative methods:

- **Does climate change as a challenge for the twenty-first century have an impact on economic activity and thus on the composition and growth rates of GDP?**

5- Study methodology:

Raised by the study, The study was divided into three chapters, the first chapter of which dealt with the study methodology divided into researchers, The first addressed the study plan in terms of relevance, objectives, hypothesis, and problematic of the study, The second research dealt with previous studies and the most prominent findings and considered them the cognitive basis from which the current study was initiated, the second chapter was divided into researchers. The first examined the theoretical rooting of the concept of climate challenges and risks that have an impact on GDP growth and the types of financial and economic risks caused by climate risks. The second examined the most prominent indicators of climate change in Iraq, which are expected to affect economic growth rates, the third and final chapter of the study was quantitatively designed through the application of a model (ARDL) (Self-degradation model of distributed deceleration) to prove or negate the nowhere hypothesis that stipulates (Lack of a statistically moral relationship between climate risks and economic growth rates) and the alternative imposition of (a statistically moral relationship between climate risks and economic growth rates), up to conclusions and recommendations.

6- The study's spatial and temporal ranges:

- Spatial scope: Republic of Iraq
- Time range: the study relied on data from local, regional, and international official sources for the period 2000-2022.

2-1: Requirement II: Previous studies:

Given the novelty of the study topic, especially after the introduction of the climate variable into financial and economic variables as influences of economic growth rates, the researcher did not find many studies on the subject in the course of the study. Below are the most prominent Arab and foreign studies in the study field:

1- Amani Abdul Ghafar Ahmed Ali's tagged study (Economic vision of the risks of climate change to sustainable development and ways to confront it in light of Vision 2030) (2019):

Through her study, the researcher tried to describe the current situation in the Arab Republic of Egypt and future perceptions of the world's climate changes and their impact on Egyptian agriculture and thus on agricultural output, the study reached a number of conclusions, notably that the risks of climate change have affected Egypt's economic growth sustainability plans through their impact on agriculture, tourism, and water and their reversal in declining economic growth rates, not to mention the effects of the acceleration of population growth in Egypt and its impact on economic resources, The study recommended the need to invest artificial intelligence applications and take advantage of the experiences of some countries in this field such as the United Arab Emirates. The study also recommended that clean

technology applications should be used to shift towards smart cities and develop a low-carbon industrial development strategy to address the risks of contemporary climate change.

2- The study (Rim Abdul Majid) tagged "The implications of climate change for the dimensions of human security in the countries of Southeast Asia" (2023):

In this study, the researcher tried to study the relationship of climate changes to human security by discussing climate changes in the countries of Southeast Asia and discussing the impact of climate changes on the region's economic, food, political, population, and environmental security, the consequences of climate changes in the South-East Asia region and their impact on human security cannot be overlooked, as the incidence of natural disasters, epidemics and disease is expected to increase due to climate changes and their increasing frequency, especially in the South-East Asia region, because of those challenges, financial and economic pressure will increase on the Governments of those States to design measures to address those challenges at the international and local levels. The research recommended the need for coordination and cooperation among States in the region through the implementation of strategies to address climate, financial, and economic challenges and the involvement of civil society organizations and religious institutions to meet those anticipated risks.

3- Nagam Hussein Nimah tagged study Managing Climate Change... Challenges and confrontation (2023):

The study confirmed that today's climate challenges are less serious than military challenges, wars, and armed conflicts in their economic and financial impacts. Despite climate changes, they occur in isolation from humanitarian intervention, such as changes in solar cycles, and cycles in oceans and seas, according to the researcher, according to a report by the Intergovernmental Panel on Climate Change (IPCC), human beings remain the most prominent accuser of these climate changes. (IPCC) in which confirmed (that there is a more than 95% probability that the temperature of the planet has increased due to human activities over the past 50 years and that industrial activities have increased atmospheric levels of carbon dioxide gas from 280 to 400 parts of a million over the last 50 years), the study recommended the need to build a growing alliance between countries to reach zero gas emissions with 2050 solutions and the need to reduce fossil fuel production by 6% annually during the decade 2020-2030.

4- Tagged Study (Challenges and Opportunities of Climate Change Policy in Various Stages of Economic Development) (2021):

The study examined the impact of growing economic growth rates by increasing international trade rates, foreign direct investment, and increasing the frequency of greenhouse gas renewable energy consumption, and fossil energy efficiency, and their impact on the increasing climate challenges facing economic policymakers in different countries of the world, and the study came to the important and dangerous conclusion that (increasing GDP growth rates contributed significantly to increasing greenhouse gas emissions, also growing international trade among different countries of the world has increased pollution rates

through export growth, and FDI has had a share in increasing the challenges of climate change. "The study recommended a number of recommendations in this regard, notably the need to use modern technology to exploit energy sources and make them efficient and low levels of pollution in the atmosphere and to shift from carbon to environmentally friendly renewable energy sources supportive of sustainable economic development.

5- Sergio Copiello & Carlo Grillenzoni study (Economic development and Climate changes. Which is the cause and which the Effect?) (2023):

The study showed that human beings and their production, consumption, and distribution activity are major causes of increasing greenhouse gas emissions and creating the climate challenge. The study attempted to link demographic growth, economic development, and climate change. The study relied on a model to demonstrate its hypothesis. (ARIMA-ARCH), which is based on the reconstruction of historical time chains of centuries-old data to illustrate the causal link between population growth and climate change, climate change has been a constant feature over the centuries, while human activities and swelling population growth are activities that increase global warming activity.

2- Chapter II

Climate risks and types of economic and financial risks caused by climate risks... Theoretical rooting

2-1: First requirement: Climate hazards... Conceptual framework:

2-1-1: Climate Risk Concept:

The global vision for climate issues has changed from simply scientific issues related to changes in the atmosphere and land to a national security issue for countries because of the risks caused by some severe climate changes, which cost billions of dollars in countries' balances to cope with those risks. (risk assessments based on formal analysis of the consequences, potential, and responses to the impacts of climate change and how societal constraints constitute adaptation options) [1], also can be defined climate risks can also be expressed as (applying common platforms and different strategies for assessing and managing risks arising from ecological hazards to climate impacts based on a changing and non-extremist climate system) [2], fifth assessment of the Intergovernmental Panel on Climate Change (IPCC) has given a different concept to the risks posed by climate changes as expressed as (Those effects of recent climate change extremes, such as global warming and droughts, floods, hurricanes and forest fires that reveal significant risks in some ecosystems and human systems exposed to climate change) [3], the United Nations Framework Convention on Climate Change (UNFCCC) also defined it as "changes in climate directly or indirectly attributable to humanitarian activity leading to changes in atmospheric and terrestrial composition" [4].

A study-specific concept of climate risk can be formulated and stated (***unexpected and sudden fluctuations in the ecological composition of the climate that directly or indirectly affect rates of heat, rainfall, wind, sea level fluctuations, greenhouse gases, carbon emissions, and leading to climate change***).

2-1-2: Types of risks from climate hazards:

Climate risks are not limited to global warming but are a mixture of two variables: global warming and greenhouse gas emissions resulting from man's economic activity. Extreme climate changes can affect certain economic and financial variables and thus stabilize the economic growth rate. This can be explained by the following:

1- Inflation risk and stabilization of overall price level:

Extreme climatic volatility and associated sudden and frequent phenomena can affect the stability of the overall price level by affecting the prices of certain essential commodities such as food, medicine, and energy, extreme weather events such as flooding or high drought rates and the resulting increasing salinity rates of agricultural land and environmental disasters affect and undoubted agricultural output and lead to supply-side economic shocks. This leads to significant relative increases in food price levels and thus higher inflation rates. Developing countries classified as middle or low-income countries whose agricultural output is the largest part of their GNP are probably the most affected by the risks of climate change. It is worth noting that these risks extend to the negative impact at advanced stages on both national income and employment [5].

