Analysis the Intensity of CO_2 Emissions from Fossil Fuel Combustion in Iraq

Ahmed S. Hassan*, Jasim H. Kadhum

Department of Atmospheric Sciences, College of Sciences, Mustansiriyah University, Baghdad, IRAQ

*Correspondent contact: ahmed.s.atmsc@uomustansiriyah.edu.iq

ABSTRACT

Carbon dioxide intensity (CI) refers to carbon dioxide emissions from fossil fuel combustion that mainly used for electricity, heat, transport, and other life requirements. The objective of this paper is better to understand CI as an indicator of Global Warming, and compared its behavior with two other variables (total CO2 emissions, and CO2 emissions per capita). The main data sources an available and activity data from Carbon Dioxide Information Analysis Center (CDIAC). Three annual variables used in this study; CI, total CO2 emissions, and CO2 per capita for fossil fuel emissions during long time series from (1971 to 2018).

The results of CI shown that the highest value found out at the beginning of the study in 1971 was (7.188 kg/kg oil equivalent), and then decreased till reach to lower value was (1.707 kg/kg oil equivalent) in 1997, after that slowly increased in the last decade near to (3.63 kg/kg oil equivalent). The total CO2 emissions were strongly related to oil prediction. The highest value for total CO2 emissions was (188.1 Mt) in 2018, with Iraqi oil production more than (4.78 million barrel/day). The total CO2 emissions increased by (65.176%) during the study period. The total CO2 emissions were inversely proportional to CI. The level of CO2 emission per capita rate fluctuated around average (3.49 metric tons per capita); the maximum rate was (4.99 metric tons per capita) in 2013.

KEYWORDS: CO_2 intensity; Total CO_2 emissions; Iraq.

الخلاصة

كثافة ثاني أكسيد الكربون (CI) تشير إلى انبعاث ثاني أوكسيد الكربون الناتج من احتراق الوقود الأحفوري والذي يستخدم بشكل أساسي في مجال الكهرباء والحرارة والنقل ومتطلبات الحياة الأخرى. الهدف من هذا البحث هو التوصل الى فهم أفضل لـ CI كمؤشر للاحتباس الحراري العالمي ، ومقارنة هذا السلوك مع متغيرين آخرين (إجمالي انبعاث ثاني أوكسيد الكربون، وانبعاث ثاني أوكسيد الكربون للفرد). ان مصادر البيانات الرئيسية والمتوفرة من قبل مركز تحليل معلومات ثاني أوكسيد الكربون (CDIAC). ثلاثة متغيرات سنوية استخدمت في هذه الدراسة : CI ، إجمالي انبعاث ثاني أوكسيد الكربون ، ونصيب الفرد من انبعاث الوقود الأحفوري خلال سلسلة زمنية طويلة (١٩٧١ ـ ٢٠١٨). أظهرت نتائج CI أن أعلى قيمة تم اكتشافها في بداية الدراسة عام ١٩٧١ كانت (٧,١٨٨ كغم / كغم مكافئ نفط) ، ثم انخفضت إلى أن وصلت إلى قيمة أقل كانت (١,٧٠٧ كغم / كغم مكافئ نفط) عام ١٩٩٧ ، بعد ذلك زادت قليلا خلال العقد الماضي لتقترب من (٣,٦٣ كغم / كغم مكافئ نفط). كان إجمالي انبعاث ثاني أوكسيد الكربون وثيق الصلة بالتنبؤ لإنتاج النفط. وبلغت أعلى قيمة لإجمالي انبعاث ثاني أوكسيد الكربون (١٨٨,١ مليون طن) في عام ٢٠١٨ ، حيث تجاوز إنتاج النفط العراقي (٤,٧٨ مليون برميل / يوم). ارتفع إجمالي انبعاث ثاني أوكسيد الكربون بنسبة (٦٥. ١٧٦٪) خلال فترة الدراسة. كان إجمالي انبعاث ثاني أوكسيد الكربون متناسبًا عكسياً مع CI. تذبذب معدل انبعاث ثاني أوكسيد الكربون للفرد حول المتوسط (٣,٤٩ طن متري للفرد) ؛ حيث بلغ الحد الأقصى للمعدل (٤,٩٩ طن متري للفرد) عام ٢٠١٣.

