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Greenhouse gas emissions from North African Countries

انبعاثات الغازات الدفيئة من دول شمال أفريقيا

Suliman, Alaa* (1) Mahmoud, Amgad (2) Eid, Mohamed(3)

(1) Corresponding author: Institute of African and Nile Basin States Researches & Studies, Aswan University

(2) Faculty of Science - Al-Azhar University

(3) Faculty of Science - Al-Azhar University

Abstract:

In this paper, we collect data on greenhouse gas emissions, (carbon dioxide CO2, Methane CH4, and Nitrous oxide N2O), from the North African region represented by five coastal countries; overlooking the Mediterranean Sea, Egypt, Libya, Tunisia, Algeria and Morocco, as well as analyzing data to determine the proportions and rates of these emissions from the five countries. Determine the behavior of these gases in these regions. In our study, we determined each country’s contribution to these emissions; Through data analysis, average annual and monthly changes in gas emissions from the study area were identified.

The study is showed an increase in emissions and concentrations of the three gases in the study area: In conjunction with a steady increase in temperatures; by analyzing the slopes of gas emissions and concentration curves, as well as temperatures; all of them were found to have a positive tendency; which means their value increases. The study also showed a positive correlation between temperature changes and changes in emissions of the three gases: Although temperatures are affected by other factors such as wind movement and weather fluctuations.

Keywords— Greenhouse Gases; GHGs; North Africa; infrared radiation; the global warming; Climate changes; Carbon dioxide; CO2; Methane; CH4, Nitrous oxide

الملخص

نقوم في هذه الورقة بجمع بيانات عن انبعاثات الغازات الدفيئة من منطقة شمال أفريقيا ممثلة بخمس دول ساحلية؛ تطل على البحر الأبيض المتوسط. مصر ؛ ليبيا؛ تونس: الجزائر والمغرب، بالإضافة إلى تحليل البيانات لتحديد نسب ومعدلات هذه الانبعاثات من الدول الخمس. وتحديد سلوك هذه الغازات في هذه المنطقة. وسنركز في دراستنا على ثلاثة غازات: ثاني أكسيد الكربونCO2 ؛ الميثانCH4 ؛ وأكسيد النيتروز N2O ، تم جمع بيانات عن انبعاثات الغاز من ثلاثة بلدان في شمال أفريقيا؛ تحديد مساهمة كل دولة في هذه الانبعاثات؛ ومن خلال تحليل البيانات تم تحديد متوسط التغيرات السنوية والشهرية في انبعاثات الغاز من منطقة الدراسة.

وأظهرت الدراسة زيادة في انبعاثات وتركيزات الغازات الثلاثة في منطقة الدراسة: بالتزامن مع الارتفاع المطرد في درجات الحرارة؛ وذلك من خلال تحليل منحدرات انبعاثات الغازات ومنحنيات التركيز وكذلك درجات الحرارة؛ وقد وجد أن جميعهم لديهم نزعة إيجابية؛ مما يعني أن قيمتها تزداد. كما أظهرت الدراسة وجود علاقة إيجابية بين التغيرات في درجات الحرارة والتغيرات في انبعاثات الغازات الثلاثة: على الرغم من أن درجات الحرارة تتأثر بعوامل أخرى مثل حركة الرياح والتقلبات الجوية. يمكننا القول أن الغلاف الجوي هو مصدر شائع للغازات الدفيئة؛ وسيؤثر ذلك على ارتفاع درجات الحرارة في العالم ككل.

INTRODUCTION

Over the past 250-year years, due to industrial and agricultural activities, human activities have been instrumental in increasing the concentrations of CO_2, CH_4, and N_2O concentrations in the Earth's atmosphere. The global atmospheric concentrations of CO_2 and CH_4 during 1999, were 30% and 145% respectively, was higher than pre-industrial levels due to human activities. These are considered to be the main forces behind global climate change. It is reported that human activities are directly contribute to more than three-quarters of all Greenhouse Gases (GHG) emissions and also affect sinks. Moreover, the growing evidence of large-scale climate modifications due to the increased concentration of GHGs represents a worrying signal at both the regional and global scales. [1][2][3][4][5]

GHGs are essential to the Earth for various reasons. Their concentration in the atmosphere varies through natural and human-induced processes. However, the current trend that the Earth faces is that GHGs are increasingly in the atmosphere due to human activities, causing global climatic impacts.[6][7][8][9][10]

