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Share of CO2 emissions in Iraq, Saudi Arabia and Kuwait from the combustion of fossil fuels: A statistical study

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Abstract: Reducing carbon dioxide emissions is one of the main challenges to mitigate the effects of climate change. The global effects of climate change threaten geographical fluctuations and increase the risks of floods, food production, transportation, power plants and all energy requirements, making adaptation to these impacts more difficult and costly in the future. This paper evaluates the average emissions of carbon dioxide resulting from the combustion of fossil fuels over a time series from 2009-2019. The study area targeted Iraq, Saudi Arabia and Kuwait, as they have the largest amount of production and storage of fossil fuels. Five variables were studied (total annual emissions, per capita fossil fuel emissions, year-on-year change in CO_2 emissions, cumulative emissions and annual share of emissions compared to global emissions). The results showed that the Kingdom of Saudi Arabia topped the highest annual emission rate of 645.4 million tons for the year 2015, and Kuwait had the highest rate of emissions per capita of 28.1 tons annually, followed by Saudi Arabia. The annual growth of emissions indicated a turbulent time series, where Saudi Arabia represented the highest level of emissions from the zero line at a rate of +65.52 million tons, while Iraq had an annual growth rate of 28.71 million tons in 2016 of carbon dioxide. The cumulative emissions of CO_2 were the highest in Saudi Arabia at 14.9 billion tons over the time series. While the share of carbon dioxide emissions for Saudi Arabia compared to the global share was at a rate of 1.54 %, followed by Iraq at a rate of 0.47 % and finally Kuwait at a rate of 0.29%.

Keywords: Carbon dioxide (CO_2), Climate change, Cumulative emission, Fossil fuel emissions.

1 INTRODUCTION

The study of carbon dioxide pollutants is interesting because of their direct impact on the climate represented by global warming resulting from the use of fossil fuels in various fields of energy. Industrial development has led to an increase in pollutants emitted as a result of combustion emitted from industrial facilities during the past decade, where the proportion of CO_2 increased to more than 80% during the year 2019. This leads to an average temperature increase of 6 degrees by the end of this century[1, 2]. The percentage of global greenhouse gases increased with a total growth of 55.6 G-tons of carbon dioxide equivalent as a result of the increase in global economic growth[3]. The proportion of carbon dioxide emissions is 10% due to the combustion of global fossil fuels, and therefore, it is considered a major impact on the regional and global scales of temporal and spatial scales[4]. China is one of the major industrialized countries, as it had the highest share of the production of carbon dioxide pollutants, at 28.5% globally in

2017. The study relied on the results of the Intergovernmental Panel on Climate Change (IPCC), which included economic and social sectors in various Chinese cities [5]. The emissions resulting from the combustion of fossil fuels of various types (gas, oil and coal) increased 14 times during the period from 1960 to 2018, as well as the percentage of liquid fossil fuels increased by 125 times for the same period[6]. The total carbon dioxide emissions of Iraq per capita with energy consumption through the gross domestic product (GDP) was proportional to economic development, and the amount of CO_2 emissions equivalent to 0.3 Kg/$ of purchasing power of GDP[7].Based on the model used in the environmental Kuznets curve (EKC), where it was shown through empirical analysis that the value of the per capita GDP in Iraq amounted to 3000$ at the greatest value of emissions represented by CO_2, and this is an important indicator of the great damage to the environment[8]. The side effects of the increase in emissions resulting from the combustion of fossil fuels are an increase in global average temperatures, which is considered a challenge all over the world to explore sustainable and low-carbon energy options[9]. Climate change led to the conclusion of the Paris Climate Agreement in December 2015, which included the need to reduce CO_2 emissions to 50% below the level recorded in 1990 to ensure a pollutant-free climate by 2050[10]. In compliance with the Paris Climate Agreement, the European Union has reduced by 20% of emissions to CO_2, which is a positive indication of a commitment to this agreement. The Kingdom of Saudi Arabia is one of the largest countries in the Arab Gulf region that produces CO_2 emissions resulting from the combustion of fossil fuels (oil), equivalent to 18 tons per capita annually[10]. Iraq has sought to conduct many research studies based on sustainable energies, such as the European Union and the Gulf Cooperation Council, using solar energy to distill brackish or hard water with zero emissions[11–13].Multiple studies have been conducted to measure emissions (CO_2, CO, NO_X and HC) by using Iraqi LPG gas as a low-pollution fossil fuel, the results of this study have a low return on pollutants and economic cost [14– 18]. The aim of this statistical study is to determine the climatic effects of carbon dioxide emissions resulting from the combustion of fossil fuels, where the study area was chosen for Iraq, Saudi Arabia and Kuwait as they are among the largest producing countries of fossil fuels.