INTRODUCTION

Study carbon dioxide intensity become more interesting when understanding climate change and its concerning with change in greenhouse gases specially when related to emit CO_2 per barrel of crude oil equivalent produced. The total of greenhouse was rapidly increased in 2019 by 80% from 1990 and continues till 2050, which make risk in climate change. This way means adds more energy by increased oil to destroy climate system.

Life on Earth would be an impossible without greenhouse effect that keeps the long term annual average temperature of the earth not more than earth temperature by 2 °C. Green House Gases (GHG) contributes to the greenhouse effect both directly by increasing GHGs emissions, and indirectly radiative forcing. The growth in total global GHG emissions reaching 55.6 gigatonnes

of CO_2 equivalent (Gt CO_2 eq.) this increased occurred while global economic growth in 2018continued above average for annual rate [1]. The major causes for global warming return to rising in greenhouse gases: i.e. (carbon dioxide, methane Nitrous oxide, chlorofluorocarbons), where global warming point out, with prevent greenhouse gases emitted to atmosphere the feature of global warming would be continue effective [2].

The synthesis was focus on the knowledge of CO_2 emissions, and the major effect on global and regional for spatial and temporal scales. The continuity of increasing emissions with time, where 10% of global fossil fuel combustion CO_2 emissions, and there much is need to understand about characteristics of these emissions [3]. Since 2004 Chinese CO_2 emissions was responsible for 28.5 percent of global CO_2 emission in 2017. Researcher set a new method for constructed emissions were consistent with the Intergovernmental Panel on Climate Change (IPCC) method that covers 47 socioeconomic sectors, 17 fossil fuels, and 24 common Chinese cities [4]. What confirms fossil fuel combustion CO_2 emissions study was focused on three state of decadal fossil fuel (gas, liquid, and solid). The results shown CO_2 emissions from gaseous in last decade (2010) was increased 10 times than its emissions in 1960, and increased 10.4 times for liquid fossil fuel for same period [5].

Several studies have noted and analysis the relation between CO_2 emissions per capita and economic development energy consumption. Recently studied examine this relation for Iraq, economic represented by gross domestic product (GDP). Total CO_2 emissions were strongly proportional with GDP per capita. The relation between CO_2 emission with CO_2 emissions per GDP become higher effective when CO_2 emission was (0.3) (kg per PPP $ of GDP) [6]. The objective study came from European Union that depend on impact of woody biomass on reduce CO_2 emissions, while the per capita for fossil fuel increased. This would take part effective to decreased dependence on conventional fuels in favor of sustainable development and hence of woody biomass energy then less dependence on fossil fuel [7]. *Empirical analysis between the total of carbon dioxide emissions and GDP per capita* used *Environment Kuznets Curve (EKC) model* in Iraq carried out by Al rukabie et al.

(2020) found that the most of CO_2 emissions concentrated when value of GDP was (3000$), and the value of residual was normal distributed, and CO_2 emission and GDP values increased with time, and this increased lead to damage environment [8].

Multiple methods were used to measure the CO_2 intensity (CI), where faced two challenges; first, development of an open source oil sector, and second using a good proprietary model - to refine the specific CI for all countries and the main drivers of these emissions [9]. In this study depend on amount of emitted CO_2 emission through the magnitude of burning fossil fuel to production energy, it also crude oil used to produce equivalent energy.

DATASETS AND METHODOLOGIES

The source data of CI (kg per kg of oil equivalent energy) that used in this work for Iraq came from the U.S. department of energy carbon dioxide information analysis center (CDIAC), environmental sciences division, Oak Ridge national laboratory, Tennessee, U. S. The annual data emissions calculated from fossil fuel consumption. The data was for long period of CI was available from 1971 to 2018. CI represented to the ratio between total CO_2 emissions and using one unit for energy in oil production of Iraq. As one of the environmental factor CO_2 intensities, this used to compare of different fuels. Total CO_2 emission was the second part of data for same period (1971 - 2018), and same source of data was from CDAIC, the unit of measurement in kilotons (kt), Kilotons, and when the quantities were estimated in thousands tons, the suitable term was million tons (Mt) was used [10].

