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The Impact of Dust Storms on Urban Environmental Quality in Susangerd

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Original Article

Abstract

INTRODUCTION: Dust storms are among the most significant natural hazards that in recent years have led to a decline in the environmental quality of many urban and rural settlements in Iran. Therefore, the present study aims to examine the impact of dust storms on the urban environmental quality of Susangerd.

METHODS: In this descriptive and analytical research, the statistical population consists of 377 citizens of Susangerd aged over 15. The designed questionnaire includes four main components. Data analysis was conducted using statistical methods, including the one-sample T-test and stepwise regression analysis, within the SPSS software environment.

FINDINGS: The findings indicate that, based on the one-sample T-test, the environmental component had a mean score of 4.27, the economic component 4.16, the social component 4.00, and the physical component 3.71, all of which exceed the baseline value of 3. This suggests that dust storms have had an adverse impact on urban environmental quality in Susangerd across all studied components.

CONCLUSION: According to the results, among the examined components, the environmental component had the most significant impact on urban environmental quality, with a beta coefficient of 0.314. Then, the economic component (0.300), the physical component (0.276), and finally the social component with a beta coefficient of 0.274 had the greatest contribution to urban environmental quality. In summary, the environmental effects of dust storms on Susangerd urban environment were more pronounced than those of the other three components.

Keywords: Assessment; Environmental hazards; Dust storms; Urban environmental quality; Susangerd.

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Introduction

These days, environmental hazards, including dust storms, are no longer merely natural crises; rather, they can trigger a range of security-related consequences and crises. Major challenges such as environmental degradation and desert expansion could become the root causes of future political and social issues. Environmental concerns, particularly dust storms, have now become integral to social and political developments, with the potential to escalate into security and societal challenges. (1)

The phenomenon of dust storms or sandstorms occurs when strong winds lift large volumes of dust and sand into the atmosphere, significantly reducing horizontal visibility. Several factors contribute to this phenomenon, including the excessive drilling of deep and unauthorized wells, dam construction, soil degradation due to agricultural activities, atmospheric instability in the deserts of Saudi Arabia, Iraq, Kuwait, and Syria, prolonged droughts, insufficient vegetation cover, decreased rainfall and humidity levels, deforestation, and the destruction of rangelands in Iraq. Additionally, fluctuations in atmospheric pressure and strong winds originating from the deserts of Iraq and Saudi Arabia further exacerbate the problem. However, for a comprehensive study on this, a wide range of natural phenomena and human interventions must be considered. (2)

On the other hand, today, the phenomenon of dust storms has become a widespread challenge in

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some regions of countries around the world, including Iran, and due to its persistence, the number of people migrating to other parts of the country is increasing day by day. As of now, 23 proveniences of the country are involved with this phenomenon in some way. (3) The neighboring county near Iraq is more affected compared to other cities and provinces of the country. In the early stages of this phenomenon’s expansion, many local residents were forced to abandon their agricultural lands and migrate to cities due to consecutive droughts (which are one of the main sources of dust storms). This led to a disruption in population balance and emergence of various national problems.(4)

Despite the significant economic, environmental, and social consequences of dust storms on affected urban areas, no official entity has provided precise statistics on the human casualties or environmental damages caused by these storms. It is important to note that Iran is not the only country suffering from this crisis; other nations in the region, particularly Syria and Iraq, face even harsher conditions. Preliminary studies indicate that the primary sources of these dust storms are located in Iraq, Syria, and Saudi Arabia. The key causes include climate change, reduced rainfall and humidity, deforestation in Iraq, prolonged droughts, land-use changes, atmospheric instability in the deserts of Kuwait, Saudi Arabia, Iraq, and Syria, significant vegetation loss, and fluctuations in air pressure and strong winds originating from the deserts of Iraq and Saudi Arabia. (5)

Dust storms, as a climate-related phenomenon, have deviated from their natural cycle in recent years, leading to an increasing number of occurrences worldwide. This phenomenon has created numerous problems and deficiencies, some of which include environmental and ecosystem degradation, the onset of various disease, social and citizen dissatisfaction, decreased production and productivity, forced migration, and ultimately, the development of a negative perception towards official institutions due to their inability to resolve this issue. (6)

