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Research Article

The Impact of Dust Storms on Road Accidents "Case Study - Jordanian Desert Road"

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Abstract

This study aimed to identify the effect of dust storms on road accidents. The study focused on research on the Jordanian desert road. The researchers used the descriptive survey method to reach real results to reveal the causes of dust storms on road accidents. The researchers relied, in their study, on the study sample of the years 2010-2019. The results of the study showed that the temperature between the years (2010-2019) above increased by (0.91) for each year and this is what mainly caused the occurrence of dust storms loaded with dust and impurities, which are reflected on the individual and society. The results also showed that the level of significance is equal to (0.335) and this value is less than (0.05). Accordingly, there are statistically significant differences in the number of desert road accidents due to dust storms for the years 2015-2019. The researchers also believe that the high accident rate in 2019 is because the Jordanian government worked to rehabilitate and repair the desert road, which led to the duplication of roads and the merging of some paths, which greatly contributed to causing many problems and fatal accidents for many individuals and increasing the number of Accidents. The results also showed a direct relationship between dust storms and dust storm accidents. Regarding table (4-5), the year (2019) witnessed the highest number of accidents and the highest number of deaths, as the number of accidents reached (660) accidents, and the number of deaths (218), and in (2011) the lowest number of accidents and deaths occurred compared to in other years, when the number of accidents reached (232) accidents, and the number of deaths reached (24) deaths compared to other years. The researchers issued several recommendations, the most prominent of which are: Work to rehabilitate the desert road, improve lighting and lighting, rehabilitate streets completely, and work to provide periodic maintenance for roads and provide logistical services for that.

Keywords

Dust storms, Road accidents, The Jordanian desert road

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Introduction

Storms are a general term that is commonly used to describe a large variety of disturbances in the atmosphere, ranging from regular showers and snowstorms to thunderstorms, winds, and wind-related disturbances, such as storms, tropical cyclones, and sandstorms. All these disturbances are characterized by low atmospheric pressure. Related to meteorology, the storm is limited to a hurricane with a strong low-pressure center, with strong winds ranging from 103 to 117 kilometers per hour, accompanied by heavy rain and, at times, lightning and thunder (Albaqami, 2020).

Dust phenomena are among the most important problems facing the Jordanian environment, especially in the desert road area in Jordan, as these areas witnessed many dust phenomena with increasing frequency, and the climatic changes that the region witnessed affected the emergence of this phenomenon due to the decrease in the amount of rain and the high temperature that led to The transformation of vast areas into a desert, in addition to other natural influences that have a role in exacerbating this phenomenon, and international organizations and the United Nations have taken an interest in this worsening problem internationally because of its effects and risks on the health of the individual, his life, and his various living arrangements (Albaqami, 2020).

Dust storms affect all facilities and living areas of the human being, including suspended dirt and creeping sand that leads to many problems that are reflected in the environmental effects on living organisms of all kinds in various fields, as storms occur in areas that are characterized by drought and lack of rain (Goudie, 2020).

Factors affecting the formation of sandstorms include natural and human forces, and very dry places around the world such as deserts; Airborne pathogenic microorganisms, some of which are highly pathogenic to humans and include bacteria, fungi, fungi, viruses and during sandstorms, are easily captured and carried with other components in the storm (Albaqami, 2020).

It can be said that dust storms are among the phenomena diagnosed in dry and semi-arid environments, which, in addition to other factors, cause the degradation of environmental resources and negatively affect economic activities, and the accumulation of mineral plankton in the atmosphere as a result of dust storms leads to (mineral aerosols) affecting public health And in the long run they cause respiratory diseases, in addition to this that dust storms pose a natural danger to transportation, especially on land, as a result of reduced or lack of visibility, which leads to serious and frequent traffic accidents under these weather conditions. On the global level, the presence of dust affects the radiative balance of the atmosphere and the earth's surface, because aerosols have an important role in influencing the radioactive balance (Al-Zghoul & Wa'il, 2020).

The problem of dust storms appears through the environmental problems and the damages that they cause when they are formed, as sandstorms and dense dust cause a lack of horizontal visibility due to high wind speed and dense dust that leads to blocking of vision, which leads to the occurrence of many accidents. The results of the total and partial collision this leads to heavy losses in life and property, and this was confirmed by the Jordan Meteorological Department that there are (30%) of accidents that take place on the desert road as a result of dust storms and low visibility.