Greenhouse gases (GHGs) are gases in the atmosphere that have the property of absorbing and emitting infrared radiation. Greenhouse gases are represented by a group of gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone, (O_3); Water vapor (H_2O), Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), as well as sulfur hexafluoride (SF_6). [11][12][13]

AREA OF STUDY

Northern Africa, is a region encompassing; the northern portion of the African; continent. There is no singularly accepted; scope for the region, and it is sometimes. defined as stretching from the Atlantic shores of Mauritania in the west, to Egypt's Suez Canal in the east. (fig1)

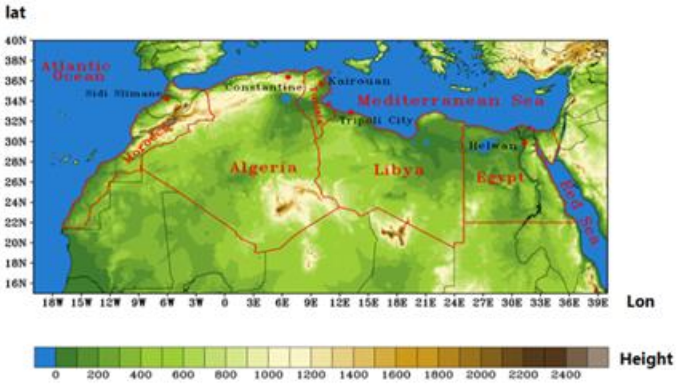

Figure (1) : North Africa

DATA AND METHODOLOGY

In this study, we used two data sources: World Meteorological Organization (WMO) data. The Copernicus Atmosphere Monitoring Service and the European Climate Assessment & Dataset. Where the data were processed statistically by The Grid Analysis and Display System (GrADS). Data were analyzed from the European Climate Assessment & Dataset; and the graphs show average monthly and secondary CO_2, CH_4, and N_2O greenhouse gas emissions from North African countries; The total monthly and annual averages of these emissions were also calculated from the countries of the region.

Data from the Copernicus Atmosphere Monitoring Service was also used by The Grid Analysis and Display System (GrADS) software; to extract and display images showing greenhouse gas gathering areas above this area; And to know its spatial and temporal distribution. Relying on the data; we will discuss the three greenhouse gas emission rates; In the five North African countries, Egypt; Libya; Tunisia; Algeria, and Morocco; During the period from 2003 to 2020; and identify the most important sectors that contribute to these emissions; As well as areas that collect these gases over North Africa; And its effect on the local temperatures in the areas of concentration of these gases; And its contribution to global warming.

RESULT AND DISCUSSION

In this section we will address the results of data processing; To reach a clearer view of the flue gas emissions over the study area; In terms of emission rates, quantities of pollutants, and the share of each country, as well as the distribution of these pollutants over the study area; down to its effect on temperatures.

1.2 Greenhouse gas emissions from North Africa

According to the data of the European Climate Assessment & Dataset, the total annual average emissions of CO_2 gas from the North African region, specifically the five countries under study, are about 733031.57 $MtCO_2e$; 70131.85 $MtCO_2e$ OF CH_4 and 14106.48 $MtCO_2e$ of N_2O in the period from 2003: 2020.

By comparing the emissions of CO_2, CH4, and N_2O, we will find a large difference in terms of quantity. The quantities of CO_2 far exceed the amounts of emissions of CH_4 and N2O,

by reviewing the monthly averages of emissions of the three gases; We find that carbon dioxide increases in the winter and the highest concentrations of CO_2 emissions reach in January. While the lowest concentrations of its emissions are in the spring during April and May; As for CH_4 and N_2O, emissions are significantly lower than carbon dioxide, but they are close throughout the months of the year. (Fig 2)

