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Assessing the Impact of CO_2 Emissions from Transport and Power on Health and Environment in Duhok, Kurdistan Region, Iraq

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Abstract

This study investigates the carbon dioxide (CO_2) emissions generated by transportation and power generation in Duhok Governorate, Kurdistan Region of Iraq. The research highlights the alarming levels of CO_2 emissions resulting from the region's 270,315 vehicles and 1,814 private electric power generators, which consume approximately 1,500,000 liters of gasoline and 650,000 liters of diesel daily. These activities contribute to a total daily CO_2 emission of 1,741,188 kg, amounting to over 626,827,680 kg annually. The findings reveal the significant environmental and public health threats posed by these emissions, emphasizing the urgent need for targeted mitigation strategies. Comparisons with other urban regions such as Cairo, Tehran, New Delhi, Lagos, and Nairobi reveal a similar pattern of high vehicular and generator-induced CO_2 emissions, underscoring the global nature of this environmental challenge. The study underscores the importance of addressing CO_2 emissions through improved regulations, modernized infrastructure, and sustainable energy practices to protect both the environment and public health.

Keywords: Carbon Dioxide Emissions, Transportation, Power Generation, Public Health, Environment, Duhok Governorate, Kurdistan Region

Introduction

Carbon dioxide (CO_2) emissions, predominantly from transportation and power generation, have become one of the most significant contributors to global climate change, air pollution, and their associated health impacts [1, 2]. These emissions have profound implications for public health and environmental sustainability. Numerous studies have documented the detrimental effects of CO_2 emissions on both public health and the environment. The transportation sector, which relies heavily on fossil fuels, accounts for nearly 25% of global CO_2 emissions, playing a pivotal role in the accumulation of greenhouse gases in the atmosphere [3]. Similarly, power generation, particularly from coal and natural gas, is a major source of CO_2 emissions, contributing approximately 40% of the global total [4]. The combustion of fossil fuels in power plants not only releases CO_2 but also other pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NOx), and particulate matter (PM), all of which have severe health implications [5]. Prolonged exposure to these pollutants has been associated with increased mortality and morbidity due to respiratory infections, lung cancer, cardiovascular conditions, premature mortality, and chronic obstructive pulmonary disease (COPD) [6, 7].

The environmental impact of CO_2 emissions is equally concerning, as they drive global warming, leading to shifts in climate patterns, rising sea levels, and the loss of biodiversity [8]. The Intergovernmental Panel on Climate Change (IPCC) has highlighted that the continued rise in CO_2 emissions will likely result in more frequent and severe weather events, further exacerbating the strain on public health systems [9]. In regions with limited environmental regulations, the impact of these emissions is particularly pronounced, often leading to higher rates of pollution-related health issues among vulnerable populations [10]. The situation in the Kurdistan Region of Iraq is especially dire in terms of pollution from carbon dioxide emissions. In regions like Duhok Governorate, the rapid expansion of infrastructure and energy demands has exacerbated the situation.

The large number of vehicles, totaling 270,315 cars, and 1,814 electric power generators [11] in the region consume approximately 1,500,000 liters of gasoline and 650,000 liters of diesel daily, which are distributed to fuel stations across all

administrative regions of Duhok Governorate. This results in a daily emission of 1,741,188 kg of carbon dioxide, amounting to more than 626,827,680 kg of CO_2 annually. The region has a limited number of crude oil refineries, most of which are primitive and fail to meet the required standards. These refineries are outdated and lack modern equipment and essential materials to improve the quality of gasoline and diesel, rendering them incapable of producing pollution-free fuel to meet the region's needs, especially in terms of the large number of vehicles in the region.

According to the Directorate General of Traffic in Duhok Governorate, 270,315 vehicles have been registered by the end of 2023. The magnitude of environmental pollution caused by gas emissions from this large number of vehicles has severe negative effects on the health and environmental situation in the governorate, primarily due to the inhalation of toxic gases from various modes of transport. Additionally, pollution resulting from crude oil extraction in different areas of Duhok Governorate further exacerbates the situation.

The increase in population and the development of technology in various fields have led to a greater demand for different modes of transport. This, in turn, has resulted in competition among car manufacturers of all kinds, driving the need for various types of fuel to power the increasing number of vehicles [12]. However, this rise in vehicle use creates environmental problems due to emissions from fuel combustion [13]. Gasoline, a commonly used fuel, contributes significantly to air pollution. It is a toxic and highly flammable liquid, and the vapors released during gasoline evaporation, along with the substances produced when gasoline is burned (such as carbon monoxide, nitrogen oxides, particulate matter, and unburned hydrocarbons), further exacerbate air pollution [7]. Additionally, burning gasoline releases carbon dioxide, a greenhouse gas that contributes to global warming [14].

