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RESEARCH ARTICLE

Calculate Greenhouse Gas Emissions from Road Vehicles in Baghdad City Using IPCC Methodology

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ABSTRACT

The transportation sector plays a vital role in facilitating human well-being by moving people and goods. In Iraq, the sector faces significant challenges, including an annual fuel loss of up to 500 billion dinars and substantial fuel wastage. Each vehicle consumes approximately 570 liters of gasoline annually due to traffic congestion, as the number of vehicles at peak times is estimated per kilometer of the three-lane street (1,059 cars km/h). In contrast, their number is estimated at regular times (450 cars km/h), leading to increased greenhouse gas emissions from fuel combustion used to operate vehicle engines. The current study analyzed fuel supply data from relevant governmental institutions covering Baghdad's roads from 2017 to 2023. It employed the Tier 1 method outlined in the IPCC guidelines to estimate greenhouse gas emissions: CO_2, CH_4, and N_2O from road transportation, revealing that 2023 experienced the highest total emissions at approximately 15,196.90 kilotons in Baghdad City (9,039.7 kilotons/yr for gasoline emissions, and 5,841.11 kilotons/yr for diesel emissions). A high rate of increase in greenhouse gas emissions resulting from vehicles was recorded, amounting to 203,137 and 211 for each of CO_2, CH_4, and N_2O emissions, respectively, and has been recorded over the recent seven years in the capital alone, as the largest percentage of citizens supply their vehicles with regular gasoline instead of premium unleaded gasoline. An increase in vehicle numbers, driven by population growth and improved living standards, underscores the need for policymakers and environmental stakeholders to consider strategies for reducing transportation-related emissions.

Keywords: Diesel, Gasoline, GHGs, IPCC methodology, Vehicle emissions

Introduction

At a time when the capital, Baghdad, is witnessing a high traffic density of vehicles, Iraq is the fifth most affected country by climate change, according to the United Nations Environment Report in 2019.[1] Climate change is linked to increased population growth and economic development which reflects negatively on our entire biosphere.[2] The environment is negatively affected by the increasing population in urban cities, the presence of industrial and production institutions, and transportation.[3] The residents of Baghdad are experiencing adverse health effects due to climate extremes, primarily caused by human activities such as pollution from factories, refinery and transportation systems.[4–7] The increase in population and the means of transportation, as well as generators since 2003, have contributed to the emission of significant rates of hydrocarbon gases, including CO_2, and thus contribute to global warming.[8] Drought and the migration of people since 2007 is a form of global warming.[9] Most people displaced by environmental factors in Iraq move to urban centers, which has led to an increasing strain on services.[10] The Iraqi government is trying in various ways to find a solution to the problem of traffic congestion by changing the official working hours of universities and government ministries, creating additional

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bridges, and previously using an odd-even system for vehicle numbers; the problem is still represented by a substantial increase in the number of vehicles, as the number is estimated approximately to be 4 million cars in the capital alone out of 7 million cars in the whole country excluding Kurdistan, while the capacity of the streets can accommodate between 150–350 thousand wheels, which increased the pressure on the roads and exceeded the carrying capacity of the streets by 3 million and 750 thousand cars, this year recorded an increase in the number of vehicles by 1.9% over the previous year, while the percentage in 2023 reached (1.8)% over the year 2022 according to statistics.[1] In addition to three-wheeler motorcycles (Tuktuks), which have exceeded one million vehicles in Baghdad. The number of cars for every thousand citizens is 128 cars, and for every one kilometer of paved streets, there are 127 cars according to the latest statistics of the Ministry of Planning in Jan. 2023, and there are 345 thousand cars that carry a plate of temporary registration, which is equivalent to 5% of the total number of cars, and while 56% of the cars carry permanent registration plates, and 39% are cars that carry modern registration plates, excluding plates that began being issued in the year 2022.[11]