2- Risk of rising poverty rates and threat to food security:

Development goals included 17 objectives supporting the achievement of a key objective of sustained economic development. Perhaps goal 13 of those goals explicitly referred to the need to address climate change, as emphasized in the Paris Climate Agreement of 2015 [6], because these changes threaten human water and food security, water and food security have a direct impact on agricultural output rates, which are one of the pillars of the composition of GDP. Therefore, negative climate changes are negatively reflected in the growth of agricultural production rates through its impact on water security, which is the first pillar of agriculture, also, declining agricultural production rates due to climate changes is one of the reasons for the increase in poverty and unemployment rates and their prevalence in societies because lower agricultural production rates will lead to surplus labor force in the agricultural sector. This will result in lower incomes of this group of workers resulting in lower overall demand and higher unemployment and poverty rates on the one hand. On the other hand, the decline in agricultural production directly threatens food security.

3- Risks of financial instability:

Climate changes and the resulting disruptions in ecological composition can result in severe economic and financial damage in the form of damage to physical assets, which are guarantees to financial and banking institutions. these climate challenges may lead to a reduction in the value of physical assets due to damage left by climate change. Through subsequent ramifications that adversely affect global supply chains, it also affects the availability of resources and all this adversely affects the financial stability of the economies affected by climate change [7], some recent studies show that climate changes, especially those related to global warming, can have a negative impact on workers' health and the attendant decrease in labor productivity and affect job supply. Global warming can also leave

a negative impact on buildings, machinery, and machinery, thus accelerating the process of extinction and eroding the value of capital at faster rates than expected, all affecting future production and price levels [8], in this context, climate turmoil and challenges can have serious implications for monetary policies targeted for financial stability because damage to physical capital, as explained, will drive enterprises and companies to channel their capital towards substitution and renewal to offset losses incurred by climate disruptions. This will reduce R & D-oriented capital, negatively affecting productivity growth rates, followed by a decline in balanced interest rates. [9], the so-called carbon bubble * may lead to further financial collapses in the value of physical assets in financial markets due to the reluctance of companies and institutions to invest in carbon-intensive assets. The value of these assets will be depreciated and investors will seek to dispose of them at any cost to avoid capital losses. Such contagion may extend to other investors. Thus, there will be a collapse in the value of the physical assets resulting in an explosion of the carbon bubble leaving negative effects on financial and economic stability [10], the following format illustrates the effects that climate challenges and risks can have on financial and economic stability:

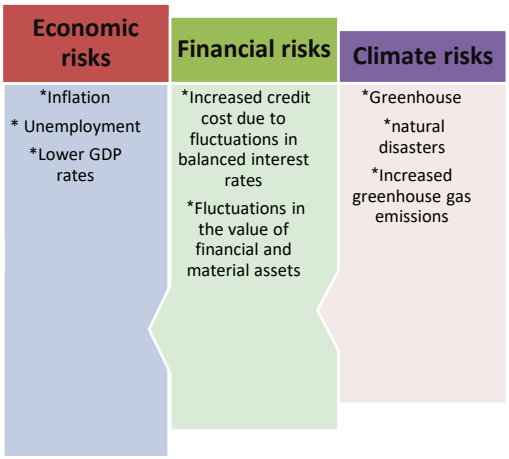

Figure (1): Relationship between climate, financial and economic risks

- researcher's preparation based on previous analysis.

(*) : Carbon Bubble: This term refers to the fact that carbon-related fossil fuel companies and enterprises are not properly resident in the stock market because the real value of the enterprises' access, which reflects the cost of policies and actions to be taken to cope with climate volatility, has not been implemented in determining the value of such enterprises and companies.

2-2: Second requirement: indicators of Iraq's climate change affecting economic growth rates:

Climate change affects various Iraqi economic sectors. These climate challenges have been reflected in Iraq's per capita living standards through their impact on water and food security. According to the sixth State of the World Environment Outlook Report for West Asia (GEO-

6), issued in 2019, Iraq was ranked among the five most vulnerable countries to climate change [11], this has been evident through its impact on financial and economic indicators, and will be relevant in a statement of the most prominent climate indicators that are expected to affect economic growth rates through their impact on certain financial and economic variables.

1- Temperature Rise Index:

Iraq classifies high-temperature countries with average high temperatures according to the latest report of the General Authority for Aerospace and Seismological Monitoring (28.5) ° C and average mini-temperatures (18.4) ° C [12], those temperatures are somewhat anomalous from the normal rate, which ranks between 0.9 and 1.5 ° C annually, while in Iraq the temperature rise rates are more than 5 ° C [13], this has brought the high temperatures above 50 degrees Celsius in the last five years, and the table shows the average temperatures for the study period.

Table (1) Average temperatures in Iraq for the period (2000-2022)/° C

Years	Average temperature/centigrade
2000	22.56
2001	23.06
2002	22.4
2003	22.5
2004	22.45
2005	22.47
2006	22.55
2007	22.41
2008	22.63
2009	22.54
2010	24.01
2011	22.01
2012	22.83
2013	22.41
2014	22.95
2015	23.16
2016	23.01
2017	23
2018	23.83
2019	23.16
2020	23.13
2021	24.42
2022	25.17

- Preparation of researcher based on: World Bank, Climate change in Iraq, Climate Change Knowledge Portal, https://climateknowledgeportal.worldbank.org/country/iraq/climate-data-historical

The following figure shows the fluctuation of average temperatures in Iraq during the study period:

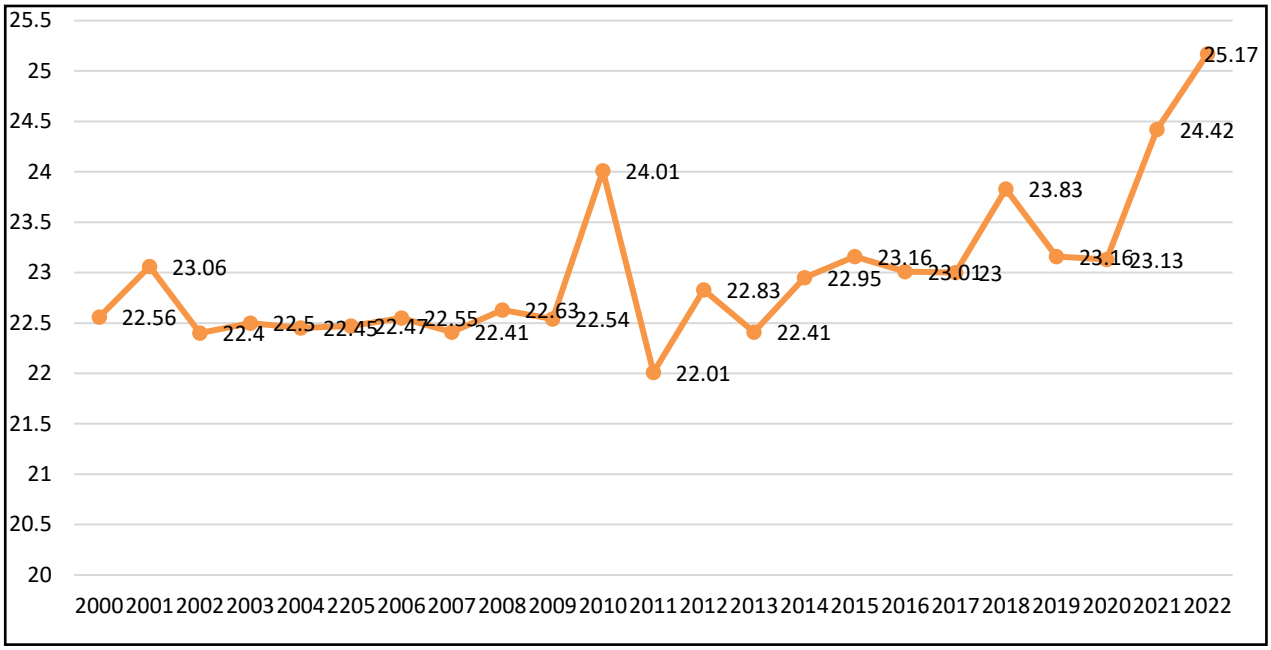

Figure (2) Average temperatures in Iraq for the period (2000-2022)/° C

- Researcher's preparation based on table (1) data

Note from the figure (2) that average temperatures are increasing on average as average temperature increases from (22.56) in 2000 to (25.17) in 2022, an increase of (2.61) ° C, temperatures are expected to increase at a rate (2) ° C by 2050 [14], hence high-temperature rates affect many economic sectors, most notably water resources, agriculture, health, and biodiversity.