The CO_2 emissions per capita are measured as the total CO_2 emissions by country divided the population of the country (Iraq) to represent CO_2 emissions per person. The annual CO_2 emissions per capita usually used in unit metric tons per capita, its came from the main source of data (CDAIC). The CO_2 emissions per capita calculated by equation (1) as following [6]:

$$CO_2 \, emission \, per \, capita = \frac{Total \, CO_2 \, emissions}{Population \, of \, the \, country} \quad (1)$$

RESULTS AND DISCUSSION

The fundamental information of most greenhouse gases emissions, and emissions factors came from IPCC. CI was the significant factor that used to

determine the level of CO2 emissions for each country by IPCC, that represented a method for convention and accurate of greenhouse emissions, beside CI usually used to compare among many environmental factors.

The highest value of CI was happen in the first year of this study (1971) was (7.188 kg/kg $_{oil\ equivalent}$), as shown in Figure 1, and then decreased to reach minimum point in 1997 was (1.707 kg/kg $_{oil\ equivalent}$), second dropped was (2.449 kg/kg $_{oil\ equivalent}$) in 2007, Then rose slightly and stabilize in the last decade of the study period to equal (3.63 kg/kg $_{oil\ equivalent}$). This result exhibit the interaction between two factors, on the one hand was total CO_2 emissions on the other hand amount of crude oil prediction used energy. The behavior of CI was non–linear relation because it depended on other IPCC factor.
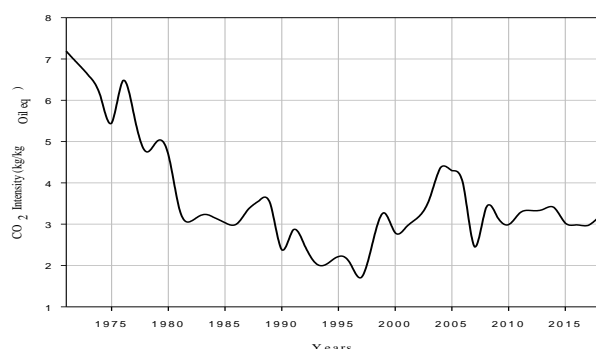

Figure 1. Trend of time series CO_2 intensity kg per kg of oil equivalent (1971-2018) in Iraq.

The total CO_2 emissions mainly depended in this study on oil production; therefore, it was instable because of the volatility of crude oil production. So that total CO_2 emissions in the beginning was low value was about (2.886 Mt) in 1971, then increased to reach (188.1 Mt) in 2018 as presented in Figure 2, with Iraqi oil production were more than (4.78 Million barrel/day). The growth rate during study period for total CO_2 emissions was increased by (65.176 %). The relation between CI and total CO2 emissions was inversely proportional.
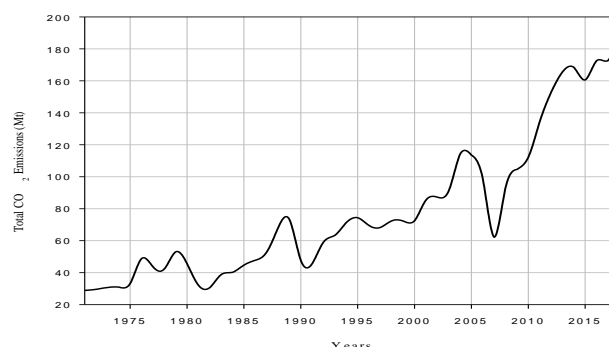

Figure 2. Trend of time series for Total CO_2 Emissions (Mt) for (1971 -2018) in Iraq.

The CO_2 emissions per capita were more volatile despite the increase in population density, but the total CO_2 emissions increased more than the population rate. The maximum level of CO_2 emissions per capita was recorded (4.99 metric tons per capita) in 2013, while minimum level was found out (2.121 metric tons per capita) in 1982, and the average was around (3.49 metric tons per capita), as shown in Figure 3.
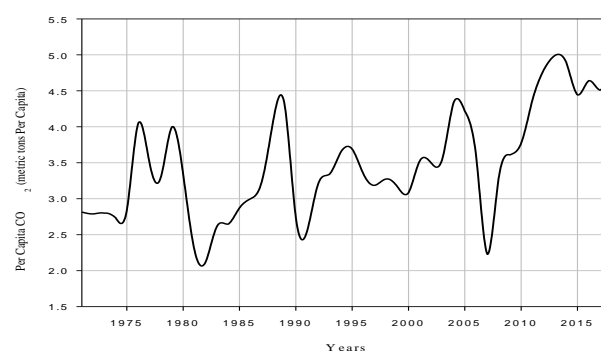

Figure 3. Trend of time series for CO_2 emissions metric tons per capita for (1971 -2018) in Iraq.