During the past ten years, from 2013 to 2022, Iraq was regarded as one of the largest importers of Japanese cars, importing 58 thousand vehicles, where the Iraqis moved from choosing small cars (saloons) to choosing large vehicles (SUVs) with a more significant number of cylinders for the engine. All these types of light and heavy vehicles and various motorcycles mainly run on fuel, gasoline, or diesel. The combustion of petroleum products by motor vehicles is one of the most common outdoor air pollution.[12] Greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and other gases are emitted during the fuel combustion process for all types of transportation, which causes global atmospheric pollution. The information on the appropriate emission factors for road transport in developing countries may need further strengthening, where the age of fleet, maintenance, fuel Sulphur content, and use patterns differ from those in industrialized countries.[13] The world is facing a rise in greenhouse gases in the atmosphere and its effects on the increasing global temperature; according to a report prepared by UNEP in 2023, total net anthropogenic GHG emissions in 1990, 2000, 2010, 2020, 2022 CO_2 eq. was (37.9 Gt, 41.8 Gt, 51.6 Gt, 54.5 Gt, 57.4 Gt) respectively,[14] where the ratio of carbon dioxide equivalent increase reached to 51% in 2022 compared to 1990. In Iraq, the CO_2 emissions percentage increased between 1990 and 2017 to 300%.[15] To combat global climate change, the Iraqi government voluntarily adopted reducing (1–2) % of carbon dioxide equivalent emissions resulting from industry and take a range of mitigating measures related to the energy sector to decrease the effects of climate change, according to the Iraqi Nationally Determined Contributions (INDC) report.[16] Using the methodology outlined by the Intergovernmental Panel on Climate Change (IPCC), this study examines the greenhouse gas emissions produced by transportation in Baghdad and their significant role in climate change. The transportation sector was specifically selected for analysis due to its substantial contribution to air pollution and global warming in Iraq, with a particular focus on Baghdad City. The primary objective of this research is to provide updated information on greenhouse gas levels and establish a comprehensive database to accurately inventory emissions from this sector.

Materials and methods

Data collection

Data on total fuel consumed in Baghdad fuel filling stations were obtained from the Iraqi Ministry of Oil for road transportation exclusively from 2017 until 2023. Obtaining data for the past decades has not been possible due to its unavailability from the related institution. The fuel used to operate engines and vehicles in Iraq is gasoline and diesel, which are used in various types of light-duty vehicles, such as automobiles and light trucks, and heavy-duty vehicles, such as tractor trailers and buses, and on-road motorcycles and three-wheelers. The unit of fuel consumed is liters per year.

Choose the method

Depending on the IPCC guidelines for national greenhouse gas inventories 2006, the Tier 1 method used to calculate greenhouse gas emissions for mobile combustion of road transportation in Baghdad since emissions from all sources of combustion can be estimated based on the quantities of fuel combusted (represented by fuel sold) based on the amount and type of fuel consumed in addition to the average emission factors.[17] Tier 2, which depends on calculating the distance traveled by vehicles depending on the type of vehicle and road, has not been applied to estimate greenhouse gas emissions in this study. However, it reduces the possibility of uncertainty in the estimate because it uses specific emission factors for the country instead of the default values at Tier 1, which is not available in the Iraqi-related institution; the same applies to Tier 3. The version of the IPCC inventory software used in the study was 2.691. The sector for the study was determined in the program, which is the (sector energy), category (fuel combustion activities), sub-category (road transportation), and type of liquid fuels (motor gasoline and gas/diesel oil).

Conversion factor type

The net calorific values (NCVs) were selected to determine energy units by the type of liquid fuels. The physical units of liquid fuel are converted to energy units by converting liters to kilograms. Kilograms are converted to 10^3 tonnes, and the 10^3 tonnes units are then converted into energy units, which are terajoules (calorific value).

Choice of emission factor

Default emission factors (EF) from IPCC 2006 for various fuel types were used depending on the fuel used, as shown in Table 1 below.

Carbon dioxide emissions

Carbon dioxide emissions factors mainly depend upon the carbon content of the fuel. Therefore, CO_2 emissions can be estimated based on the total amount of fuels combusted and the averaged carbon content of the fuels; according to IPCC methodology, the default carbon content for motor gasoline is 18.9 kg/GJ and for diesel is (20.2 kg/GJ).[13] The Tier 1 approach calculates CO_2 emissions, as shown in Eq. (1) below, by multiplying the estimated fuel sold with a default CO_2 EF.

$$Emission = \sum_a [Fuel_a * EF_a] \tag{1}$$

Where:
Emission = Emissions of CO_2 (kg).
Fuel a = fuel sold (TJ).
EF a = emission factor (kg/TJ).
a = type of fuel (e.g. petrol, diesel, etc).

Methane and nitrous oxide emissions

Emission factors for methane and nitrous oxide depend on the vehicle technology, fuel, and operating characteristics. Since it is impossible to estimate fuel consumption by vehicle type, Tier 1 was used, which uses fuel-based emission factors. The equation for estimating CH_4 and N_2O emissions was used by applying the same previous equation to find the carbon dioxide emission from road transportation. According to the equation:

1. The amount of consumed fuel was determined by fuel type for road transportation using national data in terajoules (TJ).
2. The amount of consumed fuel has been multiplied by the appropriate CH_4 and N_2O default emission factors for each fuel type Table 1.
3. Emissions of each pollutant were summed across all fuel types used.