Dust storms frequently result in the temporary closure of schools, government and private offices, and factories for specific periods. They also lead to flight cancellations, disruptions in power plant operations, reduction of water resources (depletion of water resources), interference with television signals, an increase in visits to clinics due to respiratory issues, and other related problems. The high concentration of dust particles in sandstorms contributes to sinusitis, bronchitis, asthma, and impairment of macrophage defensive functions, leading to an increase in hospital-acquired infections. Moreover, inhaling high concentrations of calcite found in dust particles can trigger sneezing and coughing. Another major component of dust particles is quartz silica dioxide, and breathing these compounds for a long period can lead to silicosis. It also causes damage to the kidney and liver. In a broader perspective, addressing the dust storm crisis can be categorized into two main approaches: crisis management and preventive management. Currently, priority is given to crisis management strategies, which focus on mitigation measures such as mulching, afforestation, and windbreak construction. Given the regional origins of dust storms, these measures inevitably require cross-border cooperation, political will, and technical collaboration among relevant institutions in affected countries. (7)

In recent governmental efforts, the Iranian government has allocated a budget to combat this phenomenon; however, this decision has been criticized by some politicians. Some political figures argue that the Iraqi government should provide the necessary budget, not the Iranian government. Others believe that the allocated budget is insufficient, leading to skepticism about the effectiveness of government measures. Notably, dust storms have already destroyed 15% of the Zagros forests in Lorestan province, severely impacting beekeepers who are now at risk of losing their livelihoods. (8)

According to research conducted by the U.S. National Oceanic and Atmospheric Administration (NOAA) in Iraq, the intensification of dust storms in Iran is primarily attributed to desertification in eastern Iraq, particularly in the Al-Jazeera region. This area, located near Baghdad between the Tigris and Euphrates rivers, was historically home to numerous wetlands and lakes. However, persistent droughts since 1990, coupled with declining rainfall and humidity levels, have led to the complete desiccation of these water bodies. Environmental factors such as upstream water management, including dam construction on the Euphrates River by Syria, multiple dam projects on the Tigris River by Turkey, and excessive water consumption in Iraq for agricultural purposes, have exacerbated the situation, transforming these once fertile lands into arid deserts.

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Susangerd is a city located in the northwestern part of Khuzestan Province, Iran. It is a strategically significant city with a hot and arid climate. The majority of the city's population is engaged in agriculture, and more than 90% of its residents speak Arabic. Throughout the year, Susangerd experiences persistent dust storms, making them a major challenge for provincial authorities and local urban management. These storms have had severe negative consequences in various sectors, disrupting daily life and causing crises for residents of Khuzestan Province, especially in Susangerd. Given the significant impact of dust storms, this study aims to analyze their effects on the urban environmental quality of Susangerd from multiple perspectives.

Ghorbani and Babaei (2018), in their study concluded that dust storms have long-term adverse effects on economic activities, the environment, natural resources, agriculture, and, overall, on the quality of life of people on the long term and indicated that the southwestern regions of Iran experience the greatest impact of dust storms, which have introduced a new environmental threat to urban areas. (9)

Mohammadhoseini Hagivar et al. (2021) in their study emphasized that public health is the result of God’s grace and a blessing for humanity. They argued that governments, based on their supervisory responsibilities, are obliged to take necessary precautions and implement sound policies to ensure public health. The study highlighted that while humanity is entrusted with preserving nature, some actions contribute to environmental degradation, leading to significant health risks. Although dust storms have historically posed health threats, their increasing prevalence in recent decades is attributed to both natural factors and human activities. The study further pointed out that Iran’s legal framework lacks comprehensive policies for addressing health damages caused by environmental pollution. The authors stressed the need for legislative reforms to protect public health and mitigate the effects of dust storms, ensuring that future generations do not inherit an increasingly polluted environment. (10)

Behvandi et al. (2022) in their research, revealed that dust storms had an impact on the economy of Ahvaz city with a coefficient of 0.30 and a significance level of 0.002. Additionally, dust storms had a significant effect on finance with a coefficient of 0.73 and a significance level of 0.000, on facilities with a coefficient of 0.45 and a significance level of 0.000, on housing with a coefficient of 0.55 and a significance level of 0.000, and on transportation with a coefficient of 0.17 and a significance level of 0.008. Therefore, dust storms had the greatest impact on finance (coefficient = 0.73) and the least impact on transportation (coefficient = 0.17). (11)

Parvanak and Khamisabadi (2021) in their study considered five environmental criteria such as aquatic ecosystems, soil, air, plant ecosystems, and animal ecosystems and indicated that among the five examined criteria, dust storms had the most severe negative impact on the air quality of Kerman city, followed by water and soil in the region. Thus, with the established priorities and integrated planning, urban crisis management in Kerman can make significant progress in mitigating and addressing the dust storm issue. (12)

Nicol and Wang (2022) showed in their research that the most common health problems reported included shortness of breath, headache, vomiting, heart problems, and fatigue, of which shortness of breath was the most frequent with 71 cases. (13)

