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The Impact of the Comprehensive Ban Due to the COVID-19 on the Quality of Ambient Air in Jordan. Study for 15th March to 15th April of 2020 Period

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Abstract:

This research deals with the impact of the comprehensive ban due to the COVID-19 pandemic during the period from (15th March 2020) until (15th April 2020) on the quality of the surrounding air in Jordan, where it highlighted the extent to which air quality is protected in international conventions and Jordanian legislation, and showed the role of Jordanian government measures taken to confront the Corona virus in reducing ambient pollutants in the surrounding air in Jordan, whereas the research dilemma lies in addressing the impact of government decisions during the COVID-19 pandemic period on reducing emissions and improving ambient air quality in main cities in Jordan, the research also concluded several results and recommendations, the most important of which is improving the ambient air quality that recorded in most monitoring centers in Jordanian cities as a result of the precautionary measures taken by the Jordanian government to limit the spread of the COVID-19, as the pivot of these measures was the closure of most industrial activities, the prevention of transportation between governorates, and the commitment of millions of the Kingdom's residents to their homes, which led to a decrease in the percentage of emissions resulting from vehicle exhaust, and industrial, commercial.

Keywords: the comprehensive ban; COVID-19 pandemic; air quality; the pollutants reduction.

JEL Classification: Q53; K32; R11.

Introduction

The World Health Organization proclaimed a global epidemic of the new coronavirus (COVID-19). As a result, several countries put significant limitations on social life and economic activity due to the virus's transmissibility and rapid spread worldwide, including stay-at-home orders, social distance, obligatory quarantines, and remote work and education. In late March 2020, these limitations put most of the world's population on lockdown (Silva *et al.* 2022).

Still, many activities and industries are spread in Jordan, in addition to population increase, economic growth, increase in the number of vehicles and traffic density, and all of the mentioned are considered as causes of air pollution that may affect air quality directly or indirectly, and hence the importance of advanced monitoring instruments in monitoring air quality in main cities.

The importance of the research lies in that it addresses the impact of the comprehensive ban due to the COVID-19 pandemic during the period from 15th March 2020 until 15th April 2020 on the ambient air quality in Jordan, this research is one of the latest and most important topics that have a significant impact on practical reality, where the research will clarify all aspects of the subject, whether theoretical or practical, and it will address the shortcomings of Jordanian environmental laws, by referring to international conventions and standards, as the research involvers hope to succeed in addressing this deficiency, ambiguity, and incapacity in the Jordanian legislative provisions.

This research aims to demonstrate the extent to which air quality protection in international conventions and Jordanian legislation and government measures taken during the period (1st March - 15th April of 2020) in

determining the levels of pollutants and available particles in the air in the main areas of Jordan during the period of the comprehensive ban, and assessment of differences in ambient air quality in the main Jordanian cities, and assessment of the condition of air quality for the period 1st March - 15th April of 2020 compared to the period 14th February - 14th March of 2020, as well as the same evaluation for the period 15th March - 15th April of 2020 compared to the same period 2019, according to different circumstances, and an evaluation of the extent of commitment to achieving ambient air quality standards in the Jordanian cities.

1. Literature Review

The subject of this study is one of the new and rare topics because it is a specialized topic on the impact of the comprehensive ban as a result of COVID 19 on air quality in Jordan; several studies will be referred to, including: "Effect of COVID-19 pandemic on ambient air quality and excess risk of particulate matter in Turkey".

This study shows the impacts of curfew rules on air quality metrics in Turkey. A statistical comparison of the March-April 2019 and 2020 indicates no significant difference in PM concentrations or SO2 concentrations at half of the sites. However, total NOx, NO2, and NO concentrations were much lower. The biggest NO2 decrease was found in a non-industrial city (40.9 per cent), while the lowest was found in a strongly industrialized city (6.83 per cent). NO and NOx showed similar trends. While CO emissions in major cities have soared (Goren *et al.* 2021).

In addition to a study entitled: "COVID-19 pandemic: What can we learn for better air quality and human health?"

This study shows that the shutting down of cities and towns resulted in a reduction in emissions. As a result, it presented a once-in-a-lifetime chance to investigate the contributions of numerous natural and artificial air pollution causes, including atmospheric chemistry and reactivity. This provides an opportunity for local and regional authorities to understand the sources of atmospheric emissions better to create evidence-based short- and long-term mitigation measures for improving air quality and reducing the related burden of disease and disability (Ravindraa *et al.* 2022).

Also, a study entitled:" The Impact of the COVID-19 Pandemic on Ambient Air Quality in China: A Quasi-Difference-in-Difference Approach".