CO_2-equivalent emissions

CO_2, CH_4, and N_2O typically contribute around (97, 2–3, and 1) % of Carbon dioxide equivalent emissions from the road transportation sector, respectively. Therefore, although uncertainties in N_2O and CH_4 estimates are much higher, CO_2 dominates the emissions from road transport. Methane and nitrous oxide CO_2-eq. emissions from road transportation are calculated using the Eq. (2):

$$C_2eq. = \text{Emission of GHGs} * \text{GWP} \tag{2}$$

Where:
Emission of GHGs = emission of specific CH_4 and N_2O in (Gg).
GWP = Global Warming Potential of CH_4 and N_2O based on their values of 25 and 298, respectively. The value of the global warming potential for carbon dioxide is 1.

Emission factor uncertainty

Road transport default CO_2 EF has an uncertainty of 2-5 % due to uncertainty in the fuel composition. The use of impure fuels may increase the uncertainty in emission factors. The uncertainties in EF for CH_4 and N_2O are typically relatively high (especially for N_2O); they depend on uncertainties of fuel composition (The possibility of fuel adulteration) and sulfur content, uncertainties in fleet age distribution, and other characterization of the vehicle stock, uncertainties in maintenance pattern of the vehicle stock, uncertainties in the use of additives to minimize the

Table 1. Default net calorific values & GHG emissions factor for road transportation combustion.

Fuel Type	Default NCVs (TJ/Gg)	Default CO_2 EF (kg/TJ)	Default CH_4 EF (kg/TJ)	Default N_2O EF (kg/TJ)
Motor Gasoline	44.3	69300	33	3.2
Gas/ Diesel Oil	43	74100	3.9	3.9

aging effect of catalysts, uncertainties in combustion conditions (climate, altitude) and driving practice.

Results and discussion

Amount of fuel combustion from vehicle

IPCC methodology was applied to calculate the quantities of liquid fuel burned, including gasoline and diesel, during the period 2017-2023 by multiplying the amount of fuel supplied with the default net calorific value (NCVs) for each fuel type as previously mentioned in Table 1. As shown in Fig. 1, The highest proportion was recorded in 2023, at an amount of 130374.9, 78819 TJ/year for both gasoline and diesel as a result of the increase in the number of vehicles in the capital, which reached 2,926,363 cars and the rise in demand for fuel as shown in Table 2. The increase in fuel consumption reflects the growing demand for cars, improved living conditions, and increased import of vehicles from various origins; in addition to traffic congestion, people tend to go to their places of work in their cars as they are faster than public transportation. At the same time, the lowest rate was recorded during 2020 by an amount of (37743.6, 16770 TJ/year). This difference in the quantities prepared and distributed by the Iraqi Ministry of Oil to fuel filling stations is due to the health conditions that the country was going through during the coronavirus epidemic and quarantine period as a result of the lack of movement and travel which contributed significantly to the reduction of gas emissions from the transportation sector. The difference in vehicle fuel consumption is due to the type of fuel used by the vehicles, as there is a clear difference in the number of cars that operate on gasoline compared to those running on diesel in Baghdad, as shown in Fig. 2.

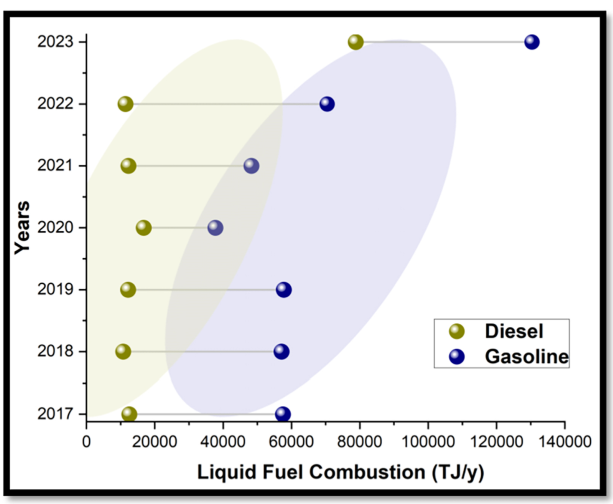

Fig. 1. Combustion of liquid fuel from road transportation.

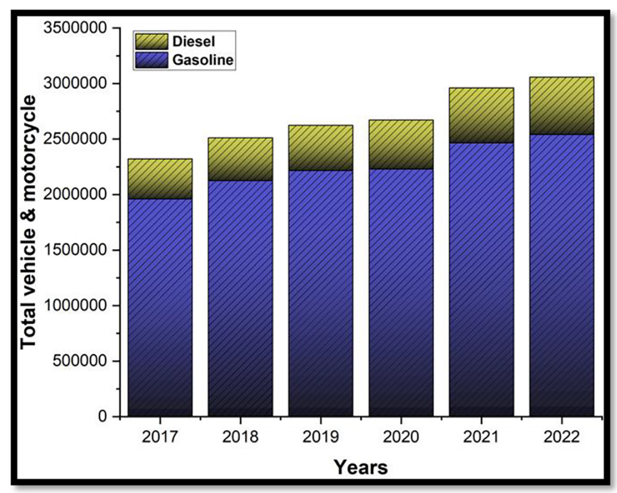

Fig. 2. Number of vehicles and motorcycles registered at the General Traffic Directorate by type of fuel (2017-2022).