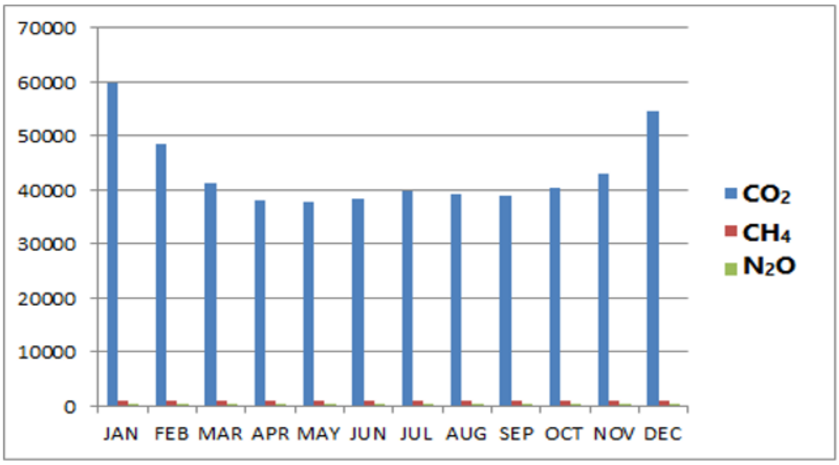

Figure (2) : showing the monthly averages of CO_2,CH_4 and N_2O emissions during the period 2003 – 2020,

1.3 CO2

Annual averages of carbon dioxide emissions in the study area indicate a general increase until 2019 and a decrease in 2020. (Fig 3)

In general, average carbon dioxide emissions in the study area increase during the winter, specifically in January. Then it begins to gradually decrease to be at its lowest levels during the spring and summer seasons. Then it rises again in the fall, starting in October. (Fig 4)

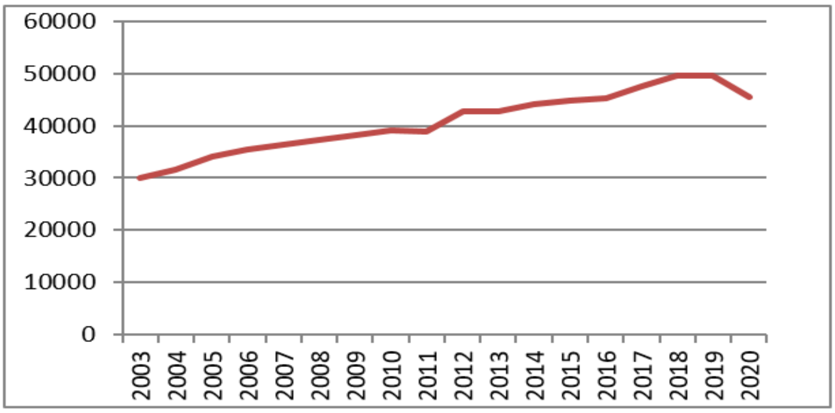

Figure (3): shows the average annual emissions of CO_2 from North Africa during period 2003 – 2020.

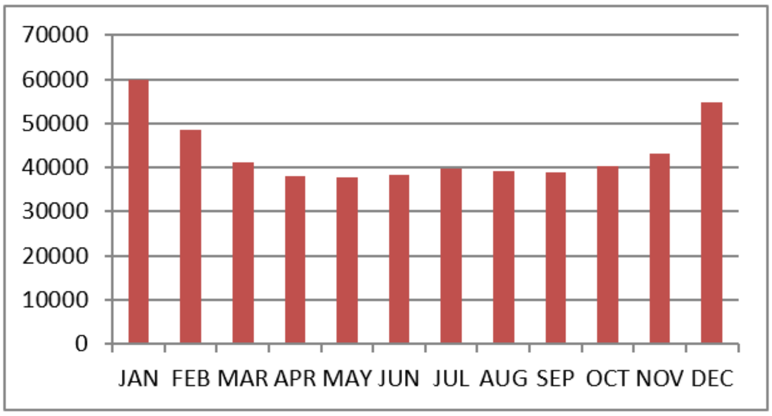

Figure (4): shows the monthly averages of CO_2 emissions from North Africa during the period 2003 – 2020.