Statement of the Problem

Jordan is affected every year by a real problem that contributes to many problems destruction and many losses in lives and property as a result of the occurrence of dust storms on the Jordanian desert road. The Jordanian Traffic Department and the Meteorological Department have proven that dust storms cause 70% of the accidents that occur on the roads during the year, and the percentage of these accidents due to dust storms and low visibility is (30%) of the accidents that take place on that road.

As a result of the sensitivity of the desert road and its direct link in those who move between governorates, it is necessary to pay attention to researching the causes that lead to these accidents and how to work to reduce these accidents or reduce their percentage, by working on developing alternatives and solutions that will work on that. And because these storms are a natural threat that causes great human and material losses and an important source of suspended air materials that cause bad health effects on the residents and workers in these areas and the lack of specialized field studies and methodology, this study came to fill this void. Based

on the above, the study problem was identified in researching the effect of dust storms on road accidents on the desert road.

Questions of the Study

To reach an answer to this question and the best solution, the following sub-questions were asked:

1. What caused dust storms and their impact on road accidents on the desert road in Jordan?
2. Do dust storms affect the increase in road accidents?
3. Is there a difference in the number of accidents on the desert road due to dust storms between 2010-2019?

Importance of the Study

The importance of the study is highlighted by the importance and sensitivity of the topic of the frequent road accidents resulting from dust storms between 2010-2019. Explain the frequent occurrence of dust storms on the desert road and the reasons for their occurrence. Clarify the relative importance of the issue of climate change, and how it affects the lack of vision and low vision of travelers on the desert road. Explain the different effects of dust storms on road transport.

Objectives of the Study

- To introduce the phenomenon of dust storms and their origins.
- Converting graphic information into quantitative figures about the percentage of accidents due to dust storms and coming up with real results about their impact on accidents.
- To identify the extent to which climate changes contribute to the increase in road accidents on the desert road.
- To examine the reality of the desert road due to the large number of road accidents.

Previous Studies

(Nick Middleton, 2019) showed that dust storms originate in many of the world's drylands and frequently present hazards to human society, both within the drylands themselves but also outside drylands due to the long-range transport of Aeolian sediments. Desert dust hazards can occur where dust is entrained, during the transport phase, and on deposition. This paper draws on studies in physical geography, medical geology, and geomorphology to discuss case studies of accelerated soil erosion, the health effects of air pollution caused by desert aerosols, injuries related to transport accidents caused by poor visibility during desert dust events, the spread of disease, and problems with water supplies and at solar power plants caused by dust deposition (Albaqami, 2020).
(Tahereh Sahraie, Shahmoradi, 2017) studied that one of the environmental concerns during the past decade is dust pollutant. This phenomenon is extensively known around the globe. In Iran, this destructive phenomenon has created serious problems among environmental policy-makers in general and agricultural producers in specific. Kermanshah Province is located near Iraq, a neighboring country in the west part of Iran. It is believed that Iraq is mostly blamed for developing dust into different parts of Iran. The impact of dust on agriculture is not known. Specifically, it is not known how agricultural producers in Sarpol-e-Zahab Township in Kermanshah Province are affected by the dust phenomenon. Thus, the purpose of this qualitative study was to determine the impact of dust on agricultural production. Using purposeful sampling, farmers and agricultural specialists, as well as natural resources experts, participated in this study. Deep interviews, as well as observation and audio recording, were used to collect data. A grounded theory approach was used to analyze the data. Results revealed that dust has impacted orchard farmers, bee farmers, rose and grape growers differently. Results also revealed that orchard farmers and bee farmers were affected most by dust storms in the region. Overall, dust is a phenomenon that can only be mitigated if farmers are to adopt effective strategies.
(Eman Ismail, 2016) explain that the study aims to investigate the negative effect that the dust storms leave on the human health in general and on the traffic safety as well. Five represented samples of the dust have been collected from the storms which occurred during (2009 and 2010) in Tikrit city/ north of Iraq to find it's particle size distribution, existence of heavy metals, and

radioactive minerals, in addition, a survey that consists from 70 samples has been collected to examine the driving difficulty during such condition. Grain size analysis show that the silt size forming the majority (62.6%), fine sand (23.52%) and clay (13.88%) , also CaCO 3 and organic content have been determined with average (25.9%) and (2.11%) respectively. The heavy metals including Cd, Ni, Pb, Cr, Co, and Zn showing that Zn , Ni, Co and Cr are more than the standards in the crust of the earth which considered pollutant elements while Cd and Pb are less than the standards. It was found that 92% of the drivers face difficulty during driving in dusty weather, 47% of the drivers has health problems concerns the dusty weather and 20% of them tend to change their destination or drive faster when they face dust storm while driving.