Table 2. Expected values of gasoline and diesel in Baghdad from (2017 to 2030).[11]

Year	Population of Baghdad (Million)	Total of Vehicles	Gasoline consumption rate (Liters)	Gasoline required annually (Million/Tons)	Diesel consumption rate (Liters)	Diesel required annually (Million/Tons)
2017	7,916,847	2,339,914	1,298,064,529	0.97	291,680,582	0.25
2018	8,126,755	2,409,390	1,289,230,401	0.97	250,300,680	0.21
2019	8,340,711	2,467,175	1,303,759,431	0.98	284,231,903	0.24
2020	8,558,625	2,479,898	851,143,232	0.64	389,870,928	0.33
2021	8,780,422	2,730,880	1,090,834,715	0.82	285,988,094	0.24
2022	9,006,001	2,828,622	1,589,605,975	1.19	265,574,054	0.23
2023	9,223,632	2,926,363	2,942,265,743	2.21	1,832,573,380	1.56
2024	9,441,263	3,024,105	3,216,132,445	2.41	2,072,722,346	1.76
2025	9,658,893	3,121,846	3,489,999,147	2.62	2,312,871,313	1.96
2026	9,876,524	3,219,588	3,763,865,849	2.82	2,553,020,279	2.17
2027	10,094,155	3,317,329	4,037,732,551	3.03	2,793,169,245	2.38
2028	10,311,786	3,415,071	4,311,599,253	3.23	3,033,318,212	2.58
2029	10,529,417	3,512,812	4,585,465,955	3.44	3,273,467,178	2.78
2030	10,747,047	3,610,554	4,859,332,657	3.64	3,513,616,144	2.99

The General Traffic Directorate provides data on the registration of vehicles and motorcycles in the private, public, and mixed sectors, categorized based on the type of fuel they utilize.[11] Table 2 shows expected values of consumed and required fuel for the coming years based on data from the Central Statistical Organization (CSO) and the Iraqi Ministry of Oil extending from (2017 to 2023);[11] the number of vehicles in the city of Baghdad is expected to increase to 3,610,554 cars by 2030, coinciding with the increase in the population of Baghdad, which is expected to reach 10,747,047 million people, accompanied by an increase in the rates of fuel required quantity (3.64, 2.99) million tons for each of gasoline and diesel, respectively, to cover the needed consumption of existing transportation, which will contributes to a more significant increase in greenhouse gas emissions into the atmosphere in the coming years. These numbers do not represent the actual number of vehicles in Baghdad. They only include those registered with the Baghdad Traffic Directorate, excluding those in Kurdistan.

Greenhouse gas emissions from road transportation

Greenhouse gas emissions were calculated according to Eq. (1) and Table 1 mentioned above. The quantities of fuel emissions were found for gasoline and diesel emissions shown in Fig. 3, the lowest rates of GHG emissions quantities due to the decrease in the quantities of diesel fuel supplied in 2018 and the decrease in gasoline fuel supplied in the year 2020 in Baghdad. On the other hand, the highest rates of GHG emissions were recorded during the year 2023