2- Rainfall Index:

International reports from international bodies and institutions such as the United Nations indicated that rainfall rates in Iraq have seen successive declines in recent years, with rainfall rates expected to be 30% lower than in previous years [15], this explains the extreme climate changes of increasing heatwaves, high drought rates, high dunes and therefore reduced arable land areas from (23.4) million dunums in 2018 to (13.5) million dunums in 2021, and also to increase the areas of land threatened by desertification from (93.7) million dunums to (94.3) million dunums for the same period [16], certainly, the decline in agricultural output growth rates for the reasons cited leads to a decline in economic growth rates in general, and the following table shows the annual rainfall rates in Iraq during the study period.

Table (2) Annual rainfall rates in Iraq for the period (2000-2022)/mm

Years	Rainfall/mm
2000	250.13
2001	233.26
2002	198.11
2003	171.05
2004	193.66
2005	201.88
2006	110.25
2007	144.61
2008	118.73
2009	198
2010	111.38
2011	116.5
2012	148.09
2013	234.15
2014	176.17
2015	167.12
2016	137.62
2017	85.06
2018	286.9
2019	224.84
2020	164.4
2021	118.33
2022	170.24

- Preparation of the researcher based on data of the Central Bureau of Statistics, environmental statistics reports of Iraq - natural conditions and geographical characteristics, different years, https://www.cosit.gov.iq/ar/env-stat/envi-stat, meteorological center reports, different years, https://www.agromet.gov.iq/monthly_inv.php.

The following form shows the fluctuation in rainfall rates during the study period:

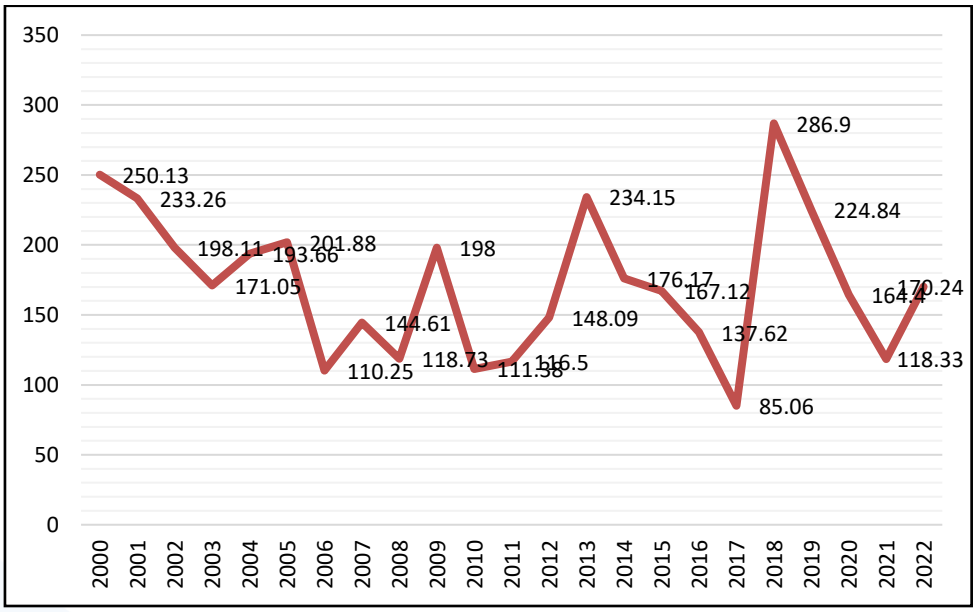

Figure (3) Rainfall rate in Iraq (2000-2022)/mm

- Researcher's preparation based on table (2) data.

From Figure 3, Iraq had the highest rainfall rate in 2018, at a rate of (286.9) mm, while the lowest rainfall rate was in 2017 at the rate of (85.06) mm, high rainfall rates in 2018 have had serious economic and financial consequences, According to the World Bank Group's

Climate and Development Report of December 2022, The torrents and river fires that occurred in 2018 in Nineveh governorates, Misan, Salahuddin, Wasit, Basra led to the displacement of more than 273 thousand people from their cities, mostly those working in the agricultural sector, As is known, cities are the centers of Iraq's economic and population growth.

3- Water Revenue Index:

The successful management of any resource requires accurate knowledge of that resource and also requires knowledge of the optimal uses of that resource, especially if it is a depleted resource, and economically exploits humanity by the amount (0.08%) of the total freshwater [17], undoubtedly, the global demand for freshwater is increasing as a result of several factors, perhaps most notably population growth and evolution in the standard of living. The sound management of water revenues is one of the most prominent determinants of economic growth in various countries. Iraq is one of the countries that has suffered from the scarcity of water revenues and the political reasons relating to water agreements with upstream States may have played a pivotal role in the management of this water resource on the one hand. On the other hand, climate challenges have deepened ecological fragility and this is evident in the decline in the water levels of the Euphrates and Tigris rivers. According to the Financial Stability Report issued by the Central Bank of Iraq in 2021, Iraq has lost its water flows from upstream countries: (Turkey, Iran, and Syria), by 29% And (73%), especially if we know that more than (50%) of Iraq's water sources are from those countries [18]. the following table shows the annual revenues of the Euphrates and Tigris rivers during the study period:

Table (3) Annual water revenues for the Euphrates and Tigris rivers (2000-2022)/1 billion cubic meters

Years	Total annual water revenues for the Euphrates and Tigris rivers/1 billion cubic meters
2000	36.08
2001	30.69
2002	53.95
2003	76.88
2004	66.05
2005	55.67
2006	65.20
2007	59.19
2008	35.07
2009	67.01
2010	67
2011	47.6
2012	51.54
2013	61.78
2014	52.34
2015	35.34
2016	54.75
2017	40.53
2018	32.96
2019	93.47
2020	49.59
2021	51.33
2022	44.25

- Source: Researcher's preparation based on: Central Bureau of Statistics, Water Resources Reports, different years cosit.gov.iq

- Source: Researcher's preparation based on: Republic of Iraq, Ministry of Water Resources Data, Planning and Follow-up Service, 2013.

The following form shows the fluctuation in water revenues during the study period:

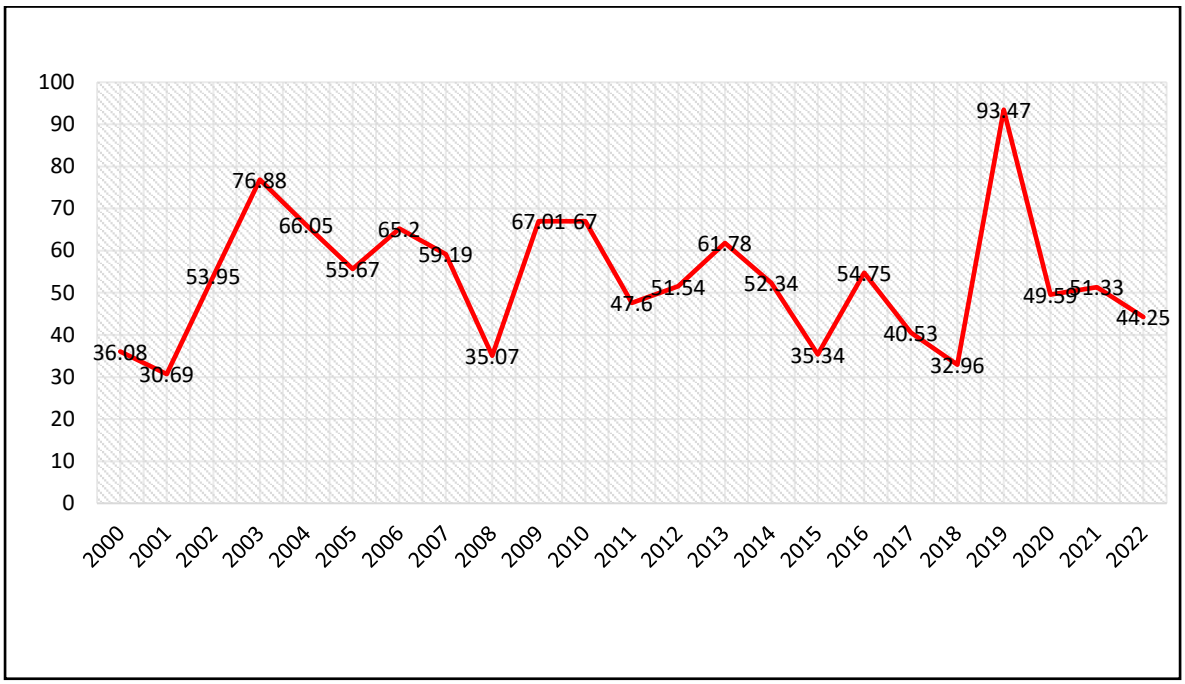

Figure (4) Total water revenue for the Euphrates and Tigris rivers (2000-2022)/1 billion cubic meters

- Researcher's preparation based on table (3) data.