Study (Mouyid Bin Islam, 2017) the rising trend of motorization and improving socio-economic status of Thai people directly influences the aggravating road safety situation with fatalities and permanently disabled injuries of about 130,000 and 500,000 respectively over the past decades. An estimated annual cost from road crashes amounts to about US$2,500 million, 3.4 percent of Gross National Product (GNP), undoubtedly inflicts Thailand with a burning public health concern in the South East Asian region. This paper addresses an in-depth study through crash investigation and reconstruction which has not yet been practised in Thailand to identify the contributory factors in road crashes by the concerned authorities. This research attempts to establish the linkage between the causes and consequences with event classification of an investigated case by highlighting the dynamic driving situation with initial traveling speed, pre-impact and post-impact speed of the involved vehicles to describe the crash scenario. Moreover, inaccurate risk assessment and late evasive action, absence of street-light facilities, inadequate lane marking and visibility were also outlined as major risk factors increasing the severity of crash and injury in this investigated case.

(Andres, Krtička, 2012) explained that official road accident statistics are, in most countries, not sufficiently detailed to allow an in-depth analysis of accidents. In-depth studies try to provide a detailed reconstruction of events that lead to accidents and to identify the factors that caused injuries. The purpose of performing in-depth analyses of accidents is both to understand factors leading to accidents and to identify the best way to prevent accidents. In-depth studies of fatal accidents have a long history in Finland and the United Kingdom but have more recently been introduced in Sweden and Norway. In recent years, in-depth studies in Finland have focused on factors that influence injury severity. Germany and the Netherlands also perform in-depth studies of accidents, as well as Denmark.

Limitations of the Study

The limitations of the study are summarized as follows:

- The study was limited to clarifying the effect of dust storms on road accidents on desert road.
- The study was limited to identifying the percentage of accidents and their number between 2010-2019.
- The study was conducted on the desert road in Jordan.

Study Approach

The methodology included the collection of field data and the use of meteorological data as observed at the meteorological station. The field survey included a direct examination of the effects of dust storms on road accidents, which included two phases: the first was to refer to the Department of Quality Meteorology and the extraction of meteorological data, which included six-hour wind speed data and horizontal visibility data between 2010 and 2019, and the wind speeds monitored to study the possibility of dust storms in the study area (desert road). The second phase is to refer to the accident department and traffic management in the desert road area and extract the number of accidents that took place between (2010-2019), changes in accidents during the period of dust storms and work to link (the first phase with data, the second phase of data), and to identify the causes and results.

Study Tools

The study relies on obtaining analytical data from 2010 to 2019 in order to identify the impact of

dust storms on road accidents on the desert road, which requires the researcher to prepare a 20-paragraph questionnaire to measure the role of dust storms on road accidents and link them to a statistical analysis to reach real results To work to clarify the causes of this phenomenon and limit or reduce it.

Statistical Treatment

Percentage models, standard deviations, and mathematical equations were used to determine the effect of dust storms on reducing road accidents on the desert road in Jordan, and linear regression will be used to research on the impact of dust storms, after using the single-contrast analysis.

Study Area

Route 15, or the desert road, is a highway linking southern Jordan with its north, at a distance of 315 km. It starts from Aqaba in the south, crosses the Ma'an governorate, and extends into the Jordanian desert to the east from all southern cities and villages until it meets Road 35 heading towards Amman.
Despite the importance of the desert road, which is Jordan's main artery for transporting imported and exported goods through the port of Aqaba, it suffers from many problems that harm its users, such as cracks and frequent drilling in it.