Zhao (2022) analyzed the intensity and duration of dust storms using field methods. The results of the temporal and spatial distribution of dust storms indicate an increasing trend during the study period, with storm durations sometimes lasting up to a month. In addition, visibility decreased to below 188 m, especially in the later years. (14)

Study Area

The city of Susangerd is located in the west of the Khuzestan plain, in Khuzestan province, 55 kilometers west of Ahvaz, and next to the Karkheh River. This city is the political center of Dasht-e-Azadegan County, and has an elevation of 130 meters above sea level. Susangerd is situated in the alluvial plain of the central part of Dasht-e-Azadegan County. The region spans an area of 1,350 square kilometers with a gentle slope (about 1%) extending from north to south. The city of Susangerd is bordered to the north by the Allah O Akbar Mountains and sand dunes, where the highest points of these landforms include the Allah O Akbar heights, Abu Ghraib, and the Meshdagh Mountain, which rise to approximately 250 meters above sea level. To the east, it is bordered by the Allah Akbar mountain range and the alluvial plain of Ahvaz; to the south, it borders the barren plain area and the city of Khorramshahr; and to the west,

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it borders Hoveyzeh. A significant natural feature of this city is the Karkheh River, which divides into two branches in the northern part of the city (Boulash neighborhood). One branch, called Nisan, flows through the city, splitting it into eastern and western parts, and exits the southern part of the city, flowing westward. This branch of the Karkheh River ultimately drains into the Houralazim Wetland. According to the 2016 census, the population of this city is approximately 51,431 people.

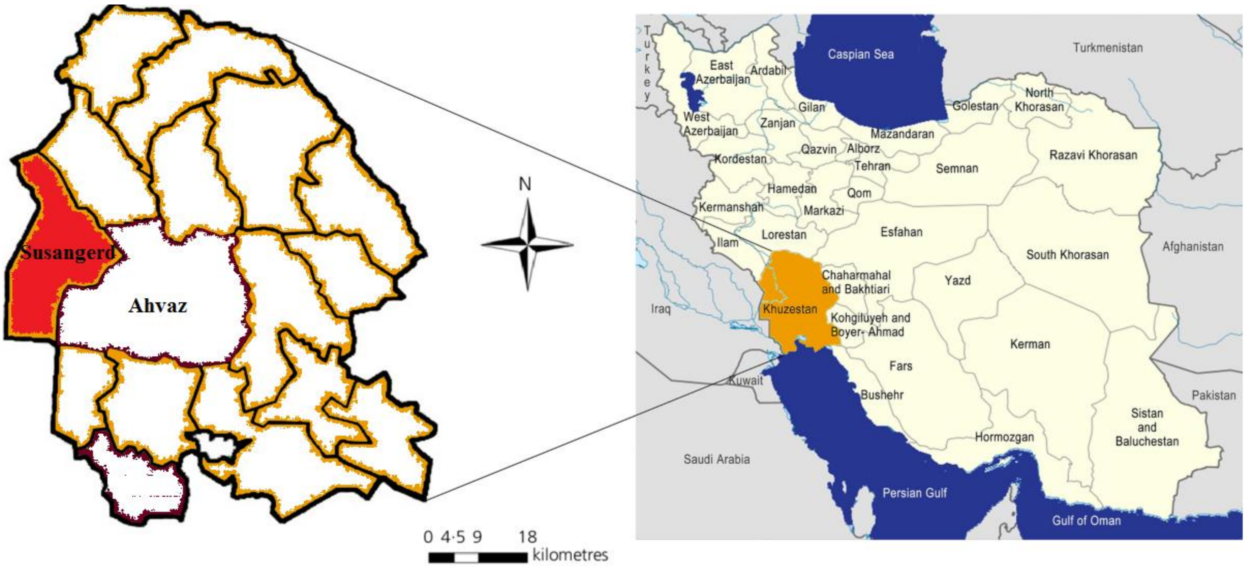

Figure 1. The map of study area

Table 1. Research components and indicators (source: authors)

Component	Indicators
Environmental	Quality of green spaces and parks, air pollution, surface water pollution, various types of pollution, quality of sanitation in road networks, quality of pedestrian pathways, soil quality in the region and city, quality of natural landscapes, desertification and increasing movement of sand dunes, degradation of waste disposal sites.
Social	Sense of security and health, increase in mobility and migration of individuals and households, dissatisfaction with living conditions, reduced academic performance and educational quality, increase in respiratory diseases, rise in allergic and sensitivity-related illnesses, increase in stress and lack of motivation, decrease in vitality and urban participation, reduction in happiness, increase in pessimism regarding future living conditions.
Economic	Decline in citizens' income, reduced diversity in economic activities, decrease in agricultural production, rise in living costs, destruction of agricultural land and gardens, job dissatisfaction in certain sectors, housing and land prices, increase in urban unemployment, higher transportation costs, damage to urban infrastructure and facilities.
Physical	Quality of urban visual aesthetics, quality of urban furniture and elements, legibility of urban spaces, deterioration of building structures, quality of urban lighting at night, degradation of residential construction materials, quality of urban roads for drivers and pedestrians, overall desirability of urban spaces.