From the previous figure, Iraq suffers from a shortage of water revenues. This is a direct reason for the decrease in rainfall rates, which has a negative impact on agricultural production, especially if we know that the decrease in water revenues leads to an increase in desertification and salinity in the land allocated to agriculture, resulting in a decrease in the agricultural sector's contribution to the composition of GDP and a threat to food and human security.

4- GHG Emission Index:

Greenhouse gases are nitrous oxide gas (NO2), carbon dioxide gas (CO2), and methane gas (CH4). All these types of greenhouse gases are believed to have direct impacts on the climate and pose risks for increasing global warming rates and thus have an impact on sustained growth of economic sectors, affecting GDP growth rates, it is worth mentioning that the fossil fuel-dependent economic sectors are the most likely to lead to a decline in economic growth rates due to their GHG production rates associated with production processes resulting in increased climate volatility and risks to economic growth and the table showing the amounts of GHG emissions during the study period.

Table (4) Quantities of greenhouse gas emissions in Iraq for the period 2000-2022

Years	CO2/MT emissions	NO2/MT emissions	CH4/MT emissions	Total emissions/million tons
2000	71715530	2915041	2090270	76720841
2001	84556040	2878124	2658320	90092484
2002	86322170	2525398	2658984	91506552
2003	90785440	2383569	1512315	94681324
2004	113635050	2689881	1618670	117943601
2005	112764260	2483426	1744310	116991996
2006	97964936	2532275	1709932	102207143
2007	61169412	2433355	1675855	65278622
2008	91803410	2534652	1792696	96130758
2009	102968940	274516	2005763	105249219
2010	110065830	2942942	1952980	114961752
2011	135274160	3112188	2008810	140395158
2012	153656660	3305264	2046029	159007953
2013	164850880	3169626	1997056	170017562
2014	166905260	3192965	1846138	171944363
2015	168214450	3381646	1561565	173157661
2016	194010860	4105888	636600	198753348
2017	211711280	4099644	1720384	217531308
2018	213431070	4245862	1717242	219394174
2019	187148430	4032738	1900040	193081208
2020	173507040	4096129	1779916	179383085
2021	185580690	4176222	1778363	191535275
2022	188755420	4833015	1789032	195377467

- Source: Researcher's preparation based on:
- Our World in Data based on the Global Carbon Project OurWorldInData.org/co2-andother-greenhouse-gas-emissions https://ourworldindata.org/co2/country/iraq.

The following format shows developments in Iraq's GHG emissions during the study period:

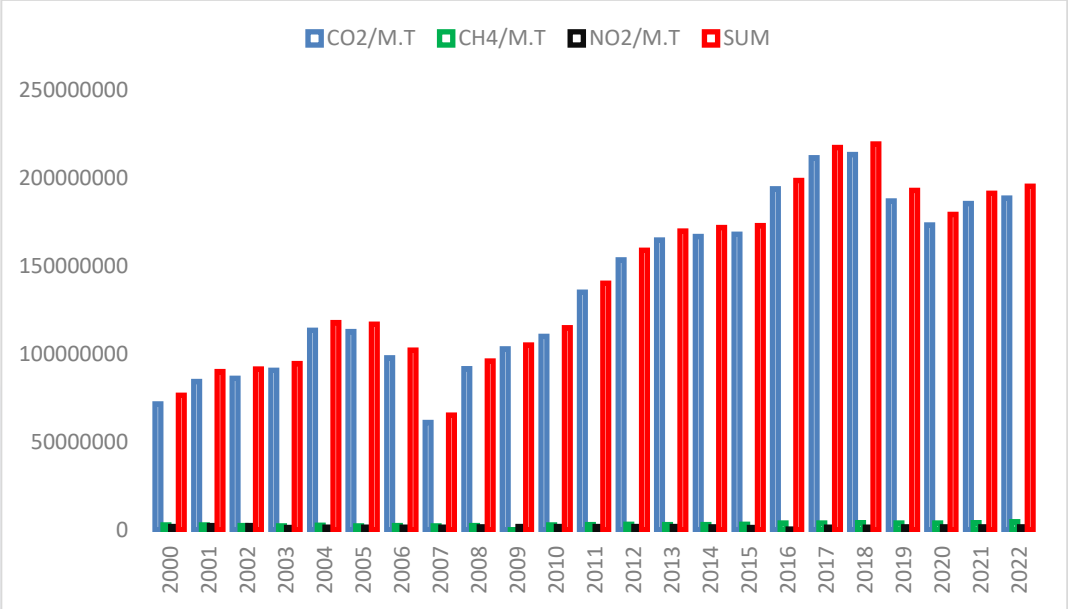

Figure (5) Greenhouse gas emissions in Iraq (2000-2022)/million tons

- Researcher's preparation based on table (4) data

From the previous figure, total GHG emissions appear to have increased overall over the period. (2000-2022) has reached a high in 2019, as total GHG emissions from (65278622) million tons in 2007, the lowest greenhouse gas emissions to (219394174) million tons in 2019, which is the highest level, and appears to be gas emissions (CO2) had the largest share of other greenhouse gas emissions.

Chapter III

Design of the ARDL model to measure the impact of climate changes on Iraq's economic growth rates for the period 2000-2022

In the current study, a model (self-regression of distributed deceleration) will be used (ARDL) to reveal the complementary relationship between economic growth rates (GGDP) (satellite variable), and among climate variables (HD, PR, WR, GGE) which are both (temperature rates, rainfall rates, water revenue rate, total greenhouse gas emissions) Time series (2000-2022) will be used to estimate the relationship between independent variables and dependent variables.

1- Study Model:

The study model can be formulated as follows:

$$\mathbf{GDP} = \propto_0 + \propto_1 \boldsymbol{HD} + \propto_2 \boldsymbol{PR} + \propto_3 \boldsymbol{WR} + \propto_4 \boldsymbol{GGE} + \boldsymbol{Ui} \dots \dots \dots$$

Where:

GDP: GDP at constant prices

$\propto_0$: Fixed limit

HD: Indicator of temperature rates

PR: Rainfall Index

WR: Water Revenue Index

GGE: GHG Total Emissions Index

: $\propto_1, \propto_2, \propto_3, \propto_4$ Interpretive Dependent Variable Response

Ui: random error element

The selection of ARDL methodology developed by both (Pesaran & Pesaran, 1997.2001), because of other joint integration test methodologies such as the (Johansen,1988) and the methodology (Engle & Granger, 1987), because the problem of uncertainty usually appears in time chains, also the degree of stability of time chains, and other methodologies are not ARDL requires complementarity in time series to be first class or zero degree, whereas in the methodology used in this study this does not require any complementarity of first class (I_1) or zero grade (I_0) or combination of both, by reformulating the equation (1) and placing it in the form of the unrestricted error model for self-degradation of distributed deceleration (ARDL), and to ensure that there are no sharp fluctuations between the values of the time series of the independent variables with each other or between the time series of the independent variables and the time series of the dependent variable, the formulation will be transformed into log wording and in the following form:

$$\ln GDP = \ln \propto_0 + \propto_1 \ln HD + \propto_2 \ln PR + \propto_3 \ln WR + \propto_4 \ln GGE + Ui \ldots\ldots\ldots\ldots 2$$