The data shows a difference in carbon dioxide emissions from North African countries. Where emissions record their highest rates from Egypt and then Algeria. While Libya and Morocco exchange their rates; Where emissions from Libya rise in the period before 2010; Then lower emissions were recorded from Morocco starting in 2011; Emissions from Tunisia come in last place during the study period.(fig 5)

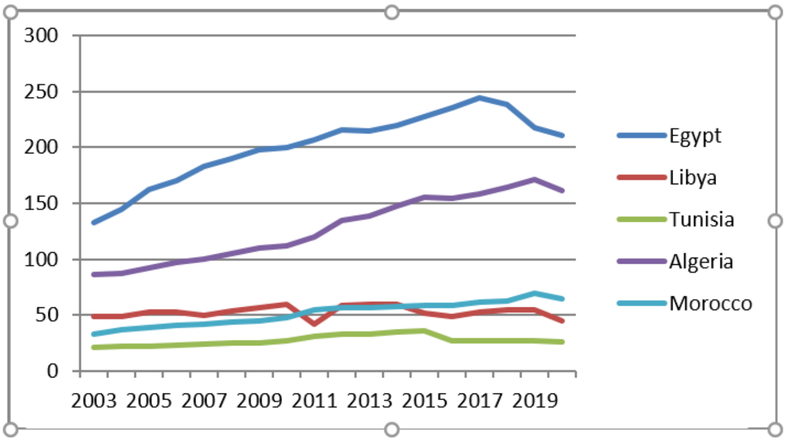

Figure (5) : shows average annual emissions carbon dioxide gas from North African countries.

1.4 CH4

Average annual emissions of methane in the study area indicate a general increase during the years of the study until 2019, then decreased in 2020. (Fig 6)

Monthly averages of methane emissions indicate a clear increase in emissions during the summer, beginning to decrease and reaching their lowest levels at the beginning of the spring, then gradually increasing again. (Fig 7)

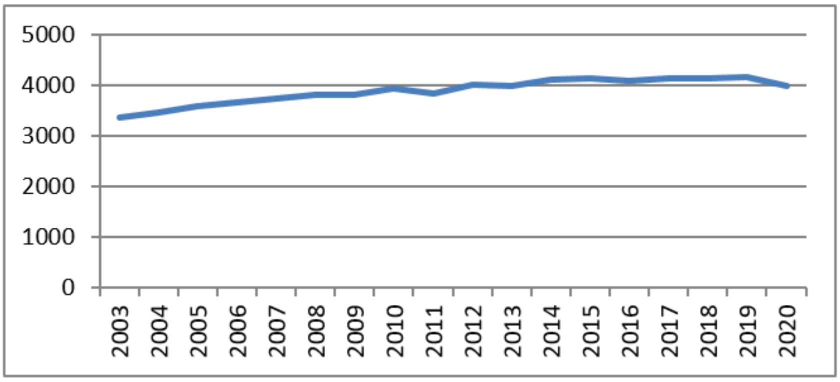

Figure (6): shows the average annual emissions of CH_4 from North Africa during the period 2003:2020.

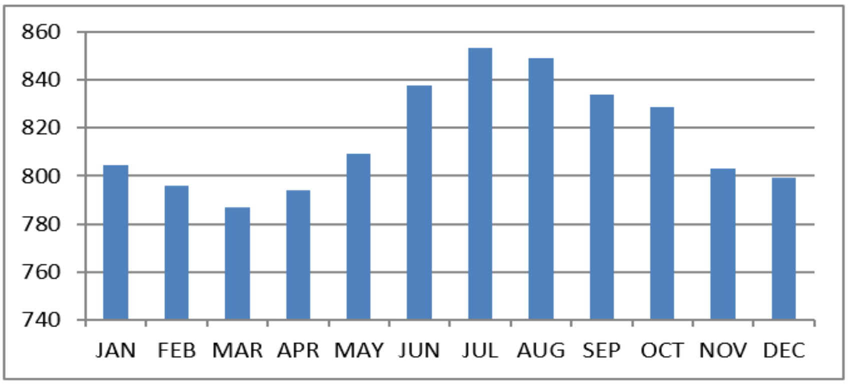

Figure (7): shows the monthly averages of CH_4 emissions from North Africa during the period 2003:2020.