Table 2. Cronbach’s Alpha coefficients for each component (source: authors' calculations)

Components	Cronbach's alpha coefficient	Number of items
Environmental component	0.87	10
Social component	0.77	10
Economic component	0.84	10
Physical component	0.81	8
All components	0.82	43

Methods

The research is applied in nature, and its methodology is descriptive-analytical. Data collection was conducted through library research, document analysis, and field studies. To assess expert opinions, a five-point Likert scale was used (where 1 means very low, 2 low, 3 moderate, 4 high, and 5 very high). A total of 377 questionnaires were randomly completed by citizens over the age of 15.

Additionally, Cronbach’s alpha test was used to ensure the reliability of the questionnaire. Data analysis was performed using a one-sample t-test and stepwise regression. Cronbach’s alpha coefficient is closely related to the internal consistency of the questionnaire, with a theoretical range between 0 and 1. Generally, a Cronbach’s

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alpha between 0.6 and 0.7 is considered acceptable, while a value above 0.7 indicates high reliability and strong internal consistency. Therefore, in the present study, Cronbach's alpha for all components was found to be above 0.77, demonstrating that the data collection instrument has high reliability and is well-suited for the research.

Findings

Descriptive statistics

In terms of gender distribution, 58.1% of respondents (219 individuals) are male, while 41.9% (158 individuals) are female. Regarding age, 35% (132 individuals) belong to the 15–30 age group, 18.6% (70 individuals) are in the 31–45 age range, 39.8% (150 individuals) fall within the 46–60 age bracket, and 6.6% (25 individuals) are over 60 years old. According to the research findings, the majority of the participants belongs to the 15–30 age group. Regarding educational background, 14.6% (55 individuals) have less than a high school education, 13.2% (50 individuals) hold a high school diploma, 41.6% (157 individuals) have a bachelor's degree, 26.3% (99 individuals) hold a master's degree, and 4.3% (6 individuals) have a doctoral degree.

Assessing Data Normality

Before conducting any statistical analysis, it is crucial to determine whether the dataset follows a normal or non-normal distribution. If the data is normally distributed, parametric tests will be applied; otherwise, non-parametric tests will be used. To evaluate normality, this study employed the Kolmogorov-Smirnov test to examine the distribution of variable scores. The results of this test are presented in Table 3.

The findings in the table above indicate the results of the Kolmogorov-Smirnov test, which was used to assess whether the research variables follow a normal distribution. According to the results, the distribution of scores for environmental, social, economic, and physical components was statistically significant at the 95% confidence level (α=0.05). Since a significant result in the Kolmogorov-Smirnov test confirms the null hypothesis of normality, it can be concluded with 95% confidence that the data follows a normal distribution.

Evaluating the Impact of Dust Storms on the Urban Environment of Susangerd

The impact of dust storms on various environmental, social, economic, and physical factors was analyzed using a one-sample Student's t-test, with a test value of 3. The mean score for each component was compared against the expected test mean (3) (sig<0.05).

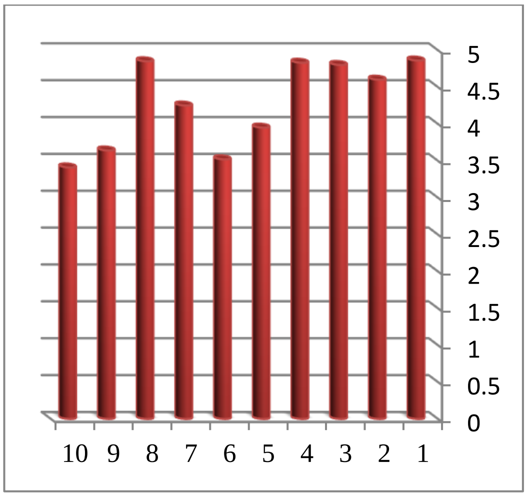

Figure 2. Diagram of the effects of fine dust on environmental items in Susangerd city