2- Descriptive Statistics:

When conducting metadata tests the results showed the following:

Table (5) Test results of model descriptive statistics

	LOGGDP	LNHD	LNPR	LNWR	LNGGE
Mean	2.052595	3.134366	5.103946	3.938963	18.71600
Median	2.221681	3.128075	5.137209	3.957761	18.75997
Maximum	2.421904	3.225653	5.659134	4.537641	19.20638
Minimum	1.340872	3.091497	4.443357	3.423937	17.99418
Std. Dev.	0.336195	0.031636	0.310054	0.286650	0.362412
Skewness	-0.742764	1.384425	-0.231357	-0.070531	-0.281691
Kurtosis	2.114273	4.487292	2.306908	2.413285	1.823535
Jarque-Bera	2.866665	9.466961	0.665544	0.348961	1.630574
Probability	0.238513	0.008796	0.716934	0.839893	0.442512
Sum	47.20968	72.09041	117.3907	90.59615	430.4679
Sum Sq. Dev.	2.486589	0.022019	2.114939	1.807702	2.889531
Observations	23	23	23	23	23

- Preparation of the researcher based on the results of the Eviews12 program.

From the previous table and by examining (Probability) for each model variable, it is clear that the variable temperature rates (HD) do not follow the normal distribution that P-Value has less than 5%. The rest of the model variables all had a value (P-Value) of more than 5%. The following format shows the normal distribution of model variables:

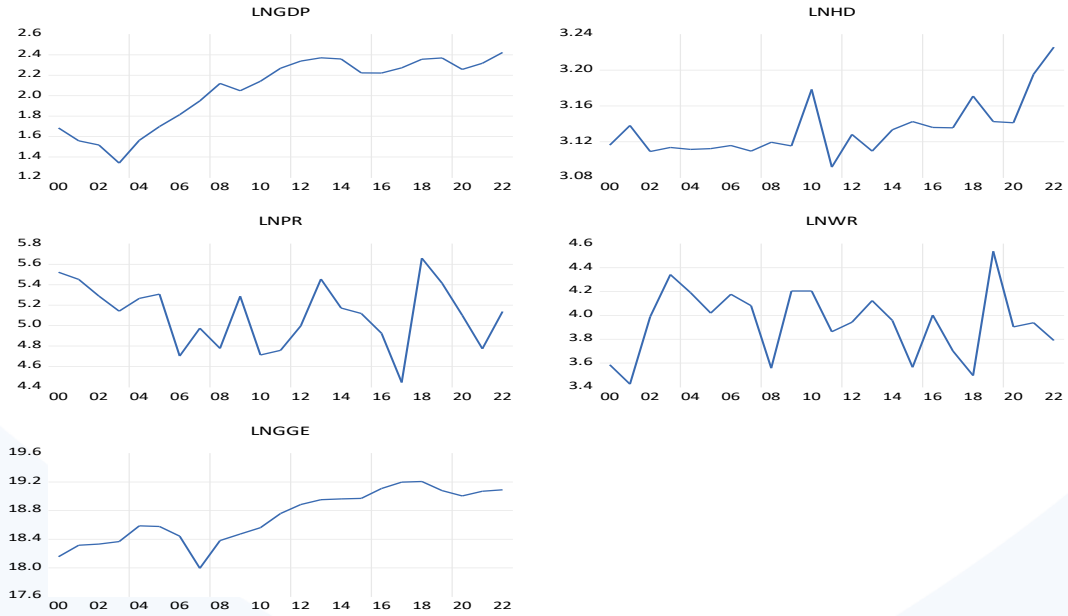

Figure (6) Natural distribution of model variables

Preparation of the researcher based on the results of the Eviews12 program

3- Unit root test using Phillips -perone (PP) test:

The PP test will be relied upon to detect the degree of integration of the variables used in the study and the degree of stillness of each variable:

Table (5) Results (Unit Root Test results) Using PP Test

PP test at Level					
LogGDP **With Trend&Intercept**				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			-1.844160	0.6484
	Test critical values:	1% level		-4.440739	
		5% level		-3.632896	
		10% level		-3.254671	
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	LOGGDP(-1)	-0.228216	0.145770	-1.565592	0.1339
	C	0.379319	0.225951	1.678767	0.1096
	@TREND("2000")	0.010331	0.007500	1.377442	0.1844
With Intercept				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			-0.787665	0.8029
	Test critical values:	1% level		-3.769597	
		5% level		-3.004861	
		10% level		-2.642242	
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	LOGGDP(-1)	-0.051832	0.071199	-0.727992	0.4751
	C	0.139037	0.146798	0.947134	0.3549
None				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			1.193504	0.9349
	Test critical values:	1% level		-2.674290	
		5% level		-1.957204	
		10% level		-1.608175	
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	LOGGDP(-1)	0.014752	0.011244	1.311991	0.2037
lnHD **With Trend&Intercept**				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			-3.415972	0.0749
	Test critical values:	1% level		-4.440739	
		5% level		-3.632896	
		10% level		-3.254671	
With Intercept					

				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			-1.541063	0.4947
	Test critical values:	1% level		-3.769597	
		5% level		-3.004861	
		10% level		-2.642242	
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	LNHD(-1)	-0.468349	0.259430	-1.805303	0.0861
	C	1.471010	0.812096	1.811375	0.0851
				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			1.265866	0.9425
	Test critical values:	1% level		-2.674290	
		5% level		-1.957204	
		10% level		-1.608175	
None	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	LNHD(-1)	0.001561	0.002146	0.727226	0.4751
				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			-4.164531	0.0176
	Test critical values:	1% level		-4.440739	
lnPR		5% level		-3.632896	
With Trend&Intercept		10% level		-3.254671	
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	LNPR(-1)	-0.922695	0.223112	-4.135560	0.0006
	C	4.740966	1.175217	4.034120	0.0007
	@TREND("2000")	-0.004388	0.010901	-0.402571	0.6918
				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			-4.360677	0.0027
	Test critical values:	1% level		-3.769597	
With Intercept		5% level		-3.004861	
		10% level		-2.642242	
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	LNPR(-1)	-0.902274	0.212669	-4.242614	0.0004
	C	4.586305	1.087132	4.218719	0.0004
				Adj. t-Stat	Prob.*
lnWR	Phillips-Perron test statistic			-7.552904	0.0000
With Trend&Intercept	Test critical values:	1% level		-4.440739	
		5% level		-3.632896	
		10% level		-3.254671	

	Variable Coefficient Std. Error t-Statistic Prob. LNWR(-1) -0.985849 0.220730 -4.466310 0.0003 C 3.961687 0.877835 4.513018 0.0002 @TREND("2000") -0.005435 0.009909 -0.548503 0.5897
With Intercept	Adj. t-Stat Prob.* Phillips-Perron test statistic -4.897701 0.0008 Test critical values: 1% level -3.769597 5% level -3.004861 10% level -2.642242 Variable Coefficient Std. Error t-Statistic Prob. LNWR(-1) -0.988828 0.216772 -4.561600 0.0002 C 3.910937 0.857552 4.560583 0.0002
lnGGE With Trend&Intercept	Adj. t-Stat Prob.* Phillips-Perron test statistic -2.196978 0.4680 Test critical values: 1% level -4.440739 5% level -3.632896 10% level -3.254671 Variable Coefficient Std. Error t-Statistic Prob. LNGGE(-1) -0.424122 0.193048 -2.196978 0.0406 C 7.760751 3.501110 2.216655 0.0390 @TREND("2000") 0.018468 0.010744 1.718895 0.1019
With Intercept	Adj. t-Stat Prob.* Phillips-Perron test statistic -1.365355 0.5800 Test critical values: 1% level -3.769597 5% level -3.004861 10% level -2.642242 Variable Coefficient Std. Error t-Statistic Prob. LNGGE(-1) -0.130570 0.094306 -1.384534 0.1814 C 2.484008 1.763737 1.408378 0.1744
None	Adj. t-Stat Prob.* Phillips-Perron test statistic 1.456513 0.9592 Test critical values: 1% level -2.674290 5% level -1.957204 10% level -1.608175 Variable Coefficient Std. Error t-Statistic Prob. LNGGE(-1) 0.002225 0.001822 1.221333 0.2355