This study shows the efficiency of quick-response measures once an environmental emergency is declared, particularly when urban air quality exceeds the red alert level, which is very dangerous for people according to WHO criteria (Zhang & Tang 2021).

In an era where severe air pollutants are on the rise, the normalized development of the COVID-19 can help mitigate extreme air pollution. However, the most fundamental strategy to significantly reduce severe air pollution is to cut fossil fuel usage, transition to more environmentally friendly energy sources, establish green transportation networks, and prevent biomass burning. In particular, the industry can be rationally organized, the energy structure can be altered, clean energy can be pushed, and clean manufacturing techniques may be applied. Continue to execute the vehicle number restriction policy and increase environmental oversight and management in key government ministries (Pan *et al.* 2021).

Therefore, the following research questions are raised.

First, to what extent do international conventions and Jordanian legislation protect air quality?

Second, what does the Jordanian government take the measures to confront the COVID-19 pandemic from 15th March 2020 to 15th April 2020?

Third, to what extent did ambient pollutants decrease in the surrounding air in Jordan as a result of the government measures to confront the COVID-19 pandemic during the period from 15th March 2020 to 15th April 2020?

According to the preceding, and in order to clarify the impact of the comprehensive ban due to the COVID-19 pandemic on the quality of the surrounding air in Jordan, the research will address the extent of air quality protection in international conventions and Jordanian legislation and the measures the Jordanian government has taken to confront COVID-19 and the decrease in ambient pollutants in the surrounding air at Jordan as a result of the government measures to confront the COVID-19 pandemic.

2. Methodology

Because of the variety of legislation that addresses the major issue of the study, a comparative method will be used in this study.

It will assist us in clarifying the distinctions between these laws and determine the strengths and weaknesses of these trends and how they are seen.

Furthermore, the study employs an analytical technique to analyze all legislative provisions linked to the subject of this study in order to discover its contents, consequences, and purposes before criticizing and commenting on them and emphasizing the researcher's critical element (Malkawi 2008).

Due to the split character of the study among legislative and convention texts, jurisprudential tendencies, and opinions, the research necessitates the use of many research methodologies.

To that end, the process in this study will be twofold:

- Analysis or interpretation.
- Critique with suggestions for adjustments.
- A conclusion outlining recommended alterations.

3. The Extent of Air Quality Protection in the International Conventions and Jordanian Legislation

Air pollution is a global problem, whereas the international community has sought various methods to establish agreements aimed at protecting the global climate and maintaining air quality; from this standpoint, the Jordanian legislator has set up several legislations aimed at protecting the local climate and maintaining air quality in Jordan. Therefore, this research on the extent to which air quality is protected in international conventions and Jordanian legislation will address the protection of air quality by the United Nations Framework Convention on Climate Change (1992), the protection of air quality according to the "Kyoto Protocol" attached to the United Nations Framework Convention on Climate Change in (2002), air quality protection by the Jordanian Environmental Protection Law No. (6) of (2017) and its amendments, and protecting air quality by the Jordanian Climate Change Law No. (69) of (2019).

3.1. The Protection of Air Quality by the United Nations Framework Convention on Climate Change (1992)

Climate change has become a major issue caused by the emission of gases from human consumption and usage, which negatively affects the Earth's climate; in which scientists and specialists paid attention to the global consequences; therefore, the United Nations Environment Program, in cooperation with the World Meteorological Organization in the year (1988), established the Intergovernmental Panel on Climate Change (IPCC) in order to obtain scientific data on climate change (Al-Haf 1998; Zerbani 2019).

The United Nations General Assembly called for an international conference on the human environment in Stockholm to stop the environment's decline, establish legal rules to preserve it, combat pollution sources, and encroach on its components and natural resources. It ended with adopting a set of extremely important principles and recommendations that formed the basis for developing international environmental law (Alhendi 2022).

Accordingly, the international community has intervened by various means to protect air quality and global climate, such as Article (1) of the UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE stipulates the following (DEFINITIONS): "For this Convention: "4. "Emissions" means the release of greenhouse gases and their precursors into the atmosphere over a specified area and period. “Greenhouse gases” means those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation”. (UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, 1992).

Furthermore, Article (41) of the same CONVENTION stipulates the following: "The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, by the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Furthermore, such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened, and enable economic development to proceed sustainably" (UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, 1992).