Theoretical Framework

Sand and dust storms usually blow when strong winds lift large amounts of sand and dust from barren and arid lands into the atmosphere. Scientists have recognized over the past decade the effects of these storms on the climate, human health, the environment, and many social and economic sectors. WMO Members are spearheading the assessment of these impacts and the development of products to guide the development of policies to prepare for, adapt, and mitigate them (Al-Hemoud, Al-Sudairawi, Neelamanai, Naseeb, & Behbehani, 2017).
Sand storms and dust storms are common weather hazards in arid and semi-arid areas. They are usually caused by thunderstorms — or the extreme variation in pressure associated with hurricanes — that increase wind speed over a vast area. These strong winds carry large amounts of sand and dust from barren and arid lands in the atmosphere, transporting them at distances of hundreds to thousands of kilometers. About 40 percent of the aerosols in the troposphere (the lower layer of the Earth's atmosphere) are made up of earthen particles caused by wind erosion. The main sources of this mineral dust are the arid regions of North Africa, the Arabian Peninsula, Central Asia, and China. Australia, America, and South Africa are also among those sources, although slightly but still important. Global estimates of earth-based emissions, derived mainly from simulation models, range from one gigaton to three gigatons per year (Albaqami, 2020).
The dust particles, after their release from the surface, rise to the upper layers of the troposphere due to turbulent mixing and rising air currents due to convection. The winds transport these particles for periods of time depending on the size of these particles and the weather conditions, before they descend to the surface again. As large molecules fall faster than small molecules, a shift occurs during the transition towards smaller particles. There is also a process of washing dust in the atmosphere due to precipitation. The residence time of dust particles in the atmosphere ranges from several hours for particles whose diameter exceeds 10 micrometers, to more than 10 days for particles with a diameter less than that(Goudie, 2020).
Airborne dust poses a threat to human health. The size of earth particles is one of the key elements that determine a stake in human health. Molecules larger than 10 micrometers cannot be inhaled and therefore can only affect the external organs, often causing skin and eye infections, conjunctivitis, and increased exposure to eye infections. Inhalable molecules, smaller than 10 micrometers, are often held in the nose, mouth, and upper part of the trachea and can then be linked to respiratory disorders such as asthma, bronchitis, pneumonia, and allergic rhinitis. However, smaller molecules can reach the lower part of the trachea and enter the bloodstream, where they can affect all organs and cause heart vessels disorders. A 2014 global nodal assessment indicates that exposure to dirt particles causes about 400,000 premature deaths of cardiopulmonary disease in over-30 age groups (Al-Zghoul & Wa'il, 2020).
Dust storms or sandstorms generally occur in areas where the ground is covered with dust or lose

sand. Sometimes, after they have traveled great distances, they can be spotted in areas not covered by dust or sand. The front of a dust storm or sandstorm may have the appearance of a wide, raised wall, advancing very quickly. Walls of dust or sand are often accompanied by a heap of sand, which may be hidden by particles of dust or sand. These storms may also occur without any clouds along the leading edge of the advancing cold air (Al-Zghoul & Wa'il, 2020).

Dust Storms Properties

Dust storms that affect Jordan are of two types: the first: local dust storms that originate from regions inside Jordan, and the second: regional dust storms that reach Jordan through neighboring countries, such as the effects of North African storms and Middle East storms(Al-Hemoud et al., 2017).
Dust storms have a set of conditions (Goudie, 2020; Jha, Tiwari, & Chatterjee, 2020):

- The surface of the land over which the wind passes must be dry, exposed and crumbling.
- The wind speed should be sufficient to carry the dust particles.
- The availability of conditions for atmospheric instability in the air near the ground.
- The air must be turbulent.
- There must be no obstacles to obstruct the winds

When studying the factors affecting the emergence of dust storms in Jordan, a group of main weather factors emerge:

- **Temperature**: The correlation of temperature with the phenomenon of dust storms is due to the temperature caused by the instability of the air and thus the instability of other weather phenomena as the air layer in contact with the surface of the earth heats up as a result of the continuous solar radiation received by the surface of the earth, which leads to the occurrence of thermal eddies that raise the dust to a height Its amount depends on the severity of the condition(Hamoui, Mars, & Almotairi, 2020).
- **Relative Humidity**: The correlation of relative humidity with the phenomenon of dust storms comes with the existence of an inverse relationship between relative humidity and temperature, which leads to soil retaining an amount of moisture due to lower temperatures, making it more coherent and consequently lower rates of dust storms in winter(Jha et al., 2020).
- **Wind**: The wind helps in the formation of dust storms, as the speed factor plays an important role in the emergence of these storms because it is the decisive factor in moving soil particles and transporting them to other locations(Hamoui et al., 2020).
- **Rain**: Rain is one of the most influential elements of the climate in limiting and reducing the impact of dust storms. The amount of rain falling in Iraq is relatively small, as it is absent during most months. In general, the annual total of rain decreases from north to south and from east to west(Jha et al., 2020).