- Preparation of the researcher based on the results of the Eviews12 program

From the results of table (5) note that all variables have not stabilized at the level except (PR, WR) they possess stable time chains at the level and with the constant limit i.e. (I_0), and when taking the first differences of unstable variables the results are as shown in table (6):

Table(6) Results of dormancy tests (unit root) after taking the first differences of variables with unstable time chains using Phillips-Perone PP test

					At first difference
LogGDP None				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			-3.477143	0.0014
	Test critical values:	1% level		-2.679735	
		5% level		-1.958088	
		10% level		-1.607830	
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	D(LOGGDP(-1))	-0.743730	0.213891	-3.477143	0.0024
lnHD None				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			-8.058372	0.0000
	Test critical values:	1% level		-2.679735	
		5% level		-1.958088	
		10% level		-1.607830	
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	D(LNHD(-1))	-1.498692	0.196538	-7.625446	0.0000
lnGGE None				Adj. t-Stat	Prob.*
	Phillips-Perron test statistic			-4.494050	0.0001
	Test critical values:	1% level		-2.679735	
		5% level		-1.958088	
		10% level		-1.607830	
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	D(LNGGE(-1))	-0.981486	0.218560	-4.490684	0.0002

- Preparation of the researcher based on the results of the Eviews12 program

Note from the previous table that all-time series that were unstable stabilized at the first difference (I_1).

- Test slowing periods using the standard (Akaike):

So that the variables are not self-related and fixed, the AIC Information Critemia Akaike rule has been used, with a maximum of two slowdowns for the dependent variable and independent variables.

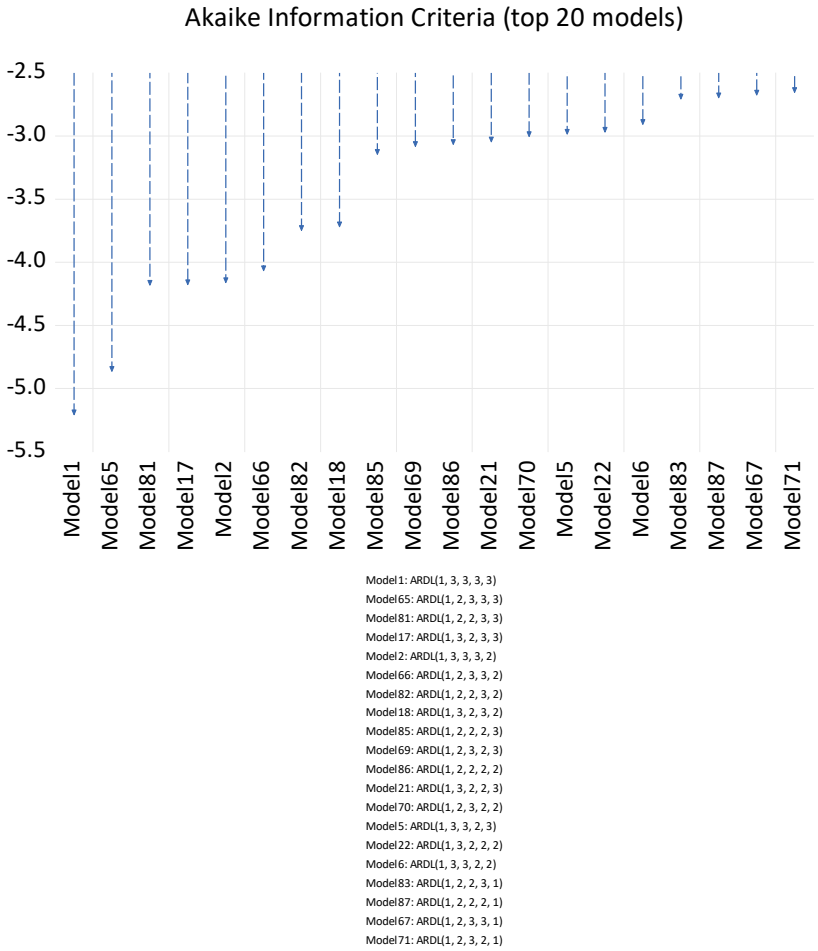

Figure (7) Slowing periods of study variables

- Preparation of the researcher based on the results of the Eviews12 program

From the comparison of the corresponding AIC values the ARDL (1,2,3,2,1) model was selected as shown in the above figure.

4- Co- Integration Test Using Border Approach:

In order to test for a long-term balance between model variables and economic growth variables represented by GDP, the study uses the "Bounds Test" method. This test is based on the nihilistic hypothesis that "there is no long-term balance between model variables" and the table below shows the results reached:

Table (7) Border test results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	54.30682	10%	1.9	3.01
k	4	5%	2.26	3.48
		2.5%	2.62	3.9
		1%	3.07	4.44

- Preparation of the researcher based on the results of the Eviews12 program

The previous table shows that the value of the statistic (F) exceeded Pesaran's upper and lower limits of 54.30682 and at morale levels (10%, 5%, 2.5%, 1%), thus rejecting the zero imposition and accepting the alternative imposition of (long-term balance between model variables).

5- Diagnostic tests to detect estimated model quality:

According to the ARDL methodology, it is assumed that all OLS method assumptions are valued, including that the model errors follow natural distribution, are not biased, have less variation and are consistent. To reveal the extent to which these assumptions are achieved, the study follows a set of diagnostic tests:

a- Natural Distribution Test for Random Errors (Normality Test):

There are a range of tests that reveal the natural distribution of random errors such as the Kurtosis test, the Skewness test and the Jarque-Berra test. Perhaps the last is the most famous test, which the study will rely on to test the H_0 hypothesis that the protector of the estimated regression equation is naturally distributed.

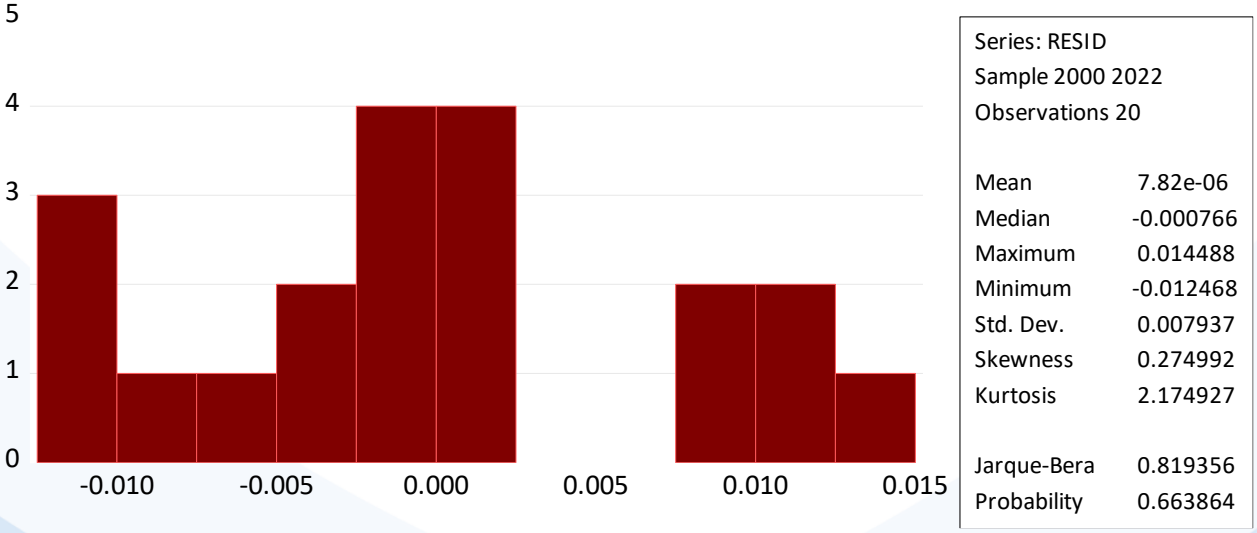

Figure (8) Natural Distribution Test for Estimated Model Protectors

- Preparation of the researcher based on the results of the Eviews12 program

Probability is greater than 5% and therefore the remains follow the normal distribution.

b- Autocorrelation Test:

The Durbin-Watson (D.W) test is one of the most famous tests to detect serial association, and there are other tests such as the (Durbin-h Test) H-Statistic, and Test (LM-Test) Breusch Goldfrey Serial Correlation, Most often a test is used (D.W) is famous but in the current study model is considered invalid as the affiliate variable added its slowed values as an independent variable in the regression model, so the LM test proposed by Breusch Goldfrey, which mandates imposition of nowhere in it, will be adopted (the absence of a serial self-association between the values of the retention), and the judge's alternative imposition (the existence of a serial link to the discretion protector).