3.2. The Air Quality Protection According to the "Kyoto Protocol" Attached to the United Nations Framework Convention on Climate Change (1998)

The "Kyoto Protocol" was adopted at the third session of the States Parties Conference held in (Kyoto, Japan) in December 1997 to reduce greenhouse gas emissions from developed countries and return them to levels 1990 by 2005, in order to achieve the objectives of The Framework Convention, which is to prevent the risks of human interference in the global climate system (Zarbani 2019).

Therefore, to maintain the air quality in the global climate, the international community contributed to the strengthening of the United Nations Framework Convention on Climate Change under the "Kyoto Protocol" through the following decisions: Article (2/1/A) of the KYOTO PROTOCOL TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE stipulates the following: “1. Each Party included in Annex I, in achieving its

quantified emission limitation and reduction commitments under Article 3, in order to promote sustainable development, shall: A. Implement and/or further elaborate policies and measures in accordance with its national circumstances, such as: Enhancement of energy efficiency in relevant sectors of the national economy; Protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of sustainable forest management practices, afforestation and reforestation; Promotion of sustainable forms of agriculture in light of climate change considerations; Research on, and promotion, development and increased use of, new and renewable forms of energy, of carbon dioxide sequestration technologies and of advanced and innovative environmentally sound technologies; Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments; Encouragement of appropriate reforms in relevant sectors aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol; Measures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal Protocol in the transport sector; Limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy". (Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1998).

3.3. The Air Quality Protection by the Jordanian Environmental Protection Law No. (6) of 2017 and its Amendments

Article (4) of the Jordanian Environmental Protection Law states the following: "The Ministry, in cooperation and coordination with the relevant authorities, undertakes the following tasks and responsibilities: A- Establishing the general policy for the protection of the environment, setting up the necessary plans and programs, developing them, and following up on their implementation. B- Cooperating and coordinating with donors and entities concerned with environmental affairs locally, regionally and internationally. C- Coordinating the national efforts aimed at predicting the process of climate change, identifying the affected sectors and reducing and mitigating greenhouse gas emissions, such as providing financing, importing technology, reallocating available grants and distributing it to climate change activities. D- Track the implementation of the provisions of any agreement related to the environment to which the Kingdom is a party, including the United Nations Framework Convention on Climate Change or any related agreements or protocols ratified by the Kingdom (The Jordanian Environmental Protection Law, 2017).

In addition, Article (11) of the same law also stipulates the following: "A facility that carries out an activity that results in emissions that exceed the permissible limits by the established technical specifications and the rules and conditions of the environmental license shall take the necessary precautions to limit any pollution resulting from its activities, including the installation of emissions control devices and prevent its spread. Every vehicle that emits emissions that may cause pollution shall take the necessary measures to reduce it, including installing special devices to control emissions before they are emitted within the permissible limits by the established technical specifications and rules and the instructions issued. The competent official authorities should not license vehicles or renew its licenses if the vehicle does not meet the conditions of the permitted specifications and technical rules" (The Jordanian Environmental Protection Law, 2017).

However, the amended Jordanian Environmental Law No. (6) (2017) did not include articles related to civil liability, and the principle of participation of different categories of civil society in environmental management, policy formulation, and enforcement of such legislation has not been solidified. Furthermore, the new law did not specify a competent court and specialized judges to consider environmental crimes, leaving the judicial system in flux (Emar & Abu Issa 2021).

3.4. Protecting Air Quality by the Jordanian Climate Change Law No. (69) of 2019

Article (3) of the Jordanian Climate Change Law states the following: "The Ministry, in coordination with the relevant authorities, undertakes the following tasks and responsibilities: Acting as the national focal point for the United Nations Framework Convention on Climate Change, and its emanated protocols and committees. Submit proposals for policies and strategies for adapting to climate change, minimizing its negative effects, and mitigating greenhouse gas emissions to the committee for approval and submit them to the Council of Ministers for approval to include these proposals in the relevant sectoral policies and strategies for the relevant authorities. Prepare the National Determined Contributions (NDCs), the National Communications Reports (NCRs), the updated communications, the national adaptation plan, and any other documents and update them by international conventions and obligations. Representing the Kingdom at the international organizations concerned with climate change.

Establishing and managing a National Inventory Registry database to document emissions data, mitigation and adaptation measures, and climate finance data. Ratify the authorities to verify the results of the reports issued by the National Inventory Registry according to specific criteria in the instructions issued for this purpose. Providing technical support to the scientific research centres by opening communication channels with similar international climate research centres. Coordination with the relevant authorities to develop a national plan for climate finance that defines the type of priority projects, programs and plans. Coordination with relevant authorities regarding market mechanisms related to climate change (Jordanian Climate Change System, 2019).