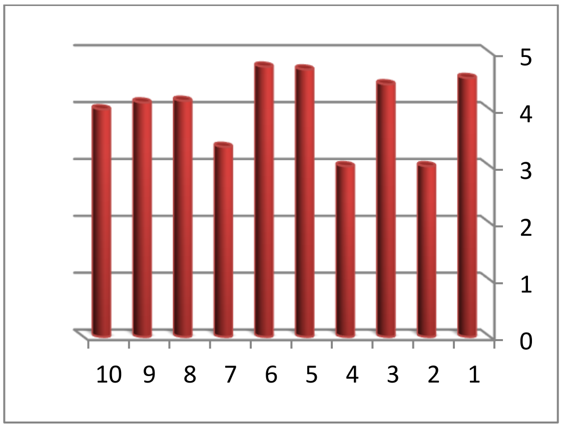

Figure 3. Diagram of the effects of dust storms on environmental items in Susangerd city

Table 3. Kolmogorov-Smirnov statistical test (authors' calculations)

Research components	Sig	Kolmogorov-Smirnov
Environmental component	0.001	0.153
Social component	0.003	0.160
Economic component	0.020	0.100
Physical component	0.001	0.076

Table 4. The effect of dust storms on environment component items using one-sample t-test

Environmental component items	Difference at 95% confidence level Upper limit	Lower limit	Deviation from the mean	Sig	T-statistic value	Mean
Quality of green spaces and parks	0	-0.28	-0.138	0.000	-1.95	4.86
Air pollution	-0.15	-0.47	-0.310	0.000	-3.74	4.60
Surface water pollution	-0.19	-0.51	-0.350	0.000	-4.30	4.80
Various types of pollution	-0.20	-0.52	-0.361	0.000	-4.53	4.83
Quality of sanitation in road networks	-0.05	-0.37	-0.212	0.000	-2.57	3.95
Quality of pedestrian pathways	-0.07	-0.24	-0.088	0.000	-1.10	3.52
Soil quality in the region and city	-0.07	-0.39	-0.225	0.000	-2.77	4.25
Quality of natural landscapes	0.01	-0.30	-0.138	0.000	-1.68	4.85
Desertification and increasing movement of sand dunes	-0.01	-0.32	-0.164	0.000	-2.04	3.64
Degradation of waste disposal sites	-0.07	-0.38	-0.223	0.000	-2.77	3.41
Environmental indicators	-0.099	-0.34	0.220	0.000	-3.58	4.27

Table 5. The effect of dust storms on social component items using one-sample t-test

Social component items	Difference at 95% confidence level Upper limit	Lower limit	Deviation from the mean	Sig	T-statistic value	Mean
Sense of security and health	0.000	-0.31	-0.15	0.000	-1.95	4.55
Increase in mobility and migration of individuals and households	-0.03	-0.35	-0.19	0.000	-2.31	3.04
Dissatisfaction with living conditions	0.12	-0.21	-0.04	0.000	1.99	4.44
Reduced academic performance and educational quality	-0.08	-0.39	-0.23	0.000	-2.98	3
Increase in respiratory diseases	-0.05	-0.37	-0.20	0.000	-2.51	4.70
Rise in allergic and sensitivity-related illnesses	-0.09	-0.41	-0.24	0.000	-3.06	4.75
Increase in stress and lack of motivation	-0.15	-0.47	-0.31	0.000	-3.77	3.34
Decrease in vitality and urban participation	-0.07	-0.39	-0.23	0.000	-2.85	4.15
Reduction in happiness	-0.03	-0.34	-0.18	0.000	-2.31	4.12
Increase in pessimism regarding future living conditions	-0.20	-0.52	-0.36	0.000	-4.49	4
Social indicators	-0.11	-0.32	-0.21	0.000	-4.02	4

Table 6. The effect of dust storms on economic component items using one-sample t-test

Economic component items	Difference at 95% confidence level Upper limit	Lower limit	Deviation from the mean	Sig	T-statistic value	Mean
Decline in citizens' income	0.05	-0.27	-0.10	0.000	-1.32	4.12
Reduced diversity in economic activities	0.20	-0.13	-0.03	0.000	0.405	3.03
Decrease in agricultural production	-0.11	-0.43	-0.26	0.000	-3.34	3.94
Rise in living costs	-0.01	-0.33	-0.16	0.000	-2.06	4.03
Destruction of agricultural land and gardens	0.01	-0.31	0.14	0.000	-1.81	3.84
Job dissatisfaction in certain sectors	-0.22	-0.53	-0.37	0.000	-4.72	4.24
Housing and land prices	-0.35	-0.66	-0.50	0.000	-6.33	4.33
Increase in urban unemployment	-0.09	-0.39	-0.23	0.000	-3.08	4.52
Higher transportation costs	-0.10	-0.41	-0.25	0.000	-3.23	4.75
Damage to urban infrastructure and facilities	-0.05	-0.38	-0.21	0.000	-2.59	4.87
Economic indicators	-0.11	-0.33	-0.22	0.000	-4.15	4.16