Table (8) Breusch-Godfrey Serial Correlation LM Test results

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 1 lag

F-statistic	0.053605	Prob. F(1,2)	0.8384
Obs*R-squared	0.522058	Prob. Chi-Square(1)	0.4700

- Preparation of the researcher based on the results of the Eviews12 program

From the results of the previous test, we refuse to impose nowhere, i.e. no subjective correlation between the protector of the regression model.

c- Homoscedasticity Test:

There are a number of tests that reveal the problem of asymmetry, and the current study will rely on the ARCH-Test test to test the imposition of inequality (constant indiscriminate error limit variation in the estimated regression model), as opposed to the alternative imposition of variability.

Table (9) Heteroskedasticity Test: ARCH results

Heteroskedasticity Test: ARCH

F-statistic	0.636759	Prob. F(1,17)	0.4359
Obs*R-squared	0.685978	Prob. Chi-Square(1)	0.4075

- Preparation of the researcher based on the results of the Eviews12 program

From test results we accept the imposition of nowhere, that the probability value of a staple (F) is greater than (5%) i.e., the contrast is constant.

The results of previous diagnostic tests show that the proposed model of the study has a standard high quality, so the joint integration model will be estimated for both long and short generations.

6- **Estimate the joint integration model in the short and long term:**

The theoretical basis of the error correction model is the assumption that there is a long-term equilibrium relationship whereby the balanced value of economic growth is determined within its determinants, but sometimes the estimated values of the model are different from the balanced values of it, and the result is a balance error that can be adjusted or corrected in the long term, thus, the error correction model is based on the assumption that there are two forms of relationship between the rate of economic growth, represented by changes in GDP as a dependent variable and changes in climate indicators as separate variables, as long-term relationships are measured by the level of model variables. While short-term relationships are measured by changes between them during each time period, in order to ascertain a long-term balance between the proposed model variables, the study resorted to a co-integration test.

Table (9) Estimate ECM according to ARDL

ECM Regression
Case 1: No Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNWR)	0.266270	0.021579	12.33914	0.0011
D(LNWR(-1))	-0.210278	0.016038	-13.11135	0.0010
D(LNWR(-2))	-0.027345	0.010932	-2.501424	0.0876
D(LNPR)	-0.107653	0.009556	-11.26487	0.0015
D(LNPR(-1))	0.344707	0.017129	20.12449	0.0003
D(LNPR(-2))	0.089997	0.017602	5.112813	0.0145
D(LNHD)	0.840375	0.133187	6.309721	0.0080
D(LNHD(-1))	2.834875	0.158335	17.90434	0.0004
D(LNHD(-2))	1.440477	0.150988	9.540365	0.0024
D(LNGGE)	0.257319	0.026840	9.587105	0.0024
D(LNGGE(-1))	-0.369346	0.032616	-11.32404	0.0015
D(LNGGE(-2))	-0.092676	0.022469	-4.124705	0.0258
CointEq(-1)*	-0.373165	0.014825	-25.17101	0.0001

Levels Equation
Case 1: No Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNWR	2.012229	0.307911	6.535095	0.0073
LNPR	-2.039002	0.155762	-13.09048	0.0010
LNHD	-5.496660	0.857163	-6.412618	0.0077
LNGGE	1.159853	0.103958	11.15696	0.0015

EC = LOGGDP - (2.0122*LNWR -2.0390*LNPR -5.4967*LNHD + 1.1599 *LNGGE)

Methodology

- Preparation of the researcher based on the results of the Eviews12 program

7- Structural Stability Test for Model Transactions:

This test is used to ensure that the estimated model is free of any structural changes by conducting two tests through which the structural stability of the estimated model's short and

long term transactions is tested, as the first test is the cumulative total of the protectors (CUSUM) The second test is the total test of cumulative retention boxes (CUSUM of Sequers) *, these tests are based on two hypotheses, zero imposition (H_0) structural instability of estimated parameters and alternative imposition (H_1) that structurally estimated parameters are stable, so that the graph of tests within critical boundaries falls at a 5% morale level, zero imposition is rejected and the estimated parameters are structurally stable.

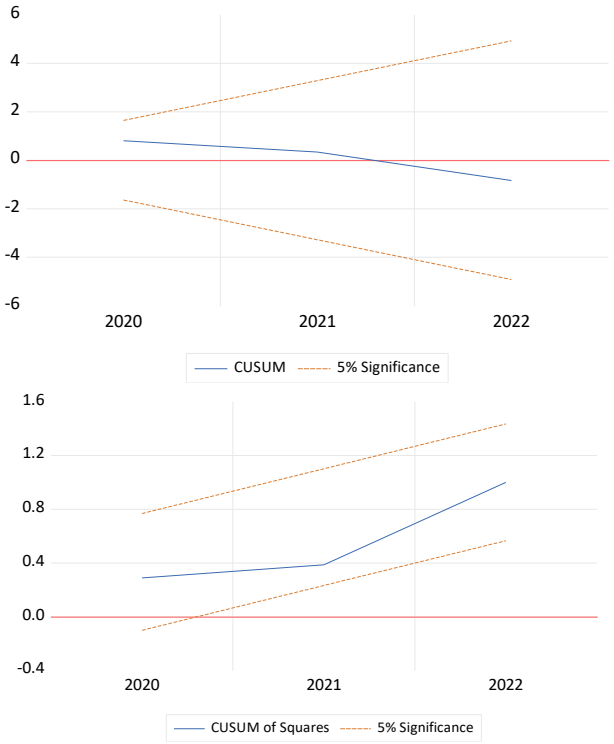

Figure (9) Cumulative Total Test For Parcels And Bouquet Boxes

- Preparation of the researcher based on the results of the Eviews12 program

From the previous figure, it is clear that the cumulative total of the protectors and the oblique squares lies within the boundaries of the critical area, confirming the stability of the estimated model at a morale level of 5%, so it can be said that there is consistency and stability between the short and long term results of the estimated model, after confirmation of long-term balance as shown in the table (7), table (9) shows the results of the joint integration, as the top of the table represents the estimate of the short-term relationship. The bottom of the table is the form of the long-term relationship. The results of the estimate of the long-term relationship show that the variable rainfall rates are statistically moral at a moral level (5%),

(*) : **Brown and al, Techniques for testing the constancy of regression relationships over time, Journal of the Royal Statistical society, serirs B, 37, 1974, pp 153.**

It has a negative impact on the GDP composition rate, meaning that an increase in rainfall rates by 1% leads to a decline in GDP composition rates by 2.03% annually, this explains that increased rainfall rates lead to severe economic and financial damage through fires and floods that displace thousands of families from their areas of residence and leave them to work, especially as most of them are employed in the agricultural sector, resulting in a decline in the productivity of this important sector in the composition of GDP and thus leaving negative effects on economic growth rates, the variable in water revenues has had a positive impact on the composition of GDP and has been statistically moral. Increasing water revenues by 1% increases the composition of GDP by 2.03%, this confirms the positive effects of increased water revenues on the composition of GDP through their effects in other economic sectors such as the agricultural and industrial sector and thus on economic growth. The variable temperatures have come morally and negatively in GDP composition rates, increasing the variable temperatures by 1%. GDP composition declines by 5.5% This underscores the harms of global warming, rising temperatures in the economic sectors, especially agriculture, as well as health for workers, all of which have led to declining economic growth rates.