4. The Jordanian Government Measures to Confront the COVID-19 Pandemic during the Period from 15th March to 15th April 2020

The Jordanian government took several measures from (15th March 2020) to (15th April 2020) to confront the COVID-19 pandemic. In contrast, Defense Law No. (13) Of (1992) was activated throughout the Hashemite Kingdom of Jordan. Accordingly, defence orders were issued based on the Defense Law, and defence notifications were issued based on those orders.

4.1. The Governmental Measures Taken on 14th March 2020

The Jordanian Prime Minister announced a set of new measures and decisions taken by the government to deal with the emerging COVID-19 in light of the rapid global developments and to protect the country and citizens, according to the measures listed below: "Educational institutions (nurseries, kindergartens, schools, universities, colleges, institutions and training institutes) are to be closed as of Sunday morning, (March 15, 2020) for two weeks. All flights to/from the Kingdom will be suspended from Tuesday (March 17, 2020) until further notice, excluding commercial cargo flights. According to the above, all land and sea border crossing points of the kingdom and airports are closed to passenger traffic, except for commercial freight. All public events and gatherings are suspended. Citizens are advised to avoid social events, including funeral homes and weddings. Under the guidance of the Fatwa Council and the Council of Churches, prayers in all mosques and churches of the Kingdom are suspended; as a precautionary and preventive measure, the call to prayer is raised as scheduled, and a unified Friday sermon is broadcasted via TV stations. Visits to hospitals and prisons are suspended until further notice. Tourist and archaeological sites are closed for a week to implement sterilization campaigns in these sites. Sporting events are suspended, and cinemas, swimming pools, sports clubs and youth centres are closed until further notice. Serving Shisha and smoking in cafes and restaurants are prohibited. The concerned official authorities are authorized to close any café or restaurant not complying with these instructions" (The government announces new measures to deal with the COVID-19, including the suspension of schools and universities, 2020- https://corona.moh.gov.jo/ar/MediaCenter/26).

4.2. The Governmental Measures Taken on 16th March 2020

The Jordanian government has announced additional precautionary governmental health measures that will be implemented immediately to prevent the spread of infection and protect the health of Jordanian citizens and those coming to the country from the emerging COVID-19, according to Jordanian Information Minister the measures include imposing a mandatory quarantine on all passengers arriving in Jordan, as all arrivals to Jordan through airports and border crossings from today onwards will be subject to a mandatory of 14-day quarantine in specific hotel facilities set by the government in the Dead Sea area in southern Jordan and the capital Amman, where they will be subject to health procedures approved by the Ministry of Health, the government also decided to prevent the reception of arrivals through airports and border crossings by their families or anyone, while only authorized persons are allowed to be at airports and border crossings, starting from today onwards, bearing in mind that the arrivals will be secured with means of transportation to relocate them to the designated quarantine places and with means of communication with their families"(Precautionary health measures in Jordan to prevent the spread of infection with the COVID-19, 2020. www.spa.gov.sa/2048120).

4.3. The Governmental Measures Taken on 17th March 2020

A Royal Decree was issued on (March 17, 2020) approving the Council of Ministers Resolution No. (9060) in its session held on March 17, 2020, which includes the following: "Given the emergency conditions that the Hashemite Kingdom of Jordan is going through, and the World Health Organization's announcement of the spread of the COVID-19 pandemic, and in order to confront this epidemic at the national level and protect public safety throughout the Kingdom, the Council of Ministers decided, that according to the provisions of Article (124) of the Constitution and Paragraphs (A) and (B) of Article (2) of Defense Law No. (13) of (1992), proclaiming the implementation of

Defense Law No. (13) of (1992) in all parts of the Hashemite Kingdom of Jordan, as of the date of issuance of the Royal Decree" (Proclaim of the implementation of Defense Law No. (13) of (1992), 2020).