Evaluation of the impact of dust storms on the items of the environmental components

According to Table 4, the greatest impact of dust storms on the environmental component is, in order, on the items of reduced quality of green spaces and parks with an average of 4.86, reduced quality of natural landscapes with an average of 4.85, and increased air pollution with an average of 4.60. The least impact was observed on the items of reduced quality of pedestrian pathways with an average of 3.52 and the destruction of waste disposal sites with an average of 3.41. Ultimately, dust storms have a significant impact on the quality of the urban environment in Susangerd. As shown in figure 2, the average of all items is higher than the baseline value. (3)

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Assessing the Impact of Dust Storms on Social Component Indicators

Among the components examined in Table 4, all the items with a significance level of less than 0.05 have been accepted, indicating that dust storms have an impact on the quality of the urban environment. Based on the average value of each component and comparing it with the theoretical median (3), their performance was assessed. The higher this value is from the baseline, the greater its influence on the quality of the urban environment of Susangerd. As the results in the table below show, the impact of dust storms on the social component has adverse effects on the quality of the urban environment in Susangerd.

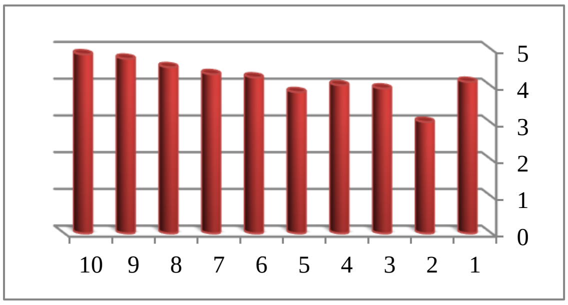

Figure 4. Diagram of the effects of dust storms on environmental items in Susangerd city

According to Table 5, we conclude that the greatest impact of dust storms on social items is, in order of magnitude, the increase in allergic and sensitive diseases with an average of 4.75, the increase in pulmonary and respiratory diseases with 4.70, and the decrease in the sense of security and health in the city with 4.55. The least impact, in order, is on the items of reduced academic performance and quality with an average of 3.00, increased displacement and migration with 3.04, and increased stress and boredom with an average of 3.34. Overall, we conclude that dust storms have an impact on all social items, with all being above the baseline and average, as indicated by Figure 3.

Assessing the Impact of Dust Storms on Economic Component Indicators

Among the components examined in Table 6, 8 items with a significance level of less than 0.05 were accepted, indicating that dust storms have an impact on the quality of the urban environment. Based on the average value of each component and comparing them with the theoretical median (3), their performance was assessed. The higher this value is above the baseline, the greater its influence on the quality of the urban environment in Susangerd. As the results in the table below show, the impact of dust storms on the economic component has adverse effects on the quality of the urban environment in Susangerd.

Based on the data in Table 6, we conclude that the greatest impacts of dust storms on economic factors are, in order of magnitude, damage to urban infrastructure and equipment with an average of 4.87, increased transportation costs with 4.75, and rising unemployment in the city with 4.52. The least impact, in order, was observed on factors such as reduced diversity in economic activities (average of 3.03), damage to agricultural lands (3.84), and decreased agricultural production (3.94). Overall, we conclude that dust storms have an impact on all economic factors, with all values being above the baseline and average, as illustrated in Figure 4.

Assessing the Impact of Dust Storms on Physical Component Indicators

Among the components examined in Table 4, all items with a significance level of less than 0.05 have been accepted, indicating that dust storms have an impact on the quality of the urban environment. Based on the average value of each component and comparing them with the theoretical median (3), their performance was assessed. The higher this value is above the baseline, the greater its influence on the quality of the urban environment in Susangerd. As the results in the table below show, the impact of dust storms on the physical component has adverse effects on the quality of the urban environment in Susangerd.

Based on the data in Table 7, we conclude that the greatest impact of dust storms on the physical structure of the city is related to the reduction in the quality of the urban landscape and appearance, with an average of 4.72, followed by the decrease in the quality of urban elements (4.51), and the reduction in the quality of streets for drivers (average of 4.00). The least impact, in order, is observed on factors such as the deterioration of building structures (average of 3.01), damage to construction materials (3.03), and the legibility of urban spaces (3.06). Overall, it can be concluded that dust storms affect all physical factors of Susangerd urban environment.