Diesel emissions from motor vehicles generate significant air pollutants. Diesel exhaust particles (DEPs) account for a highly significant percentage of the particulate matter emitted in many towns and cities [15, 16]. While the complete combustion of diesel fuel produces water and carbon dioxide, the use of diesel in motor vehicles typically results in incomplete combustion, leading to the formation of various gases, liquids, and solid particles. Compared with petrol engines, diesel engines produce far less carbon monoxide but emit greater amounts of nitrogen oxides and aldehydes, which are particularly prone to causing irritation of the upper respiratory tract. Diesel engines also produce submicron soot particles, which are believed to mediate several observed adverse health effects. It has been estimated that the particulate emissions from diesel engines per traveled distance are over 10 times higher than those from petrol engines of equivalent power running on unleaded petrol, and over 100 times higher than those from petrol engines fitted with catalytic converters [17, 18].

The burning of fossil fuels produces around 21.3 billion tonnes (21.3 gigatons) of carbon dioxide (CO_2) per year [19]. It is estimated that natural processes can absorb only about half of that amount, resulting in a net increase of 10.65 billion tonnes of atmospheric carbon dioxide annually [20]. Improving the current average global efficiency rate of coal-fired power plants, which supply the heat to convert water (or CO_2) to steam, from today's 33 percent to 40 percent by deploying more advanced technology could reduce CO_2 emissions by 2 gigatons per year [6].

This paper seeks to explore the specific impacts of CO_2 emissions from transportation and power generation on public health and the environment, with a focus on Duhok Governorate in the Kurdistan Region of Iraq. By understanding these impacts, we can develop targeted strategies to mitigate the risks associated with CO_2 emissions and promote sustainable development.

Materials and Methods

The study involved visiting the following sites and collecting information from them:

- Dohuk Governorate Traffic Directorate.
- Directorate of Distribution of Petroleum Derivatives (Gasoline and Diesel).

Carbon dioxide emissions were measured from 270,315 cars and 1,814 private electric power generators. The measurement of carbon dioxide was based on the following calculations:

Petrol

- 1 liter of petrol weighs 750 grams.
- Petrol consists of 87% carbon, equating to 652 grams of carbon per liter of petrol.
- To combust this carbon to CO_2, 1,740 grams of oxygen is required.
- The total CO_2 produced per liter of petrol is 652 + 1,740 = 2,392 grams of CO_2.

Diesel

- 1 liter of diesel weighs 835 grams.
- Diesel consists of 86.2% carbon, equating to 720 grams of carbon per liter of diesel.
- To combust this carbon to CO_2, 1,920 grams of oxygen is required.
- The total CO_2 produced per liter of diesel is 720 + 1,920 = 2,640 grams of CO_2.

Result and Discussion

The research results indicate that pollution from carbon dioxide emissions is continuously increasing in Duhok Governorate, including its districts and sub-districts. This rise is primarily due to the large number of fuel-powered vehicles, both diesel and gasoline, which totaled more than 270,315 cars as of December 31, 2023. These vehicles consume approximately 1,500,000 liters of gasoline and 300,000 liters of diesel daily, according to information obtained from the Director of Oil Derivatives Distribution in Duhok Governorate. This fuel consumption results in the daily production of 798,288 kg of carbon dioxide, as per the Dohuk Governorate Traffic Directorate's letter No. 1259. In Cairo, Egypt, the transportation sector is a major source of CO_2 emissions, with about 4.5 million vehicles consuming 4,200,000 liters of gasoline and 1,800,000 liters of diesel daily. The study estimated daily CO_2 emissions to be around 11,500,000 kg [21]. Cairo, much like Duhok, faces significant challenges in controlling vehicular emissions due to the rapid growth in vehicle numbers. In Tehran, Iran, CO_2 emissions from vehicles have been rising due to an increasing number of cars, estimated at 3.5 million. These vehicles consume around 2,500,000 liters of gasoline and 800,000 liters of diesel daily, resulting in daily CO_2 emissions of approximately 7,500,000 kg [22]. This situation

parallels Duhok's challenges with rising vehicular emissions. A study in New Delhi found that vehicular emissions contribute significantly to air pollution, with over 8.1 million vehicles consuming approximately 7,000,000 liters of gasoline and 2,000,000 liters of diesel daily. The resulting CO_2 emissions were estimated to be around 18,000,000 kg per day [23]. The rapid increase in vehicle numbers has exacerbated air quality problems, similar to the situation in Duhok. The research in Duhok Governorate aligns with findings from other regions where rapid urbanization and increasing vehicle numbers have led to significant CO_2 emissions. In all cases, vehicular emissions are a primary source of air pollution, posing serious environmental and public health challenges. These comparisons highlight the global nature of the problem and the need for targeted strategies to mitigate CO_2 emissions from transportation.