4.4. The Governmental Measures Taken on 20th March 2020

Article (1) of Defense Ordinance No. 2 of 2020, issued under the provisions of the Jordanian Defense Law No. 13 of 1992 and published in the Official Gazette No. 5627 on the page No. 1920. Issued on March 20, 2020 reads as follows: "Based on what was stated in Paragraph (A) of Article (4) of Defense Law No. 13 of 1992, and given the emergency health situation that our region and the world are going through, and preventing the spread of epidemics, I have resolved to issue the following Defense Ordinance: It is prohibited for individuals to move and roam in all regions of the Kingdom, starting from seven in the morning on Saturday, corresponding to 21st March 2020, until further notice. Furthermore, all shops will be closed in all regions of the Kingdom, and specific times will be announced on Tuesday morning (24th March 2020) to allow citizens to meet their necessary needs and by the mechanism that will be announced at that time. The Persons authorized by the Prime Minister and the Minister of Defense and whose duty nature is required to maintain the public utilities are excluded from the ban. As for emergency medical cases, citizens must report the Public Security / Civil Defense to take the necessary measures to protect their health and safety by the rules. Anyone who violates the provisions of this Defense Ordinance and the circulars issued by the Prime Minister and the Minister of Defense under it shall be punished with immediate imprisonment for a period not exceeding one year." (Defense Ordinance No. 2 of 2020, issued by the provisions of the Jordanian Defense Law No. 13 of 1992, 2020).

While Circular No. (1) was issued based on the provisions of Clause (2) of Defense Ordinance No. 2 of 2020 and published in the Official Gazette No. 5628 on the page No. 1922, issued on 24th March 2020 stated: "Only basic food stores, vegetable and fruit stores, bakeries, pharmacies and water supply outlets will open, and any other stores for which a decision is issued by the Prime Minister and the Minister of Defense or whomever delegates, between (Ten) in the morning until (Six) in the evening, starting from the morning of Wednesday (25th March 2020), until further notice, during this period, citizens are allowed to purchase their essential needs by walking and individually, for ages between (16-60) years. Furthermore, the movement of vehicles is continued to be strictly prohibited, except for individuals authorized to do so, if there are no other individuals in the vehicle who are not authorized. Furthermore, about the distribution of vehicles, the competent minister determines the number of its passengers" (Circular No. (1) - issued based on the provisions of Clause (2) of Defense Ordinance No. 2, 2020).

4.5. The Governmental Measures Taken on 26th March 2020

Defense Ordinance No. 3 of 2020 was issued under the provisions of Defense Law No. 13 of 1992 and published in the Official Gazette No. 5628 on the page No. 1921 on 26th March 2020 stipulates by: "Based on the provisions of Articles (3) and (7) of Defense Law No. 13 of 1992 and subsequently to Defense Ordinance No. (2) dated (20th March 2020), I decided to issue the following defence orders: First: Anyone who violates Defense Ordinance No. 2 of 2020, which stipulates preventing individuals from moving and roaming in all regions of the Kingdom, and the circulars issued under it, shall be punished with the following penalties: A fine of not less than (100) dinars and not more than (500) dinars if the violation is for the first time, and there is no prosecution if the violator pays the minimum fine within a week from the date of the violation. Imprisonment for a period not exceeding one year or a fine of no less than (100) dinars and not more than (500) dinars, or both penalties in case of recurrence. The vehicle used during the curfew will be confiscated for (30) days. Second: Anyone authorized and opens his store outside the permitted times shall be punished with a fine of no less than (1000) dinars and the store's closure for (14) days. Third: Whoever is unauthorized, and opened his store, shall be punished with imprisonment not exceeding (3) months or a fine of (3000) dinars or both penalties." (Defense Ordinance No. 3 of 2020, issued by the provisions of the Jordanian Defense Law No. 13 of 1992, 2020).

5. Reduction of Ambient Pollutants in the Surrounding Air in Jordan as a Result of Government Measures to Confront the COVID-19 Pandemic during the Period from 15th March 2020 to 15th April 2020

Factories and vehicle engines contribute to air pollution because it contains compounds of lead, beryllium, arsenic, copper, zinc, fine particles, nitrogen dioxide, sulfur dioxide, carbon monoxide, in addition to ozone gas, as the main elements of air pollution are the smokes emitted from the combustion of solid fuels (coal), liquid fuels (petroleum), gaseous fuels and natural gas, where these materials are still used in power generation in most industries (Sharq 1999).

Correspondingly, government measures that extended during the period from 15th March 2020 to 15th April 2020 to confront the COVID-19 pandemic reduced vehicle use and factory operation, which contributed to a decrease in pollutants emissions in ambient air surrounding the Hashemite Kingdom of Jordan, the Covid-19 pandemic affected the environment and climate significantly from several aspects. In contrast, the sharp decrease in travel and movement of individuals and social and commercial activities led to a decrease in air pollution in many Jordanian regions.

5.1. The Reduction of the Inhalation of Fine Particles Available in the Air

Fine particulates are considered the most common air pollutant which is dispersed and generated from many sources, whether liquid or solid; it is also the heaviest dust that comes from mechanical activities and also contains industrial dust and ash, particles of different types and sizes share a range of physical characteristics, it grows by condensation, absorbs or mixes with vapours and gases, it freezes or spreads, and it absorbs or scatters light (Gharibeh and Farhan 2000).