The significant years were found out in this work (1991, and 2007), these years have dropped value although inversely proportional between CI, and total CO_2 emissions, and even per capita CO_2 emission had sink through study period.

CONCLUSION

CO_2 emissions have increased by nearly 90% from fossil fuels due to fossil fuel combustion and industrial processes. Main conclusions were presented with three main themes: CI, total CO_2 emissions, and CO_2 emission per capita.

CI shows highest level found out in 1971 with value was (7.188 kg/kg $_{oil\ equivalent}$), where lowest value was (1.707 kg/kg $_{oil\ equivalent}$), 1997 then slowly increased in the last decade of study (3.63 kg/kg $_{oil\ equivalent}$). Total CO_2 emissions had strong

49

relationship with oil production, that recorded higher value (188.1 Mt) in 2018, when the oil production more than (4.78 Million barrel /day). The growth rate of total CO_2 emissions was increased by (65.176 %). The behavior of CI was inversely proportional with total CO_2 emissions. The last themes deal with CO_2 emissions per capita that found out maximum value was (4.99 metric tons per capita) in 2013, while minimum value was (2.121 metric tons per capita) in 1982, and rate fluctuated around average 3.49 metric tons, the maximum rate was (4.99 metric tons per capita) in 2013.

ACKNOWLEDGMENT

REFERENCES

[1] J.G.J. Oliver, J.A.H.W. Peters, "Trends in global CO_2 and total greenhouse gas emissions. 2020", report. PBL Netherland Environmental Assessment Agency, The Hague, the Netherland, 2020, P. 70.

[2] Stephen E. Schwartz," The Greenhouse Effect and Climate Change," Environmental and Climate Sciences, Brookhaven National Laboratory, 2017, PP. 1-19.

[3] R. J. Andres, T. A. Boden, F.-M. Bréon, P. Ciais, S. Davis, et al., "A synthesis of carbon dioxide emissions from fossil-fuel combustion," Biogeosciences, vol. 9, 2012, PP. 1845–1871.

[4] Yuli Shan, Guan Dabo, Liu, Jianghua, Mi, Zhifu, Liu, Zhu, et al., " Methodology and applications of city level CO2 emission accounts in China," Journal of Cleaner Production, Vol. 161, 2017, PP. 1215-1225.

[5] Ahmed S. Hassan, Khawla Nihad Zaki, " Decadal Analysis of Carbon Dioxide Emission from Different State of Fossil Fuels in Iraq," Indian Journal of Public Health & Development, Vol. 9(12), 2018, PP. 865-868.

[6] Ahmed S. Hassan, " Relationship between Per Capita CO2 emissions and GDP in Iraq," plant Archive, Vol. 20(2), 2020, 1206- 1209.

[7] Chindo Sulaiman, A. S. Abdul-Rahim, Christopher Amechi Ofozor, " Does wood biomass energy use reduce CO_2 emissions in European Union member countries? Evidence from 27 members," Journal of Cleaner Production, Vol. 253, 2020, PP. 119996 - 120003.

[8] Jamal Alrukabie, Ahmed S. Hassan, Jasim H. Kadhum, "Empirical analysis of CO2 emission using EKC model in Iraq", International journal of advance sciences and technology. Vol. 29. (3s), 2020, PP. 557-564.

[9] Mohammad S Masnadi, Hassan M. El-Houjeiri, Dominik Schunack, Yunpo Li, Jacob G. Englander, *et al*., " Global carbon intensity of crude oil Production", Science, Vol. 361(6405), 2018, PP. 851-853.

[10] G. Maryland, T Oda, Boden TA., "Per capita carbon emissions must fall to 1955 levels," Nature. Vol. 565(7741), 2019, P. 567.