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Table 7. The effect of dust storms on physical component items using one-sample t-test

Physical component items	Difference at 95% confidence level		Deviation from the mean	Sig	T-statistic value	Mean
	Upper limit	Lower limit				
Quality of urban visual aesthetics	-0.04	-0.36	-0.19	0.000	-2.41	4.72
Quality of urban furniture and elements	-0.33	-0.64	-0.48	0.000	-6.21	4.51
Legibility of urban spaces	-0.18	-0.49	-0.33	0.000	4.23	3.06
Deterioration of building structures	0.17	-0.15	-0.01	0.000	0.13	3.01
Quality of urban lighting at night	0.09	-0.23	-0.07	0.000	-0.88	3.26
Degradation of residential construction materials	-0.26	-0.57	-0.41	0.000	-5.23	3.03
Quality of urban roads for drivers and pedestrians	-0.13	-0.44	-0.28	0.000	-3.70	4
Overall desirability of urban spaces	0.09	-0.23	-0.07	0.000	-0.88	4.12
Physical indicators	-0.11	-0.43	-0.23	0.000	-3.92	3.71
Quality of urban visual aesthetics	-0.04	-0.36	-0.19	0.000	-2.41	4.72
Quality of urban furniture and elements	-0.33	-0.64	-0.48	0.000	-6.21	4.51

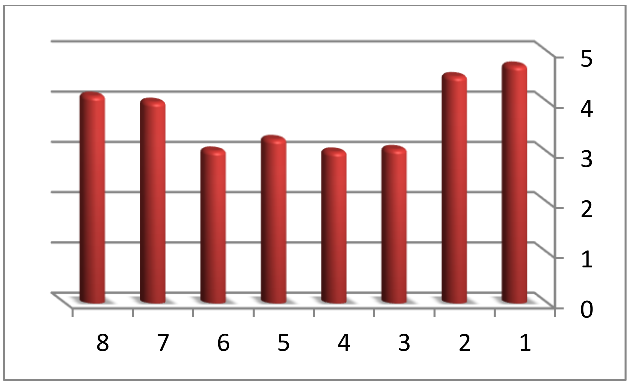

Figure 5. Diagram of the effects of dust storms on physical items in the city of Susangerd

Table 8. Input variables and the contribution of each variable to the quality of the urban environment in the stepwise regression model

Stage	Standard error	Adjusted coefficient of determination	Coefficient of determination	Multiple correlation coefficient	Variable entered into the model at each stage
First step	0.402	0.822	0.822	0.907	Social
Second step	0.217	0.948	0.948	0.974	Physical
Third step	0.119	0.984	0.984	0.992	Environmental
Fourth step	0	1	1	1	Economic

Table 9. Stepwise regression coefficients for measuring the effect of independent variables on the quality of the urban environment of Susangerd

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Dependent	0.474	0.059		8.027	0.000
	Social	0.827	0.020	0.907	41.64	0.000
2	Dependent	0.109	0.034		3.19	0.000
	Social	0.598	0.013	0.655	45.53	0.000
	Physical	0.363	0.012	0.435	30.25	0.000
3	Dependent	0.305	0.019		1.83	0.000
	Social	0.437	0.009	0.479	48.38	0.000
	Economic	0.329	0.007	0.395	49.29	0.000
	Environmental	0.221	0.007	0.277	29.44	0.000
4	Dependent	-4.44	0.000		0.000	0.000
	Social	0.250	0.000	0.274	492.18	0.000
	Economic	0.250	0.000	0.300	832.21	0.000
	Environmental	0.250	0.000	0.314	85.82	0.000
	Physical	0.250	0.000	0.276	503.55	0.000

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Analysis and Identification of the Impact of Dust Storms on the Environmental, Social, Economic, and Physical Components Using Stepwise Regression

To identify the most influential component on the quality of the urban environment in Susangerd, the stepwise regression method was applied. In this regard, all components were computed, and then, to examine the relationship and impact of these variables, a multivariate stepwise regression was used. In the multivariate stepwise regression method, four research variables were entered as influencing factors in the equation. As the effects of dust storms (overall) in a linear combination with the entered variables equal 1, this indicates a strong relationship between the independent and dependent variables.

The first independent variable entered into the model was the social index, with a correlation coefficient of 0.907. In the second step, the physical index was entered into the model, which increased the R value to 0.974, and the R^2 value, when combined with the previous variable, increased to 0.948 or 94.8%. In the third step, when the environmental variable was introduced into the equation, the R value increased to 0.992 and the R^2 value rose to 0.984. Finally, with the inclusion of the economic variable, the R value reached 1, and the R^2 value also reached 1. This means that these four variables explain 100% of the variance in the dependent variable.