Some Digital Statistics on The Causes of Dust Storms on The Desert Road in Jordan

- **The amount of rain**

The first contract records 62 dust storm rose to 99 repeated storms in the last decade of the study period, and this indicates anything, for shows the strength of the relationship between the increased frequency of dust storms and the amount of rain falling as well as rising temperatures unprecedented heat for the last period .See Table (1).
Egyptian General Authority for Meteorology Air Jordan unpublished data.

- **Temperatures**

The temperature has a great effect on dust phenomena, whether in increasing their frequency or decreasing them. The big difference in the temperature range affects the increase and intensity of the repetitions of dust phenomena, as well as a difference in the pressure systems of low and heights (10). Rising temperatures also result in environmental changes, especially in vegetation cover. Rising temperatures lead to intense evaporation and thus to the emergence of a state of desertification, which helps in the easy transfer of dust particles through the wind (11). As shown

in table (3), a significant increase in the annual rate of temperature where the annual mean between 22.9 m and 24.7 m increased in the last decade (2010 - 2019) to range between 24.8 - 25.6 m. As for the annual temperature range, it varies between 8.3 m and 13.1 m, and this affects the loosening of the soil and the ease of transporting dust particles, which led to the increase in these temperatures in the recent period to an increase in the frequency of dust storms in the region.

Results

- **What caused dust storms and their impact on road accidents on the desert road in Jordan?**

These sandstorms, or also called dust storms, are caused by strong winds that blow on soft or sandy soils, as a lot of these materials move, from dust and sand, which in turn reduces the level of visibility to a large extent, and perhaps the large number of soft sands scattered in the desert makes it The most common location for sandstorms to form.
And sandstorms begin to spread and appear when there is an area suffering from drought and drought, where they can pull the smallest particles of sand from the ground by the wind, and it is believed that static electricity in the storm can cause more particles to be pulled from the ground, and this comes in addition to wind effect, as already mentioned.
Although sandstorms are a natural event, it is considered a natural phenomenon, but it is believed that poor agricultural techniques may contribute to exacerbating and increasing this problem, due to the depletion and erosion of the topsoil by raising animals and grazing, which in turn leads to the detection of sand and the main dust, which cause and stimulate these storms most.
Regarding table (2), the temperature increased dramatically in the years (2015-2019), and the percentage of rain decreased compared to the temperature in table (1), which led to an increase in the amount of fear and air loaded with dust, agglomeration, and impurities, and the appearance of the descriptor of dust in general, it can also be observed in table (3), which clearly shows that the temperature range between the above-mentioned years increased by (0.91) for each year and this is what mainly caused dust storms loaded with dust and impurities, which are reflected in the individual and society.
From the above, the problem of sandstorms greatly affects road accidents and health and social problems that affect the individual and others, and this will appear in the results of the following questions.

- **Do dust storms affect the increase in road accidents?**

To answer this question, the arithmetic averages and standard deviations of the impact of dust storms on the number of accidents on the desert road were extracted and the following table shows the results.
The table shows that the level of significance is equal to (0.120), and this value is higher than (0.10). Therefore, this indicates that there are differences in the number of accidents on the desert road due to dust storms, and this greatly indicates that dust storms affect accidents and their number.
The researcher believes that the observer of the movement of climate change and the accompanying changes in temperature and the amount of precipitation, which is greatly reflected in the increase in the occurrence of dust storms, and after confirming the data issued by the Jordanian Meteorological Department, in the period (2010-2019) by referring to the tables and their statistical links, it is believed The researcher said that the increase in accidents between the past years was due to the high temperature and the lack of rainfall compared to the years in which the temperatures and precipitation decreased. Increased.
It can be said that dust storms constitute (59%) of accidents in (2014), while dust storms accounted for (40%) of accidents on the roads on desert roads in (2015). However, it is noticeable that the resulting dust storms are Regarding climate change, it accounted for 85% of the accidents on the Jordanian desert road, where they exceeded (660) accidents during the total number of months in the year (2019), and it is noticed that these accidents reflected greatly on the deaths that exceeded the limits of (180). Death during the last months of the year (2019) and is clearly caused by dust storms, not to mention the various accidents that can happen to an individual and affect his health as a result of dust storms.