2 STUDY AREA

The emissions resulting from the combustion of fossil fuels in the countries targeted in this study (Iraq, Saudi Arabia and Kuwait) are considered a major challenge, as these countries have the highest rates of fossil fuel production at a rate of about 20% of global production. Therefore, it has become necessary to find environmentally friendly energy as a target for these countries in order to help improve the environment, public health, the economy and other aspects.

IRAQ: Iraq is geographically located in the continent of Asia - the Middle East, with an area of 438.217Km^2, and a gross domestic product of 250 billion US dollars. Crude oil is the main source of income with 89% of the revenues. Where oil was discovered in Iraq in 1923 by the Turkish Petroleum Company (TPC) in the city of Kirkuk (EIA, 2019). Iraq produces crude oil at a rate of 4.9 million barrels/day, which makes it sixth in the world.With regard to natural gas, Iraq occupies the twelfth place in the world in terms of gas reserves[19].

KSA: Saudi Arabia is the largest country in the Arabian Gulf, with an area of 2,150,000 square kilometers, and has the advantage of being one of the world's top crude oil producers, accounting for 70% of its revenues in 2021[20].The Kingdom of Saudi Arabia is the largest oil exporter in the world. Oil and natural gas are among the most important natural resources in the Kingdom of Saudi Arabia. It was discovered in

the Arabian Peninsula for the first time in the territory of the Kingdom of Saudi Arabia in 1925. It has the second largest oil reserves in the world, with 268.5 billion barrels. The amount of Saudi oil reserves is the fifth of the world's oil. Its daily production is more than 11 million barrels, and crude oil exports amount to more than 8 million barrels per day, and of natural gas about 180.5 trillion standard cubic feet until 1990 AD, and exports of natural gas liquids amounted to about 274 million barrels in 2004 [21].

Kuwait: The State of Kuwait has a GDP estimated at 125 billion US dollars, of which crude oil and petroleum gas are the main revenue and 92% of the income [22].Oil is Kuwait's most important export. Kuwait is the seventh largest oil exporter in the world and is a founding member of OPEC. Oil reserves in Kuwait are estimated at 104 billion barrels, equivalent to 10% of the world's oil reserves. The largest oil field in Kuwait is the Burgan field, which is the second largest oil field in the world. In addition to crude oil, Kuwait also produces about 20,000 barrels per day of condensate and 150,000 barrels per day of natural gas liquids.

3 DATA SETS CO2 EMISSIONS

Total CO_2emissions have increased in the countries studied in the past years. In this section, an annual timeline of each country's CO_2emissions will be presented and compared to the global average emissions. Furthermore, the total CO_2emissions in the region and the contributing sectors for each country. Fig. 1 shows the amount of carbon dioxide (CO_2) that is produced from the year 2009-2019 [23].

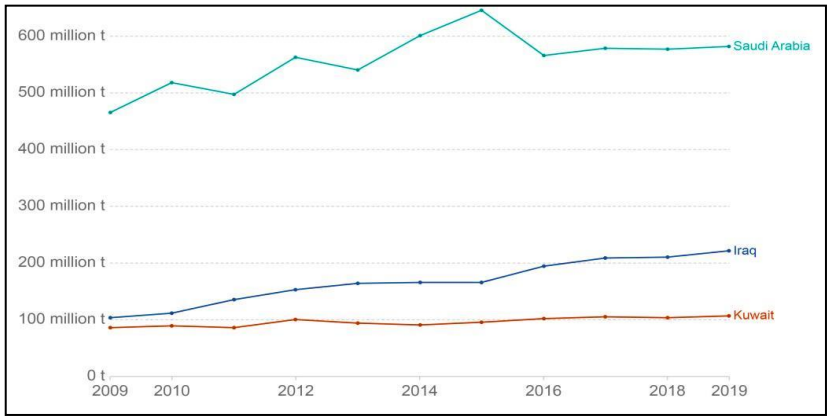

Fig. 1. Annual CO2 emissions.

The annual carbon dioxide emissions represent the countries' contribution to improving the climate through the reflection of population size and rates of combustion in fossil fuels in Iraq, Saudi Arabia and Kuwait per capita[23], as shown in Fig. 2 below.