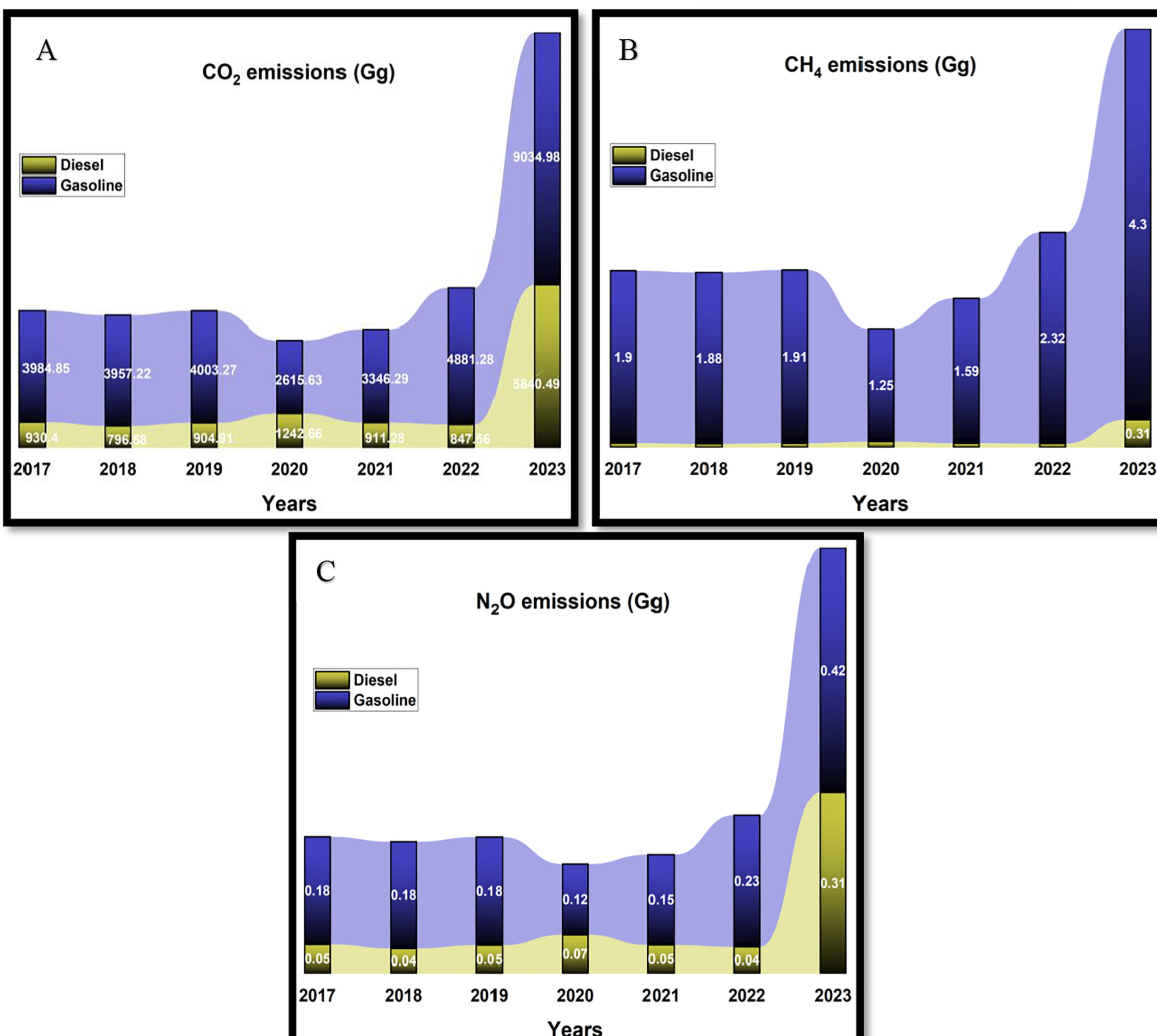

Fig. 3. (A, B, and C) Emissions of GHGs from vehicles during (2017-2023).