Also, several Jordanian cities recorded a noticeable decrease in the concentration of fine particles in the first quarter of the year (2020) compared to the same period of (2019), as the average decrease in the daily rates of fine particles (PM10) with calculating the impact of dust storms monitored by ambient air quality monitoring stations during the period from 15th March 2020 to 15th April 2020 in the city of Amman was about (38%), and in the city of Irbid about (15%), and in the city of Zarqa about (30%), while the rate of decline in monitoring stations in the three governorates was about (28%), taking into account that the average percentage decrease in the daily rates of fine particles (PM10) without calculating the impact of dust storms to demonstrate the extent of the impact of stopping most human activities from transportation, industry and services, which was monitored by ambient air quality control stations in the city of Amman about (47%), and in the city of Irbid about (32%) and in the city of Zarqa about (36%),where the rate of decline in all monitoring stations in the three governorates was about (38%) (Report of the Ministry of Environment's measures during the COVID-19 pandemic, a study of the percentages of decrease in pollutants in the surrounding air in Amman, Irbid, and Zarqa as a result of government measures taken during the period from 15th March, 2020 to 15th April, 2020 to confront the COVID-19 pandemic -The National Center for Disease Prevention and Control, The Healthy Environments and Community Affairs - 2020).

Table1. The Percentage of Decrease in the Daily Average Concentrations of Fine Particles (PM10) in the Three Main Jordanian Cities

The Fine particles inhaled in the air with a diameter of less than or equal to (10 microns)	The city	The percentage of decrease in daily rates for the period 15th March to 15th April of 2020 compared to the period 14th February to 14th March of 2020	The percentage of decrease in daily rates for the period 15th March to 15th April of 2020 compared to the same period of 2019	Average
PM10 (With Dust Storms)	Amman	43.3 %	32.7 %	38 %
	Irbid	16.2 %	13.5 %	14.8 %
	Zarqa	30.7 %	29.5 %	30.1 %
	All Monitoring Stations	30.1 %	25.2 %	27.6 %
PM10 (Without Dust Storms)	Amman	48.2 %	46.1 %	47.1 %
	Irbid	26.7 %	36.8 %	31.8 %
	Zarqa	32.8 %	39 %	35.9 %
	All Monitoring Stations	35.9 %	40.6 %	38.3 %

5.2. The Reduction of Nitrogen Dioxide

The average decrease in the daily rates of nitrogen dioxide (NO2) concentrations was due to the cessation of most human activities from transportation, industry and services, which ambient air quality monitoring stations monitored during the period from 15th March 2020 to 15th April 2020 in the city of Amman was about (50%), and in the city of Irbid about (71%), and the city of Zarqa about (56%), while the average drop in all monitoring stations in the three governorates is about (59%) (Report of the Ministry of Environment's measures during the COVID-19 pandemic, a study of the percentages of decrease in pollutants in the surrounding air in Amman, Irbid, and Zarqa as a result of

government measures taken during the period from 15th March 2020 to 15th April 2020 to confront the COVID-19 pandemic).

Table 2. The Percentage of Decrease in the Daily Average Concentrations of Nitrogen Dioxide (NO2) in the Three Main Jordanian Cities

Nitrogen Dioxide	The city	The percentage of decrease in daily rates for the period 15th March to 15th April of 2020 compared to the period 14th February to 14th March of 2020	The percentage of decrease in daily rates for the period 15th March to 15th April of 2020 compared to the same period of 2019	Average
(NO2)	Amman	51.8 %	48 %	49.9 %
	Irbid	66.7 %	75.8 %	71.2 %
	Zarqa	43.6 %	68.4 %	56 %
	All Monitoring Stations	54 %	64.1 %	59 %

5.3. The Reduction of Sulfur Dioxide

Several methods are used to monitor sulfur dioxide in the air; the most important are colourimetry, electrical conductivity, electrochemical transducer using the photochemical technique, infrared spectroscopy, or gas chromatography (Khanfar 2010).

Furthermore, the average decrease in the daily rates of sulfur dioxide gas (SO2) concentration due to the cessation of most human activities, including transportation, industry and services, which ambient air quality monitoring stations monitored during the period from 15th March 2020 to 15th April 2020 in the city of Amman, was about (18%), and in the city of Irbid about (47%), and the city of Zarqa about (44%), while the average drop in all monitoring stations in the three governorates was about (37%) (Report of the Ministry of Environment's measures during the COVID-19 pandemic, a study of the percentages of decrease in pollutants in the surrounding air in Amman, Irbid, and Zarqa as a result of government measures taken during the period from 15th March 2020 to 15th April 2020 to confront the COVID-19 pandemic).