Table 1
Monthly and annual total amount of rain falling mm in the desert area for the period 2010-2019

Year	January	February	March	April	May	June	July	Father	September	October	November	December	Total
2010	13 2	1	13.3	30.6	15 6	0	0	0	0	0.6	14.3	24.3	112. 9
2011	22.9	5.2	66.5	17.8	11.3	0	0	0	0	0	9	23.4	156. 1
2012	13 7	3	0.1	5.2	0.1	0	0	0	0	0	0	46.6	68.7
2013	45.8	60.3	70.2	0	0	0	0	0	0	0	1.2	19.6	197.1
2014	52.4	52.1	0.001	47.6	7.3	0	0	0	0	0	2	16.9	178.3
2015	15. 8	14.1	21.1	9.5	10.5	0	0	0	0	2.5	0.001	48.9	122. 4
2016	13 4	28.8	11.4	1.2	3.3	0	0	0	0	17.7	11.2	27	114
2017	1.6	2.1	3	0	0.001	0	0	0	0	0	13 6	51.3	71.6
2018	34.2	2.4	15. 8	0.001	0.9	0.001	0	0	0	0.5	17.8	19.5	91.1
2019	22.3	16.3	14.3	14.3	4.1	7.5	2.5	0	0.5	3.9	14	18.6	108.6

Table 2
Wind speed for the desert m/s for the period 2019 – 2010

Year	January	February	March	April	May	June	July	Father	September	October	November	December	Total
2010	3.8	4.2	3.7	4.2	3.9	4. 4	6.5	6.8	4	3.7	3.1	3.2	4.3
2011	3.4	3.7	4.5	4.6	4.2	5	5.3	4.6	5.1	4.2	3.4	4.2	4. 4
2012	4.3	4.5	5	5.3	4.8	5.3	6.1	5.3	4.3	3.5	4.2	3.1	4.6
2013	3.8	4.2	5.1	4.6	4.6	5.8	5	4.6	4. 4	4.3	3.5	3.6	4.5
2014	3.2	4	4.1	3.7	4.5	5.6	4. 4	4.2	5	4.5	4.6	4.5	4. 4
2015	3.1	4	4.2	4	4.6	5.2	5	6.9	6. 6	3.5	3.8	2.7	4.5
2016	3.9	4.2	4.6	5.3	4.5	5.4	6.2	4.19	5.1	3.9	3.4	2.6	4.5
2017	3.8	4.3	3.9	4.1	4.3	5.1	4.7	5	3.2	2.5	3.2	2.5	3.9
2018	2.7	2.8	3.5	3.2	3.5	63	5.5	4.19	4.8	3.1	2.9	2.6	3.8
2019	3.8	4.3	3.9	4.1	3.3	5.1	4.7	5	3.5	2.7	3.2	2.5	4.3

Source: General Authority for Meteorology Air Jordan data not published

Table 3
Average annual, maximum and minimum temperatures and thermal range (m) for the desert region

Year	the average Annual m	Rate Degree the heat Great m	Rate Degree the heat Micro	Term Thermocouple M
2010	24.16	27.86	16.6	11. 26
2011	25.17	27.99	17.5	10. 49
2012	24.6	27.72	17.9	9. 82
2013	24.39	25.98	17.6	8. 38
2014	24.46	28.07	17.4	10. 67
2015	24.56	28.02	17.1	10. 92
2016	24.28	27.78	17.6	10. 18
2017	22.93	25.48	16.3	9. 18
2018	24.03	26.69	17.7	8. 99
2019	25.59	30.1	19.1	11

Source: General Authority for Meteorology Air Jordan, unpublished data

- **Number of accidents without fatalities**

The number of accidents varied in the years related to this study as shown in Table (4).