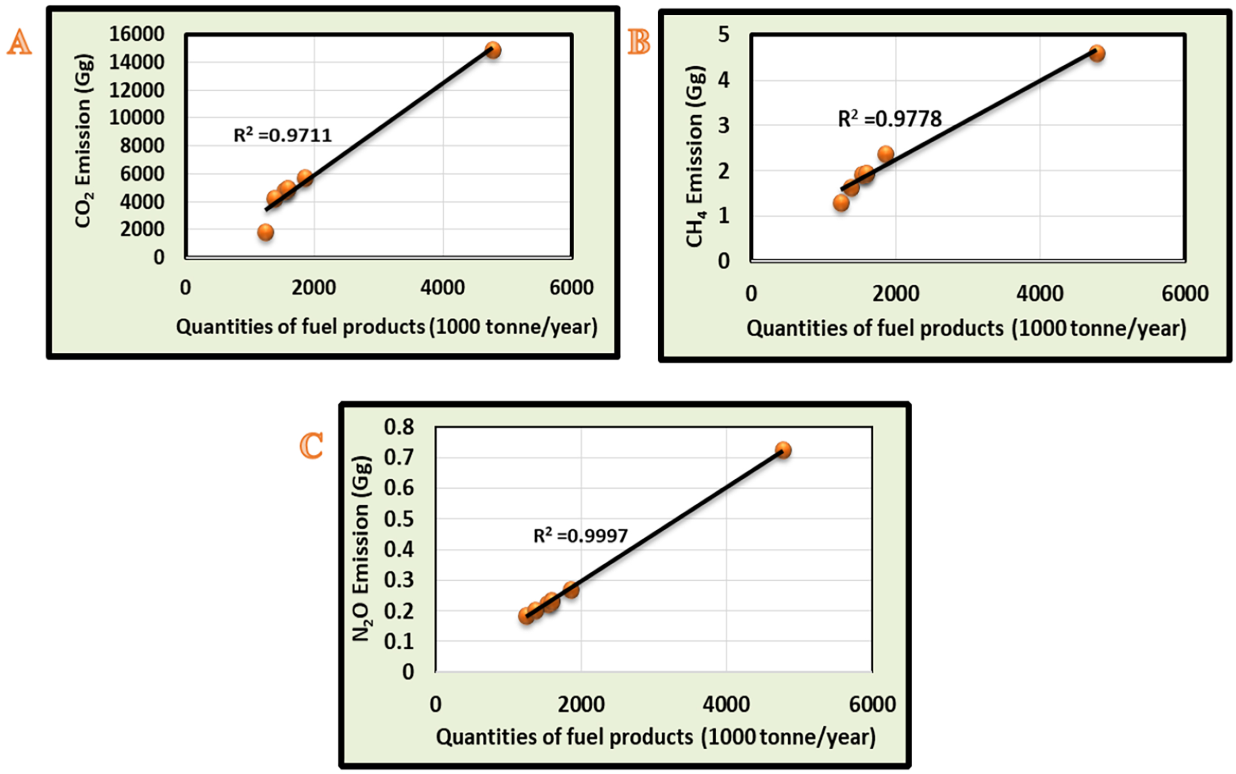

Fig. 4. (A, B, and C) The correlation coefficient and regression between GHG emissions and consumption of the fuel quantities from road transportation in Baghdad.

compared to other years of the study due to the high fuel supply as shown in the Table 2.

The higher amounts of carbon dioxide emission compared to methane and nitrous oxide are due to the emission factor used by IPCC for CO_2, as shown previously in Table 1, which is 2100 times higher than CH_4 and 21656 times higher than N_2O in gasoline fuel. For diesel fuel, the emission factor for CO_2 is 19,000 times higher than that for CH_4 and N_2O.[18] Higher CO_2 emission factors are attributed to organic carbon, the primary component of fuels, which reacts with oxygen to release heat; all the carbon in the fuel is burned and converted into carbon dioxide and water in complete combustion.[17] The methane emitted by gasoline and diesel engines is usually small compared to CO_2 emissions. The percentage of CH_4 emissions from vehicles to the radiative forcing of climate change is estimated to be (0.3–0.4%) of the CO_2 emissions from vehicles; therefore, it can be said that methane can be emitted from incomplete combustion of gasoline and diesel, but its concentration is usually lower than CO_2 emissions.[19] The similarity in values of methane and nitrous oxide emissions for consumed diesel fuel during the study period is expected, as the emission factor used to estimate methane emissions by IPCC is 3.9, the same as for estimating nitrous oxide gas.

The Pearson correlation coefficient, as shown in Fig. 4, reveals a direct linear relationship between the quantities of fuel consumed by vehicles in Baghdad running on gasoline or diesel fuel (influencing variable) and the emissions of greenhouse gases (CO_2, CH_4, and N_2O) (dependent variable). The complete combustion of fuel generates various emissions and pollutant gases.[17] In transportation, gasoline and diesel have traditionally been the primary fuels. However, adding specific materials to gasoline has been necessary to prevent engine knocking, leading to incomplete fuel combustion and releasing significant emissions; previous studies discussed the relationship between fuel quantities and emissions resulting from transportation and indicated similar results.[20] The remaining percentages of effect for CO_2, CH_4, and N_2O are 2.9%, 2.2%, 0.03%, respectively, which can be attributed to random and unknown factors influencing greenhouse gas emissions. Results imply that as the fuel quantities increase, there is an increase in the percentage of greenhouse gas emissions in the atmosphere.

Value of GHG emissions CO_2-equivalent

Table 3. The value of carbon dioxide, methane, and nitrous oxide emissions CO_2-equivalents from road

Table 3. GHG emissions for total gasoline and diesel fuel from the transportation sector.

Year	CO_2 emissions (Gg CO_2-eq./yr)	CH_4 emissions (Gg CO_2 -eq./yr)	N_2O emissions (Gg CO_2 -eq./yr)	Total
2017	4915.2466	40.8768	72.2216	5028.345
2018	4753.7921	40.4526	69.6426	4863.8873
2019	4908.1762	41.0328	72.0694	5021.2784
2020	3858.2885	27.5298	57.7166	3943.5349
2021	4257.5709	34.4701	62.769	4354.81
2022	5728.8399	49.7496	83.702	5862.2915
2023	14875.4685	96.8051	224.6241	15196.8977

transportation is calculated according to Eq. (2). The lowest values of the global warming potential of GHG emission were recorded in 2020 for CO_2, CH_4, and N_2O emissions CO_2-equivalent respectively, which are 3858.2885 Gg/yr, 27.5298 Gg/yr and 57.7166 Gg/yr respectively; while the global warming potential of GHG emission reached their highest value in 2023 (14875.4685 Gg/yr, 96.8051 Gg/yr and 224.6241 Gg/yr) for CO_2, CH_4, and N_2O emissions CO_2-equivalent respectively. This study showed that the value of carbon dioxide emission CO_2-equivalents was higher than the other gas emissions because CO_2 accounts for the largest share of GHG emissions from the transportation sector, While the value of nitrous oxide emission CO_2-equivalent was higher than that of methane emission CO_2-equivalent, the reason lies in the global warming potential (GWP) calculations of GHG emissions, as previously shown in Eq. (2), the GWP values for CO_2, CH_4, and N_2O are 1, 25, and 298, respectively. N_2O is detrimental to the ozone layer and a potent GHG with GWP nearly 300 times greater than CO_2;[21] GWP of N_2O emission CO_2-equivalent is higher than CH_4 emission CO_2-equivalent about 12 times as shown in Eq. (2).