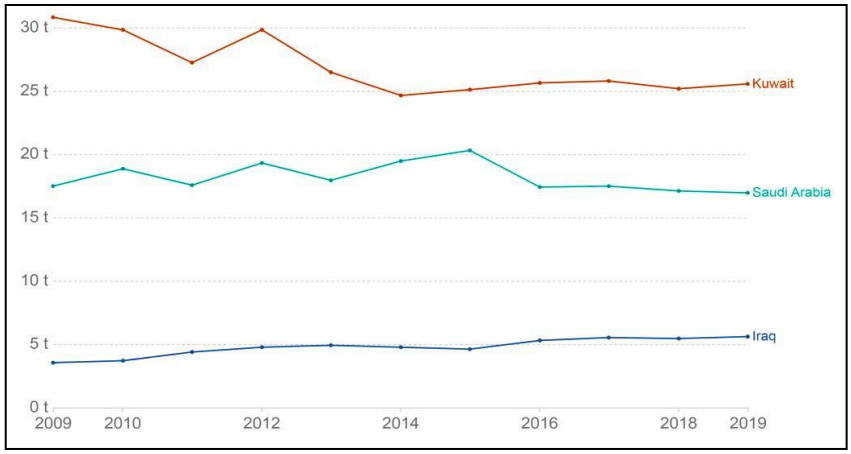

Fig. 2. Carbon dioxide (CO2) emissions from the burning of fossil fuels for energy production.

As for the annual change in carbon dioxide emissions for the countries studied, it is shown in Fig. 3. As the increases from the zero level indicate an increase in emissions for that year and the decreases represent less emissions than the previous year, and this represents a fluctuating series of emissions[24].

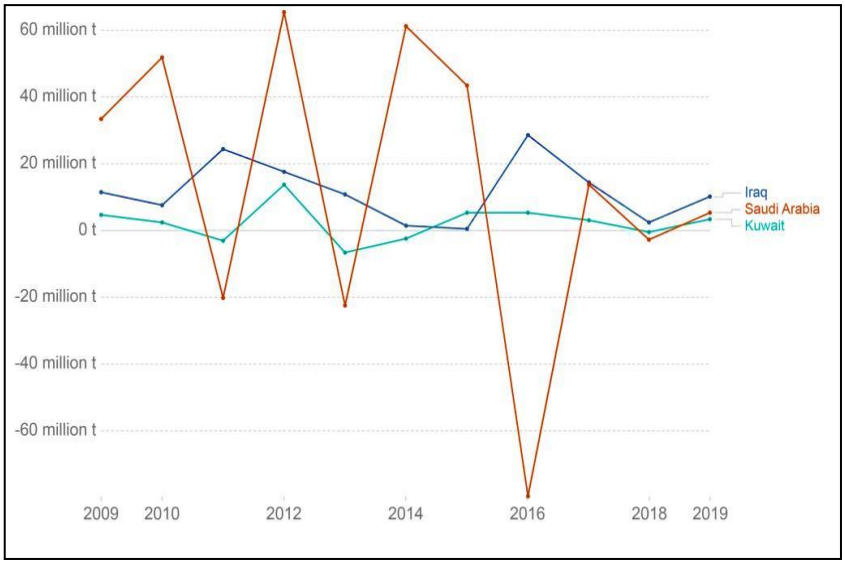

Fig. 3. Year-on-year change in CO2 emissions.

As for the cumulative emissions of carbon dioxide, they are shown in Fig. 4. Represents an impression of the total amount of emissions during 10 years for the period from 2009 - 2019 in each country, which must be taken into account and work to reduce to preserve the climate[24].

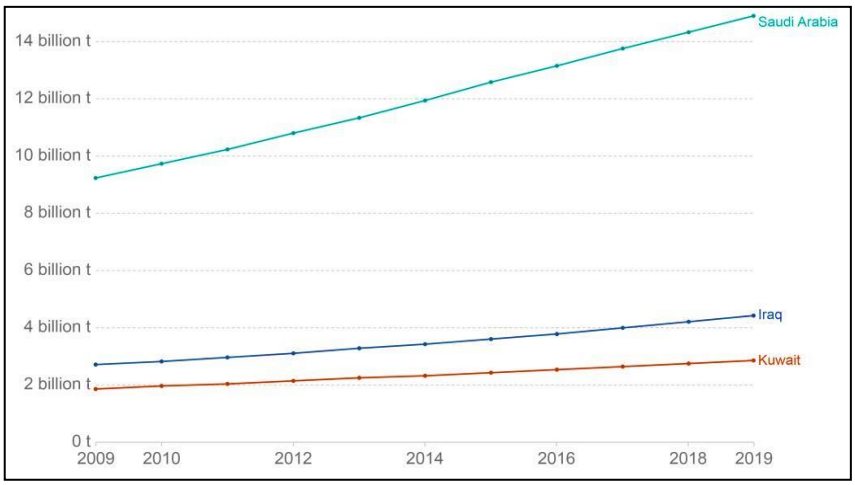

Fig. 4. Cumulative carbon dioxide (CO2) emissions represents the total sum of CO2 emissions produced from fossil.