Table 3. The Percentage of Decrease in the Daily Average Concentrations of Sulfur Dioxide (SO2) in the Three Main Jordanian Cities

Sulfur Dioxide	The city	The percentage of decrease in daily rates for the period 15th March to 15th April of 2020 compared to the period 14th February to 14th March of 2020	The percentage of decrease in daily rates for the period 15th March to 15th April of 2020 compared to the same period of 2019	Average
(SO2)	Amman	24.4 %	11.6 %	18 %
	Irbid	34.6 %	60.2 %	47.4 %
	Zarqa	28.5 %	59.5 %	44 %
	All Monitoring Stations	29.2 %	43.8 %	36.5 %

5.4. The Reduction of Carbon Monoxide

Carbon monoxide is mainly produced by burning processes in factories, inside residential buildings for heating purposes, and car and aircraft exhausts that radiate carbon monoxide (Abdel-Wahab 1997; Shehata 2002).

Therefore, the average decrease in the daily rates of Carbon Monoxide (CO) concentration due to the cessation of most human activities, including transportation, industry and services, which ambient air quality monitoring stations monitored during the period from 15th March 2020 to 15th April 2020 in the city of Amman, was about (18%), and in the city of Irbid about (32%), and the city of Zarqa about (42%), while the average drop in all monitoring stations in the three governorates was about (30%) (Report of the Ministry of Environment's measures during the COVID-19 pandemic, a study of the percentages of decrease in pollutants in the surrounding air in Amman, Irbid, and Zarqa as a result of government measures taken during the period from 15th March 2020 to 15th April 2020 to confront the COVID-19 pandemic).

Table 4. The Percentage of Decrease in the Daily Average Concentrations of Carbon Monoxide (CO) in the Three Main Jordanian Cities

Carbon Monoxide	The city	The percentage of decrease in daily rates for the period 15th March to15th April of 2020 compared to the period 14th February to 14th March of 2020	The percentage of decrease in daily rates for the period 15th March to 15th April of 2020 compared to the same period of 2019	Average
(CO)	Amman	26 %	9 %	17.5 %
	Irbid	8 %	55 %	31.5 %
	Zarqa	48 %	35 %	41.5 %
	All Monitoring Stations	27.3 %	33 %	30.2 %

5.5. The Reduction of Ozone Gas

In Fact, the average decrease in the daily rates of Ozone Gas (O3) concentration due to the cessation of most human activities, including transportation, industry and services, which were monitored by the two ambient air quality monitoring stations during the period from 15th March 2020 to 15th April 2020 in the city of Amman, was about (24 %), and in the city of Irbid about (21%), while the average drop in all monitoring stations in Amman and Irbid was about (22%) (Report of the Ministry of Environment's measures during the COVID-19 pandemic, a study of the percentages of decrease in pollutants in the surrounding air in Amman, Irbid, and Zarqa as a result of government measures taken during the period from 15th March 2020 to 15th April 2020 to confront the COVID-19 pandemic).

Table 5. The Percentage of Decrease in the Daily Average Concentrations of Ozone Gas (O3) in the Main Jordanian Cities

Ozone Gas	The city	The percentage of decrease in daily rates for the period 15th March to 15th April of 2020 compared to the period 14th February to 14th March of 2020	The percentage of decrease in daily rates for the period 15th March to 15th April of 2020 compared to the same period of 2019	Average
(O3)	Amman	41 %	6 %	23.5 %
	Irbid	17 %	25 %	21 %
	All Monitoring Stations	29 %	15.5 %	22.3 %

Conclusion

After completing the topic of the impact of the comprehensive ban due to the spread of the COVID-19 pandemic during the period from 15th March 2020 to 15th April 2020 on the quality of the surrounding air in Jordan, which this research dealt with, the following set of outcomes and recommendations were reached:

- Reduction in the emission of greenhouse gases that cause global warming, especially fine particles, nitrogen dioxide, sulfur dioxide, and carbon monoxide, in addition to ozone gas in Jordan and a significant decrease in the demand for petroleum products and other natural resources.
- While the Coronavirus has terrified the world, it has another positive side regarding one of humanity's most important issues: climate change.
- The temporary closure measures, suspension of many industrial facilities, and travel restrictions in Jordan have contributed to a significant decrease in emissions of gases and pollutants for some time.
- The Ambient air quality improved in most monitoring centres in Jordanian cities during the period 15th March 2020 to 15th April 2020 as a result of the measures taken by the Jordanian government to limit the spread of COVID-19, represented in suspending most industrial activities and preventing movement between governorates, and the commitment of millions of residents to their homes, reduced the emissions from vehicle exhaust and industrial, commercial and human activities.
- The necessity of continuing to monitor air quality in Jordanian cities, increasing the areas covered by the monitoring, and expanding the scope of monitoring in terms of the number of detected pollutants to include all regions of the Kingdom.
- Establishment of highly efficient public transport systems that contribute to alleviating traffic congestion.
- Encouraging industrial establishments and institutions to use renewable and clean energy to control emissions.

- The necessity for public and private institutions and companies to activate the flexible work system (online work style) for some activities and duties to reduce pollution caused by traffic movement to and from work and expand the scope of online education through educational platforms.

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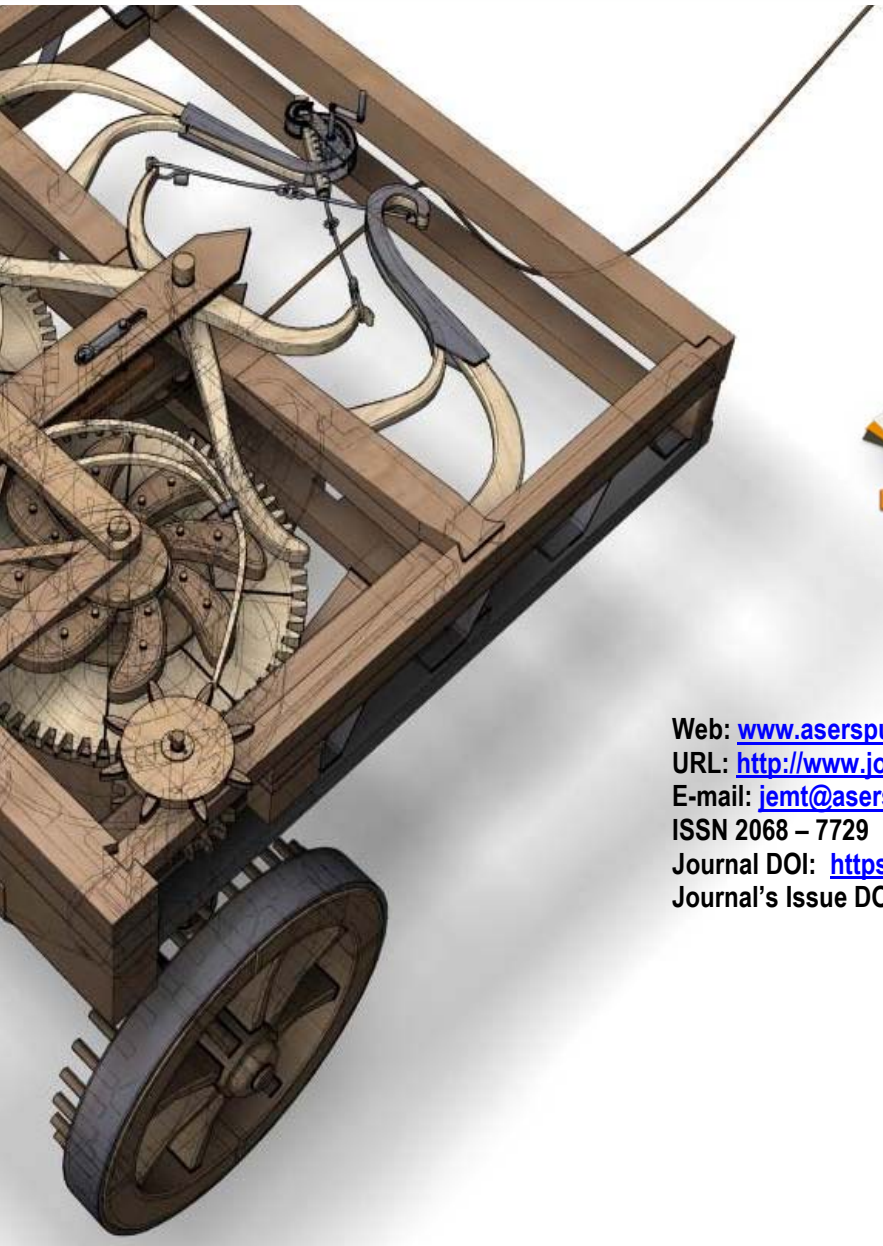

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