The total GHG emissions of seven recent years ranged from 5028.345, 4863.8873, 5021.2784, 3943.5349, 4354.81, 5862.2915, and 15196.8977 Gg/yr or Kiloton per year, or it can be represented as a percentage (11.4, 11, 11.3, 8.9, 9.8, 13.2, 34.3)% where the highest percentage reached was in 2023 (34.3) % compared to the lowest rate (8.9) % in 2020 as shown in Fig. 5, this variation between the years belongs to previous quantities of fuel proven in Table 2.

The ratio of increase in GHG emissions

Table 4. Shows that during the study period (2017-2023) the highest ratio of CO_2, CH_4, N_2O emissions resulting from the total combustion of vehicles (gasoline and diesel) fuels was reached in 2023 (14875.46847 Gg, 4.60976 Gg, 0.72459 Gg) respectively, compared to the CO_2, CH_4, N_2O emissions reached in 2017 (4915.24662 Gg, 1.94652

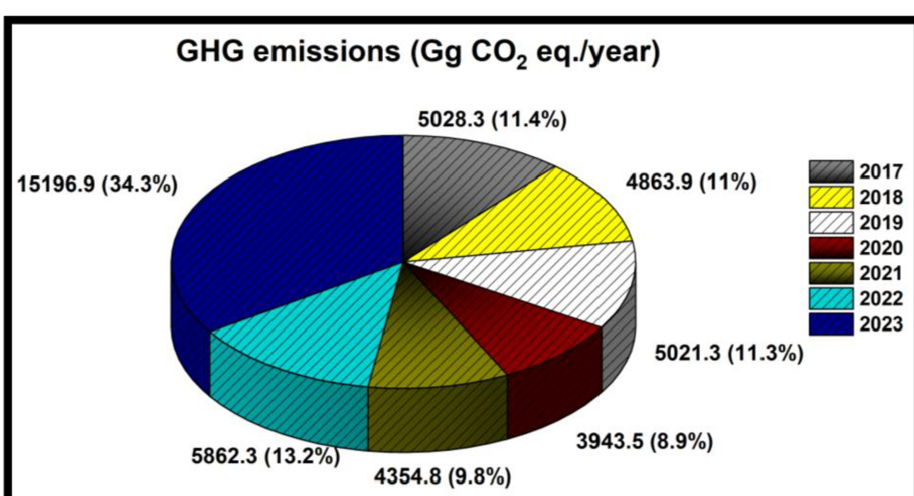

Fig. 5. Total GHG emissions (Gg CO_2 -eq./ year) during (2017-2023).

Table 4. Total fuels consumption (Gasoline & Diesel).

Year	Total CO_2 emissions (Gg/yr)	Total CH_4 emissions (Gg/yr)	Total N_2O emissions (Gg/yr)
2017	4915.24662	1.94652	0.23297
2018	4753.79211	1.92632	0.22466
2019	4908.17616	1.95395	0.23249
2020	1858.28848	1.31094	0.18618
2021	4257.5709	1.64143	0.20248
2022	5728.8399	2.36903	0.27001
2023	14875.46847	4.60976	0.72459
XR of GHGs (%)	203	137	211

Gg, 0.23297 Gg) respectively. The following formula (Eq. (3)) is used to calculate the ratio of increase (X.R.) in greenhouse gas emissions from road transportation:

$$XR = \left(\frac{Final\ value - Initial\ value}{Initial\ value}\right) * 100\% \qquad (3)$$

The rate of increase in carbon dioxide emissions reached 203% over the past seven years, compared to 137% and 211% for methane and nitrous oxide emissions in Baghdad.

Comparison of XR of CO_2 emission between the current study and a previous study

When comparing the results of the current study with a previous study conducted by Hashim in 2005, which included the ratio of increase (XR) of CO_2 emissions from the transportation sector in Iraq entirely,[21] it appears that there is a noticeable increase in the rate of CO_2 gas emission into the atmosphere compared to past decades, especially since the previous study included all governorates of Iraq, while the current study included transportation emissions in Baghdad, the capital only. Table 5. indicates that it is a significant indicator of Baghdad's suffocation with carbon dioxide gas, and it negatively influences the environment and the health of citizens; this rise is due to the increase in population density and the increased demand for purchasing vehicles, which increases fuel consumption, so it has become necessary to move towards sustainable development and use environmentally friendly means of transportation to reduce emissions.