Table 4
monthly and annual total for the number of accidents in the period between2019 - 2010

Year	January	February	March	April	May	June	July	Father	September	October	November	December	Total
2010	9	15th	17	8	91	19	8	11	19	11	12	99	319
2011	8	8	33	5	11	11	2	21	41	22	10	60	232
2012	12	2	2	8	19	12	19	15th	2	189	155	44	479
2013	18	60	25	18	21	19	22	11	11	11	18	190	424
2014	22	22	36	35	22	10	19	22	19	125	166	15th	513
2015	10	10	60	51	15th	22	18	10	33	22	12	19	282
2016	10	10	22	22	4	23	3	10	326	60	22	22	534
2017	9	10	29	20	33	71	3	16	22	11	39	8	271
2018	9	18	22	11	12	19	4	3	11	16	91	70	286
2019	50	59	110	11	15th	18	9	6	22	12	189	159	660

Source: Jordanian Accident Management and Road Security, unpublished data.

- **Number of accidents with no deaths**

The number of accidents varied in the years associated with this study as shown in Table(5) .

Table 5
Monthly and annual total for the number of accidents in the period between 2010- 2019 with the presence of deaths

Year	January	February	March	April	May	June	July	Father	September	October	November	December	Total
2010	1	0	4	1	9	11	2	2	7	2	0	7	46
2011	0	0	5	0	0	0	0	0	0	10	0	9	24
2012	2	1	2	1	1	1	1	1	1	19	2	5	37
2013	2	20	0	0	0	0	0	1	1	1	1	9	35
2014	2	5	2	8	9	0	9	6	9	5	5	5	65
2015	3	2	11	2	7	1	0	0	5	5	5	2	43
2016	1	2	0	1	1	8	5	7	25	11	11	2	74
2017	9	9	7	11	12	15th	0	11	0	1	0	1	66
2018	14	11	10	13	10	10	3	2	5	8	9	4	99
2019	22	33	18	9	10	11	7	5	11	10	33	49	218

Source: Jordanian Accident Management and Road Security, unpublished data.

Table 6
Arithmetic averages, standard deviations, and percentages of the number of accidents in years

Field	Variable	Average	s-dt	percentage
Dust storms	2014-2010	4.2130	.374420	40.8
	2017-2015	3.8279	.487350	55.8
	2019-2018	3.8974	.583720	81.8

It is evident from the previous table that there is a variation in the arithmetic averages and standard deviations of the percentage of accidents on the desert road due to dust storms, most of which are in the years (2018-2019).

Table 7
The results of the analysis of unilateral variance analysis to indicate the differences between the sample averages

The number of accidents	Source	Sum of squares	Medium squares	F	SIG
	Between groups	1.204	.602	2.190	.120
	Within groups	17.040	.275		
	TOTAL	18.244			

The statistical information is by referring to the Meteorological Department and linking the results of the tables (1-2-3) with the tables numbered (4-5), which denies the presence of an accident or death on a natural day without dust storms, as the information received excludes ordinary accidents without the presence of dust storms.

- **Is there a difference in the number of accidents on the desert road due to dust storms between 2010-2019?**

To answer this question, the researcher extracted simple regression models for the variable of dust storms on the variable number of accidents, in order to reveal the effect of the independent variable on the dependent.

Table 8
Results of the impact of dust storms on the number of accidents

Variable	Coefficient	Std. Error	t-statistic	Prob
C	1.980894	0.302886	6.540069	0.0000
X2	0.002573	0.010029	0.256599	0.7994
R-square	0.002346	Mean dependent		2.029000
Adjusted R-square	-0.033284	S.D. dependent		1.281835
S.E of regression	1.302993	Akaike info criterion		3.431545
Sum squared reside	47.53813	Schwarz criterion		3.524958
Log likelihood	-49.47318	Hannan-Quinn criter		3.461429
F-statistic	0.065843	Durbin-Watson Stat		1.743808
Prob (F-statistic)	0.00065			

***Source:** Prepared by the researcher based on the statistical program (Eviews, 7.0).

It is evident from the previous table that there is a positive relationship between dust storms and the number of accidents on the desert road, and this positive relationship is high, and it is in increments of (0.00065) with the variation of the years from 2010-2019.
In order to show the interactions between the number of accidents and years, the researcher extracted the arithmetic mean, the standard deviation and the probability value on the number of accidents and years, and table (9) illustrates that.
The signal test was applied to analyze the number of accidents for the years (2010-2019), and the results in the table show that the probability value of the general average of the number of accidents on the desert road is equal to (0.00), which is less than (0.05), and therefore it is generally statistically significant. And since the general average number of accidents on the desert road is equal to (65.485), this means that the level of the number of accidents on the desert road is high.