Algeria comes in first place in terms of methane emission rates among North African countries, followed in second place by Egypt, then Libya, Morocco, and finally Tunisia.(fig 8)

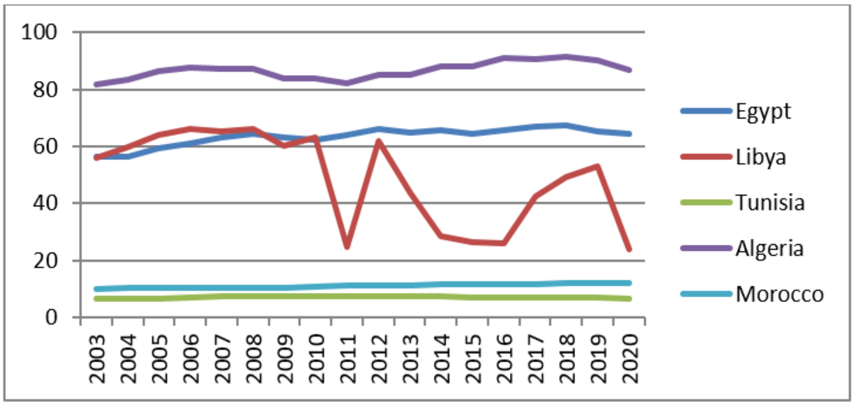

Figure (8): shows the average annual emissions of CH_4 from North African countries during the period 2003:2020.

1.5 N2O

For nitrous oxide; There is a steady increase throughout the study period, but at levels lower than carbon dioxide and close to methane,[Fig 9] For monthly averages of nitrous oxide emissions; It reaches its highest levels during the winter; Specifically in January; The increase begins in the fall, beginning in October. Then it decreases after January to reach its lowest levels during the spring and summer.(fig10)

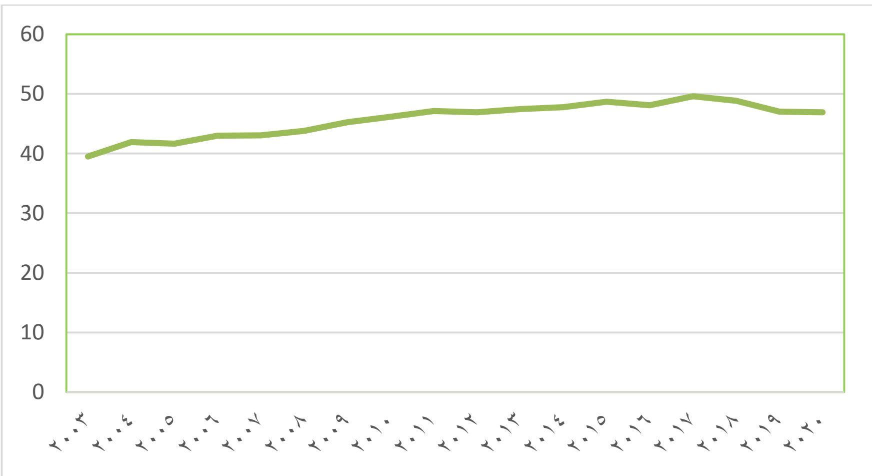

Figure (9): shows the average annual emissions of N_2O from North Africa during the period 2003:2020.

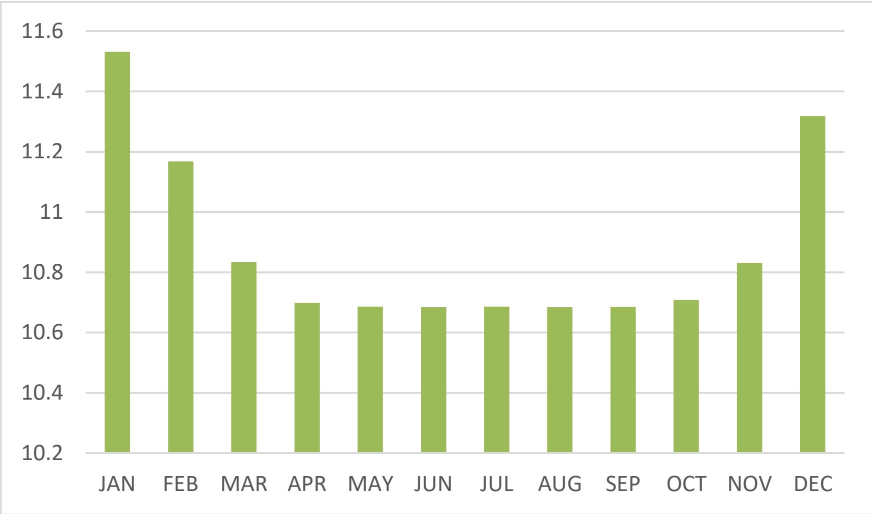

Figure (10): shows the monthly averages of N_2O emissions from North Africa during the period 2003:2020.