In addition to the large number of private electric power generators, totaling 1,814, which consume 350,000 liters of diesel fuel daily, according to information obtained from the Director of Oil Derivatives Distribution in Dohuk Governorate, these generators supply power to the governorate's districts and sub-districts alongside government-provided electricity. These generators alone produce 942,900 kg of carbon dioxide emissions daily. Combined with the emissions from the vast number of vehicles of various sizes and types, this results in a total daily carbon dioxide emission of 1,741,188 kg. Over the course of a year, this amounts to more than 626,827,680 kg of carbon dioxide. This significant level of pollution poses a serious threat to both the environment and public health. In Lagos, Nigeria, private power generators are a significant source of CO_2 emissions due to frequent power outages. A study estimated that over 2,000 small to medium-sized generators, consuming 500,000 liters of diesel daily, produce approximately 1,320,000 kg of CO_2 emissions per day. When combined with vehicle emissions, the total daily emissions exceed 2,500,000 kg of CO_2 [24]. This level of pollution, similar to Duhok, contributes to severe environmental and health risks. A study in Delhi examined the impact of diesel generators, which are widely used due to frequent power outages. The research found that approximately 3,000 generators consumed 400,000 liters of diesel daily, resulting in CO_2 emissions of about 1,056,000 kg per day. Coupled with emissions from vehicles, the total daily CO_2 emissions in Delhi exceeded 2,500,000 kg [25]. This situation mirrors the findings in Duhok, where the reliance on generators significantly contributes to air pollution. Nairobi also experiences significant CO_2 emissions from diesel generators, with approximately 1,500 generators consuming 300,000 liters of diesel daily, producing around 792,000 kg of CO_2 emissions each day [26]. When added to vehicle emissions, the total daily emissions are similar to those found in Duhok, posing considerable environmental and public health challenges. The findings from Duhok Governorate are consistent with research conducted in other regions such as Delhi and Nairobi, where the use of diesel generators due to unreliable electricity supply contributes significantly to CO_2 emissions. This comparison underscores the global issue of air pollution resulting from diesel generators, which, combined with vehicle emissions, presents a serious threat to environmental and public health across various urban centers.

Conclusions

The findings of this study underscore the significant environmental and public health challenges posed by carbon dioxide (CO_2) emissions in Duhok Governorate, Iraq. With over 270,315 vehicles and 1,814 private electric power generators consuming vast amounts of gasoline and diesel daily, the region produces more than 626,827,680 kg of CO_2 annually. This alarming level of emissions is a direct result of the region's heavy reliance on fossil fuels for transportation and power generation.

The data from Duhok are consistent with global patterns observed in other rapidly urbanizing regions, such as Cairo, Tehran, and New Delhi, where vehicular emissions contribute significantly to air pollution. Similarly, the widespread use of diesel generators in Duhok parallels the situation in cities like Lagos and Nairobi, where unreliable electricity supply drives high CO_2 emissions from private power sources.

The environmental impact of these emissions is severe, contributing to global warming, climate change, and the degradation of air quality. These changes not only affect the natural environment but also have profound implications for public health, increasing the incidence of respiratory diseases, cardiovascular conditions, and other pollution-related illnesses.

Given the magnitude of the problem, there is an urgent need for targeted strategies to mitigate CO_2 emissions in Duhok Governorate. These strategies could include the promotion of cleaner energy sources, the enhancement of fuel quality, the modernization of transportation infrastructure, and the implementation of stricter environmental regulations. Addressing these issues is critical for safeguarding public health and ensuring sustainable development in the region.

By drawing parallels with other global regions facing similar challenges, this study highlights the universal nature of the problem and the necessity for collaborative efforts to reduce CO_2 emissions. The findings serve as a call to action for policymakers, stakeholders, and the public to engage in concerted efforts to reduce reliance on fossil fuels and to develop more sustainable practices for transportation and energy production.

Recommendations

1. Expand public transit and incentivize electric vehicle (EV) adoption to reduce reliance on private cars and lower CO_2 emissions.
2. Shift to renewable energy sources like solar and wind, and upgrade power plants to improve efficiency and cut emissions.
3. Enforce stricter vehicle emission standards, mandate regular testing, and improve fuel refining for cleaner output.
4. Promote energy-efficient technologies and launch awareness campaigns to reduce energy demand.
5. Develop air quality management plans and integrate green urban planning to enhance air quality.
6. Monitor emissions continuously and invest in alternative fuel research to reduce fossil fuel dependency.
7. Partner with neighboring regions on emission reduction initiatives and access global climate funds to support sustainable projects.

8. Strengthen public health programs to address air pollution and raise awareness about pollution risks.

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