Finally, the GHG variant is statistically moral and has a positive impact on GDP composition, increasing GHG emissions by 1%. Increases GDP composition by 1.15% The explanation for this is that the increase in greenhouse gas emissions is an indication of the increased use of fuel by its types in production processes and increased production has a positive impact on the increased composition of GDP and long-term economic growth rates.

At the top of table (9), error correction flexibilities appear, and the estimate results show that all variables are statistically significant at moral levels (5%), the Water Revenue Index (WR) has been positive in the sense of increasing water revenues by 1% in the short term will increase the composition of GDP by 2.66% in the short term, the variable rainfall rates were statistically significant and had a negative impact in the short term. An increase in rainfall rates by 1% led to a decline in GDP composition by 1.07%, the variable of rising temperatures is statistically moral and has a positive effect in the short term. Increasing temperatures by 1% increases the composition of GDP by 8.4%. The first slowing of the GHG emission index variable is negative, in other words, increasing greenhouse gas emissions by 1% will lead to a reduction in GDP composition by 3.7% in the short term.

In the light of the results shown in table (9), note the morale of the error correction limit slowing factor at a moral level (1%) The purpose of the slowing factor of the error correction limit is to identify the slowness or speed of the return of the estimated model variables to the state of equilibrium. The morale of the error correction limit factor indicates a long-term balance relationship. It is necessary to limit its value between (0.1) to not falling into the problem of false regression. * This confirms the existence of a long-term balance relationship.

The error correction threshold (37.3) was valued at a very negative and morally high value (0.0001) at a moral level (1%) which means that the return to balance was sufficiently rapid. From the foregoing in the theoretical and applied framework of the study, it can be emphasized that the study's hypothesis has been realized and there are indeed direct impacts

of climate changes on GDP composition rates and thus economic growth, varying in terms of impact from variable to variable.

Conclusions and recommendations

a- Conclusions:

1- From the results reached in the applied aspect, there is a reverse relationship between rainfall rates and long-term GDP composition rates from 2000 to 2022.

2- The sharp fluctuations in rainfall rates have had negative consequences for GDP composition rates through their impact on increasing the reverse rates of displacement from agricultural areas to city centers on the one hand. On the other hand, agricultural sector's contribution to GDP composition has decreased due to floods and floods that have damaged most agricultural crops.

3- The results of the economic measurement showed a correlation between increased water revenue rates and short-term GDP composition rates, But the impact is somewhat minimal contrary to what is expected due to the lack of optimum utilization of water releases from upstream countries and the presence of significant waste in Iraq's water resource on the one hand. On the other hand, successive Iraqi Governments, since the 2003 change in the political system, have not been serious about developing effective national strategies for investing water revenues.

4- The results of the study confirmed a reverse correlation between increased greenhouse gas emission rates and short-term GDP composition rates, in particular CO2 emissions, as shown in table 4 of the study.

b- Recommendations:

1- The need to urgently develop a national water resources strategy aimed at establishing appropriate mechanisms for the investment of water revenues, which is the key to revitalizing the agricultural sector and increasing its contribution to the composition of GDP, thereby increasing expected economic growth rates.

2- The need to develop an annual national plan to develop rainfall harvesting mechanisms, especially in governorates where rainfall rates are increasing, and to take advantage of the water resource from rainfall, from a risk indicator to a support indicator for economic growth rates.

3- Encourage the State and community banking sector and reconsider granting green credit to its beneficiaries in order to reduce environmental-contaminated economic activities and shift towards environmentally friendly economic activities with a view to reducing greenhouse gas emission rates and thereby improving economic growth rates.

(*) : **Helmut Lutkepohl and Markus Kratzig, Applied time series econometrics, CAMBRIDGE university press, 2004, pp 9.**

4- Allocate at least 10% of public budget revenues to increase green spaces and reduce desertification rates in order to reduce global warming rates. The study has shown that they have negative economic and financial repercussions through their impact on the health of workers in the economic sectors and thus reduce their productivity rate on the one hand. On the other hand, it affects infrastructure and physical assets by increasing the frequency of consumption ratios of machinery and machinery and decreasing the financial value of such assets, thereby reducing capital accumulation rates and resulting in lower GDP and economic growth rates.

References

1. "General Authority for Aerospace and Seismic Monitoring Natural Condition Schedules 2020," vol. 4, 2020.
2. "Sustainable development agenda -- sustainable development."
3. A. Bowen and S. Dietz, “The effects of climate change on financial stability, with particular reference to Sweden,” 2016.
4. A. Breitenfellner, W. Pointner, and H. Schuberth, “The potential contribution of central banks to green finance,” *Vierteljahrshefte zur Wirtschaftsforsch.*, vol. 88, no. 2, pp. 55–71, 2019, doi: 10.3790/vjh.88.2.55.
5. BOE, “The impact of climate change on the UK insurance sector,” A Clim. Chang. Adapt. Rep., no. September, pp. 1–87, 2015, [Online]. Available: http://www.bankofengland.co.uk/pra/documents/supervision/activities/pradefra0915.pdf.
6. De Nederlandsche Bank (DNB), “DNB Occasional Studies: Central bank and prudential supervisor of institutions,” *DNB Occas. Stud.*, vol. 16, no. 7, 2018, [Online]. Available: https://www.dnb.nl/binaries/OS_Transition risk stress test versie_web_tcm46-379397.pdf. http://www.centralbank.org.bb/news/article/10982/the-2021-financial-stability-report.
7. IPCC, Technical Summary. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. 2021.
8. J. Studies, “Middle east Journal of Legal and Jurisprudence Studies,” vol. 2211, pp. 64–76, 2022.
9. K. Z. (Canada) Myles Allen (UK), Mustafa Babiker (Sudan), Yang Chen (China), Heleen de Coninck (Netherlands), Sarah Connors (UK), Renée van Diemen (Netherlands), Opha Pauline Dube (Botswana), Kris Ebi (USA), Francois Engelbrecht (South Africa), Marion Ferrat (UK/France), “GLOBAL WARMING OF 1. 5 ° Can IPCC special report on the impacts of global,” Ipcc, no. October 2018, 2018, [Online]. Available: https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/.
10. L. J. Beaumont, A. Pitman, S. Perkins, N. E. Zimmermann, N. G. Yoccoz, and W. Thuiller, “Impacts of climate change on the world’s most exceptional ecoregions,” Proc. Natl. Acad. Sci. U. S. A., vol. 108, no. 6, pp. 2306–2311, 2011, doi: 10.1073/pnas.1007217108.
11. M. Carney, “Breaking the tragedy of the horizon - climate change and financial stability - speech by Mark Carney | Bank of England,” Bank Engl., no. September, pp.1–

16,2015,[Online].Available: https://www.bankofengland.co.uk/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability.

12. W. N. Adger, I. Brown, and S. Surminski, “Advances in risk assessment for climate change adaptation policy,” Philos. Trans. R. Soc. A Math. Phys. Eng. Sci., vol. 376, no. 2121, 2018, doi: 10.1098/rsta.2018.0106.
13. Ф. Котлер, "World Bank Group Climate and Development Report", p. 282, 2008.
14. UN Environment, GEO-6 HEALTHY PLANET , HEALTHY PEOPLE Edited by. 2019.
15. Central Bureau of Statistics, "Environmental Statistics Report 2021 Agricultural Indicators," No. Ccdm, p. 2022. 2022.
16. J. Ward, “Climate Change 2014. Impacts, Adaptation, and Vulnerability. Top-level findings from the working group II AR5 summary for policy makers,” Ipcc, 2014, [Online]. Available: http://hdl.handle.net/1826/309.
17. Central Bank of Barbados and Financial Services Commission, “2021 Financial Stability Report,”pp.1–94, 2022, [Online].Available:
18. P. Analysing, “ECOLOGICAL,” 2023.