In North African countries' share of nitrous oxide emissions; Egypt comes in first place; Followed by Algeria, then Morocco, then Tunisia, and finally Libya.(fig 11)

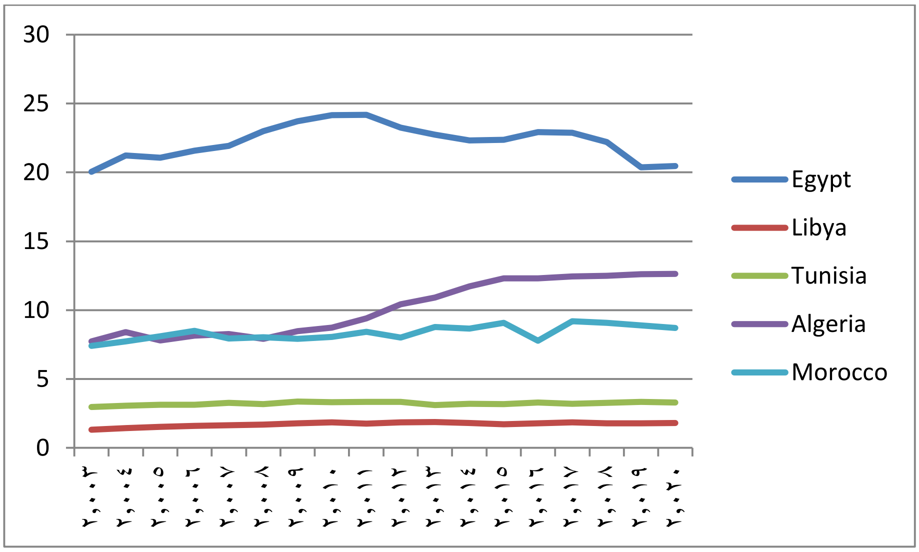

Figure (11): shows the average annual emissions of N_2O from North African countries during the period 2003:2020.

2. Greenhouse gases over North Africa and temperatures

Through meteorological data on temperatures at five stations, namely Abbasiya in Egypt; Tripoli in Libya; Kairouan in Tunisia; Skikda in Algeria, and Al-Nuwaisir in Morocco; Average monthly temperatures were calculated at the five stations;

Draw the curve, which shows a positive slope estimated at 0.00562,For the trend curve; Which shows the increase in temperatures during the study period; With a change of approximately one degree Kelvin. (Fig 12)

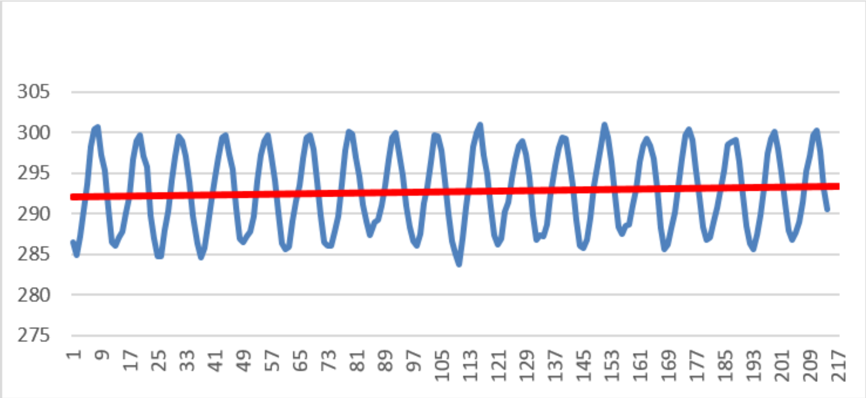

Figure (12): shows the average monthly temperatures over North Africa during the period 2003:2020.

I. DISCUSSIONS

The substantial rise in temperatures in the region entails important consequences for diverse sectors, such as agriculture, water, and health. For example, sustained temperatures above 35-40°C may cause heat exhaustion, especially among workers in the agricultural sector, and beyond this temperature, the threat of mortality could increase, particularly among vulnerable groups. The summer temperatures also widely exceed the comfort threshold across the area. Heatwaves in the region not only stress the populations concerned but also present water shortages for irrigation. Such conditions may lead to increased demands for food via the use of stored fresh water. Overall, changing hydroclimatic conditions have significant socioeconomic impacts on the region. [14][15][16]