To demonstrate the significance of the differences between the sample averages according to the number of accidents on the desert road, the researcher used the One Way ANOVA as shown in table (10).

Table 9
Results of analyzing the coefficients of the number of accidents with years

No	Variable	Average	s-dt	probability
1	2015-2010	40.22	7.72	0.00
2	2019-2015	90.57	7.56	0.00
Average		65.485	7.64	0.00

Table 10
The results of the analysis of unilateral variance analysis to indicate the differences between the sample averages

The number of accidents	Source	Sum of squares	Medium squares	F	SIG
	Between groups	.636	.318	1.115	.335
	Within groups	17.697	.285		
	TOTAL	18.333			

The table shows that the level of significance is equal to (0.335), and this value is less than (0.05). Therefore, there is a statistically significant difference in the number of accidents on the desert road attributable to the dust storms for the years 2015-2019.
The researcher also believes that the increase in the rate of accidents in 2019 is because the Jordanian government worked to rehabilitate and repair the desert road, which led to duplication of roads, merging some paths, which contributed greatly to causing many problems and fatal accidents for many individuals and increasing the number of accidents.
According to the table (4), which is linked to dust storms, their number, quantity, and time of their occurrence, the observer of accidents notice that the number of accidents differed clearly and with a direct relationship between dust storms and accidents? And by referring to Table (4-5), the year (2019) had the highest number of accidents and the highest number of deaths, as the number of accidents reached (660) accidents, and the number of deaths (218) deaths, and in (2011) it happened The lowest number of accidents and deaths compared to other years, as the number of accidents reached (232) accidents, and the number of deaths reached (24) deaths compared to other years.

Recommendations

After issuing the results and comparing them between the years (2010-2019), the researcher recommends the following:

- Work on rehabilitating the desert road, improving lighting and lighting, and completely rehabilitating the streets.
- Work to provide periodic maintenance of roads and provide logistical services for that.
- Work to conduct more studies about dust storms and their impact on the health of the individual.
- Increase the volume of vegetation and agriculture in the desert area.

References

Al-Hemoud, A., Al-Sudairawi, M., Neelamanai, S., Naseeb, A., & Behbehani, W. (2017). Socioeconomic effect of dust storms in Kuwait. Arabian Journal of Geosciences, 10(1), 18 .

Al-Zghoul, B. M., & Wa'il, Y. (2020). New Gaussian Plume Equation for the Impacts of Dust Storms on Radionuclide Transport. Aerosol and Air Quality Research, 20(1), 119-127 .

Albaqami, S. (2020). Spatial and temporal analysis of dust storms in Saudi Arabia and associated impacts, using Geographic Information Systems and remote sensing .

Bhattachan, A., Okin, G., Zhang, J., Vimal, S., & Lettenmaier, D. (2019). Characterizing the Role of Wind and Dust in Traffic Accidents in California. GeoHealth, 3, 328-336.

Goudie, A. S. (2020). Dust storms and human health. In Extreme Weather Events and Human Health (pp. 13-24): Springer.

Hammad, M., Khalaf, A. (2021).An Assessment of the Climatic Characteristics and Their Impact on the Traffic Accidents in the City of Ramadi. PSYCHOLOGY AND EDUCATION, 58(1), 5088-5095.

Hamoui, B., Mars, M., & Almotairi, K. (2020). FloDusTA: Saudi Tweets Dataset for Flood, Dust Storm, and Traffic Accident Events. Paper presented at the Proceedings of The 12th Language Resources and Evaluation Conference.

Hussein, N., (2013). The impact of Dust and Sand Storms on Traffic Safety of Tikrit City in Particular and Iraq in General. 1st International Conference for Geotechnical Engineering and Transportation ICGTE in 24-15/4/2013.

Islam, M., Alharthi, M., Alam, M. (2019).The Impacts of Climate Change on Road Traffic Accidents in Saudi Arabi .

Jha, A. N., Tiwari, G., & Chatterjee, N. (2020). Road Accidents in EU, USA and India: A critical analysis of Data Collection Framework. Strategic System Assuranceand Business Analytics. 419-443, DOI: 10.1007 / 978-981-15-3647-2_31.

Tezangi, M. (2016). Studying the role of climatic phenomena in road accidents in yazd province. 7(2), 459-465.