To compare the carbon dioxide emissions of the countries studied with the global emissions, we note that they constitute small percentages of emissions, as the Kingdom of Saudi Arabia represented the highest pollution rates at a rate of 1.71%, followed by Iraq at a rate of 0.48% and then Kuwait at a rate of 0.29% of the amount of global emissions percentage for the period from 2009 – 2019[24], as shown in Fig. 5.

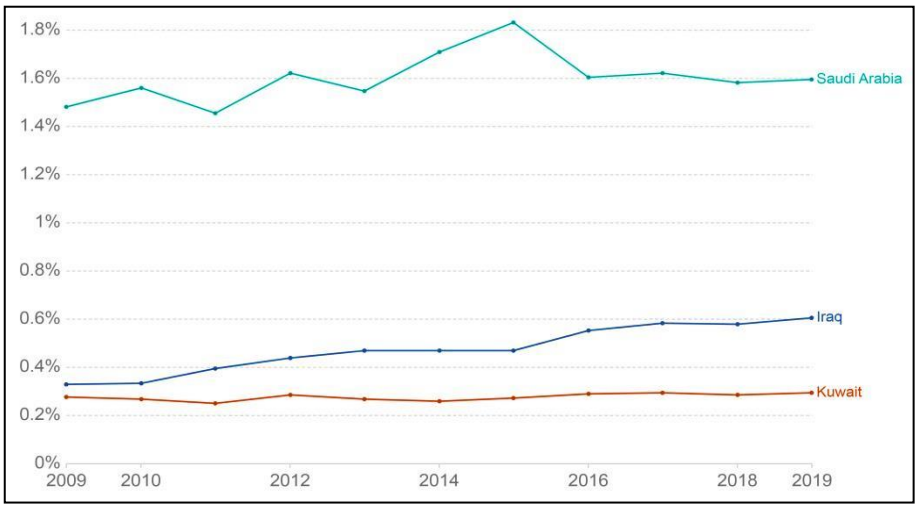

Fig. 5. Measured as each country's emissions divided by the sum of all countries' emissions in a given year.

4 CONCLUSIONS

The challenges required for a suitable climate are similar to the countries studied, due to the geographical location and the convergence of climatic conditions and economic activities. This paper evaluates the carbon dioxide emission rates resulting from the combustion of fossil fuels based on the period from 2009-2019 from the statistical data. The Kingdom of Saudi Arabia had the highest annual emission of CO_2 with an average of 523.5 million tons, and the highest percentage of annual pollutants was 645.4 million tons for 2015. Concluded from Fig. 2 that Kuwait represented the highest amount of pollution from per capita emissions at a rate of 28.1 tons annually, followed by Saudi Arabia at a rate of 17.24 tons annually, and Iraq

came last at an annual rate of per capita emission of 4.6 tons.Regarding the annual growth in carbon dioxide emissions, a tumultuous time series has been created that ranged from high and low levels to the zero line. The Kingdom of Saudi Arabia had a variable time series, where the year 2012 represented the highest emission level of +65.52 million tons and the lowest level in 2016 was -79.66 million tons. While there was convergence in the tumultuous time series between Iraq and Kuwait, as shown in Fig. 3.As for the cumulative emissions of carbon dioxide, it was concluded that the Kingdom of Saudi Arabia had the largest share in the annual cumulative emissions and in an upward manner, due to its possession of the largest stock of fossil fuels and thus the highest rate of combustion and it is considered one of the important obstacles to reach a clean climate free of emissions as shown in Fig. 4.For global emissions of carbon dioxide, emissions are measured for each country divided by the total global emissions in that year. Saudi Arabia topped the emissions share of the study area for the period from 2009-2019, followed by Iraq and Kuwait.The summary of this paper indicated that Iraq, Saudi Arabia and Kuwait have low emissions compared to the global community, despite having large reserves of fossil fuels.

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