According to the national temperature anomalies for each North African country, Tunisia has recorded the highest rise in temperatures since 2003, at approximately 0.5°C every decade. Rising temperatures in Libya mainly occurred between 2003 and 2012, and the warming had continued in 2012-2020, albeit at a slower pace of 0.35°C per decade. Additionally, the pattern of temperature change is recognizable in the data. In Algeria, the warming started in 2012, although at a small rate (around 0.07°C per decade). A wave pattern of temperature change is observable in Egypt, with significant periods of warming in 2003-2008, 2010-2014, and 2014-2020. This temperature anomaly is characterized by a period of cooling from 2009 to 2010. Cooling was experienced at a constant rate of -0.1°C per decade, although significant warming has followed since 2014, at a mean temperature increase of 0.6°C per decade. In Morocco, temperatures have changed between cooling and warming. And since around 2018, the pattern has been one of declining temperatures. [17][18]

To explore the relationship between greenhouse gas emissions and climate change in the North African region, we examine the temperature changes in five of the main countries of the region from 2003 to 2020. We observe different patterns of temperature increases, with

Libya and Tunisia experiencing the most significant warming, particularly since 2012. Egypt and Algeria have also observed rising temperatures since 2012. Only Morocco shows significant declines in temperatures, especially in 2005-2010 and 2015-2020, with stabilization or slight increases between those years. The country analysis shows that droughts negatively impacted agricultural yields for all of these countries and that agriculture, water resources, and human health were affected by the heat. Moreover, analyses of regional and country data for Africa, South Africa, and Uganda show that the long-term trends are increasing and statistically significant. [19][20][21]

Although the increase in temperature is associated with the increase in emissions of the three greenhouse gases from the study area during the study period; However, the increase in temperatures is consistent with the increase in greenhouse gas emissions from the whole world; Because the effect of greenhouse gases depends on the atmospheric content of these gases; Its behavior is affected by several factors such as wind movements and weather fluctuations. Therefore, it must not be overlooked that the atmosphere is considered a common source of all emissions worldwide.

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The reason for the decrease in emissions of greenhouse gases in the summer while they increase in the winter, periodically and regularly, is likely to be not only a result of human activities. Rather, it is likely that there is a natural source that is the reason for this regular change. This also reflects the fact that temperature growth is not 100% consistent with greenhouse gas emissions. This confirms that human activities is one of the influential factors, but it is not the main cause. Some previous studies [25-28] suggested the presence of natural factors, and that they are the main source of the rising of greenhouse gas emissions that cause global warming. It has been proven that these gases change naturally and are linked to space, as some of them come in different forms from space sometimes amid the solar wind or comets and asteroids, which increases these gases in the atmosphere, and they can also escape into space. It has been proven that the من concentration of these gases is variable and changes the total air mass, which results in a disturbance in the Earth’s orbit around the sun due to this slight change in the Earth’s mass, which results in achange in the Earth’s center of gravity.[24][25]

SUMMARY AND CONCLUSION

The study has attempted to quantify the impact of different greenhouse gases on both precipitation and temperature in North Africa using long-term data between 2003-01-01 and 2020-01-16. We have used at least 10 years of data because we do not want our results to be generated from anomalies. As a consequence of all this hard work, it has been documented that greenhouse gases are qualitatively very important. In particular, the carbon dioxide greenhouse has a positive and substantial impact on summer temperatures. For the rest of the panels, their inter-temporal variation with precipitation or temperature results in stronger effects on variability, especially cloud cover. Although there is some consensus that an increased amount of clouds due to stronger convection would reduce the energy coming to the near-surface, contradicting results are reported in the literature about how cloud properties affect temperatures. There is still much more to learn about how the impacts of cloud amounts and all other greenhouse gases differ for the different seasons and locations. During the period from 2003 until 2020; There was a significant increase in emissions and concentrations of carbon dioxide, methane, and nitrous oxide.

CO2 emissions are the highest compared to methane and nitrous oxide.

The increase in CO2 reaches its peak in winter, specifically in January.

CH4 increases in summer and the increase reaches its peak in July.

The largest contributor to CO2 emissions is Egypt, followed by Libya.

The largest contributor to CH4 emissions is Algeria, followed by Egypt.

There is a steady increase in surface temperatures over North Africa; It is clearly linked to the increase in emissions and concentrations of carbon dioxide and methane.

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