Table 5. XR of CO_2 emission from the transportation sector.

Year	Period	XR of CO_2 emission (%)
Previous Study/Iraq[20]	1970–1980	330
	1981–1991	78
	1992–2002	19
	2003–2013	60
Current study/Baghdad	2017–2023	203

Conclusion

Greenhouse gas emissions in Baghdad were calculated for gasoline and diesel fuels, with the highest rates recorded in 2023. Carbon dioxide emissions were higher than methane and nitrous oxide emissions. Fuel consumption increased due to a rise in the number of vehicles and demand for fuel. The lowest consumption was in 2020 during the pandemic. The consumption of large amounts of gasoline and diesel substantially impacted the rise of greenhouse gas emissions and vice versa, leading to increasing GHG emissions CO_2 -equivalent. The type of fuel used by vehicles affects CO_2 emissions. Future projections show increased automobiles and fuel consumption, the nature of the transportation, and the amount of fuel required, which may change with changes in infrastructure and the nature of imported automobiles. However, continuing with the current approach would lead to an increase in greenhouse gas emissions. The study suggests transitioning to environmentally friendly and hybrid vehicles in Iraq to reduce greenhouse gas emissions. Improving fuel quality, supporting premium fuel, and legalizing vehicle imports from cheaper sources are also advised. Government involvement is crucial in implementing emission factors and Tier 2 and Tier 3 IPCC methods for accurate emission estimates.

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Authors' declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Furthermore, any Figures and images that are not ours have been included with the necessary permission for republication, which is attached to the manuscript.
- No animal studies are present in the manuscript.
- No human participants, human data, or human tissue are present in the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee at University of Baghdad, Iraq.

Authors' contribution statement

Z.A. collected the data, calculated emissions according to IPCC methodology, and wrote the paper. A.T. organized and checked the manuscript. M.S. suggests the research project and the implementation used to conduct the study. All authors have read and agreed to the published version of the manuscript.

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حساب انبعاثات الغازات الدفيئة من مركبات الطرق في بغداد باستخدام منهجية IPCC

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الخلاصة

يؤدي قطاع النقل دورًا حيويًا في رفاهية الإنسان من خلال نقل الأشخاص والبضائع. يواجه هذا القطاع في العراق تحديات كبيرة، منها خسارة سنوية في الوقود تصل إلى 500 مليار دينار وهدر كبير في الوقود. تستهلك كل مركبة حوالي 570 لترًا من البنزين سنويًا بسبب الازدحام المروري، إذ يُقدرعدد المركبات في أوقات الذروة لكل كيلومتر من الشارع ذي المسارات الثلاث (1059 سيارة كم/ساعة). في المقابل، يُقدر عددها في الأوقات الاعتيادية (450 سيارة كم/ساعة)، مما يؤدي إلى زيادة انبعاثات غازات الاحتباس الحراري الناتجة عن احتراق الوقود المستخدم لتشغيل محركات المركبات. حللت الدراسة الحالية بيانات إمدادات الوقود من المؤسسات الحكومية ذات الصلة التي تغطي طرق بغداد من عام 2017 إلى 2023. واستخدمت طريقة المستوى الأول الموضحة في إرشادات اللجنة الدولية للتغيرات المناخية (IPCC) لتقدير انبعاثات الغازات الدفيئة: ثاني أكسيد الكربون والميثان وأكسيد النيتروز من وسائط النقل البري، وكشفت أن عام 2023 شهد أعلى إجمالي انبعاثات بحوالي 15,196.90 كيلوطن في مدينة بغداد (9,039.7 كيلوطن/سنة لانبعاثات البنزين و5,841.11 كيلوطن/سنة لانبعاثات الديزل). تم تسجيل معدل زيادة مرتفع في انبعاثات الغازات الدفيئة الناتجة عن المركبات، إذ بلغت 203 و137 و211 لكل من انبعاثات ثاني أكسيد الكربون والميثان وأكسيد النيتروز على التوالي، وقد تم تسجيله على مدى السنوات السبع الأخيرة في العاصمة وحدها، إذ إن النسبة الأكبر من المواطنين يزودون سياراتهم بالبنزين العادي بدلاً من البنزين الممتاز الخالي من الرصاص. إن الزيادة في أعداد المركبات، الناجمة عن النمو السكاني وتحسن مستويات المعيشة، تؤكد على ضرورة قيام صناع السياسات وأصحاب المصلحة البيئيين بالنظر في استراتيجيات للحد من الانبعاثات المرتبطة بالنقل.

الكلمات المفتاحية: الديزل، البنزين، غازات الاحتباس الحراري، منهجية IPCC، انبعاثات المركبات.