As shown in Table 9, Beta represents the standardized coefficients. The larger the Beta and T values, and the smaller the significance level (Sig), the greater the impact the independent variable (predictor) has on the dependent variable. As shown in the table below, among the indicators studied, the environmental index, with a Beta coefficient of 0.314, had the most significant impact on the quality of the urban environment. This was followed by the economic index (0.300), the physical index (0.276), and lastly, the social index (0.274), which had the least impact on the urban environment quality. In general, the impact of dust storms on the environmental component of the urban environment in Susangerd was greater than the other three components, highlighting the need for strategic planning and prioritization in this aspect.

As Figure 6 shows, among the components studied, the environmental component, with a Beta coefficient of 0.314, had the most significant impact on the quality of the urban environment.

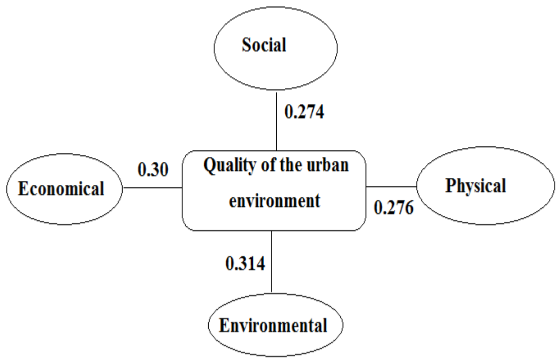

Figure 6. Diagram of beta values for each of the urban environment quality measurement criteria

This was followed by the economic component (0.300), the physical component (0.276), and lastly, the social index (0.274), which had the least impact. Overall, the impact of dust storms on the environmental component of Susangerd urban environment is more significant than the other three components, necessitating strategies and prioritization in this area.

Discussion and Conclusion

The present study aimed to analyze and assess the impact of dust storms in the economic, social, physical, and environmental dimensions on the quality of the urban environment in Susangerd.

Dust storms are fine particles suspended in the air, primarily composed of soil and sand, which are lifted into the atmosphere due to strong winds. This phenomenon typically occurs in arid and desert regions and can intensify due to climate change, droughts, and human activities.

Dust storms lead to a reduction in air quality, disturbances in public health, and environmental damage. Susangerd, one of the cities of Khuzestan, Iran, faces various challenges regarding dust storms due to its geographical location and specific climate. This natural phenomenon becomes more intense, especially during the warm seasons, affecting not only air quality but also public health and the daily lives of residents.

Dust storms are caused by the drying of wetlands, decreased vegetation cover, and human activities such as agriculture and industry. Consequently, the residents of Susangerd face issues such as breathing polluted air, an increase in respiratory diseases, and an urgent need for measures to combat this crisis. Local and national efforts to manage this crisis, including wetland restoration and the enhancement of vegetation cover, are still ongoing. The average impact of dust storms on urban environmental quality, as tested by

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the one-sample t-test, is as follows: for the environmental index, 4.27; social index, 4.00; economic index, 4.16; and physical index, 3.71.

The average desirability of Susangerd urban environmental quality is 4.03 (higher than the baseline of 3), indicating that respondents generally believe that Susangerd urban environment is in an ecological stress state due to the effects of dust storms. Additionally, the results from the stepwise regression test show that among the indicators studied, the environmental index, with a Beta coefficient of 0.314, has the greatest impact on the quality of the urban environment. This is followed by the economic index (Beta of 0.300), the physical index (Beta of 0.276), and lastly, the social index (Beta of 0.274). Overall, the environmental impact of dust storms on the urban environment in Susangerd is more significant than the other three components, requiring strategic focus and prioritization in this regard.

Based on the analysis, the following recommendations are made: 1) development of green jobs: creating employment opportunities in environmental protection and natural resource restoration, focusing on organic and sustainable agriculture. 2) encouraging investment in watershed projects: supporting the private sector and NGOS to invest in projects that help control soil erosion and reduce dust storms. 3) subsidies for tree planting: providing subsidies to farmers and landowners for planting trees and native plants that help prevent dust storms. 4) creation and protection of green areas: developing urban parks and green spaces to mitigate the effects of dust storms and improve air quality. 5) construction of earth dams and gabions: building protective structures around areas prone to dust storms to reduce wind speed and control dust phenomena. 6) green roads: creating roads and transportation routes with plant cover around them to prevent the intrusion of dust into urban areas. 7) formation of community groups: establishing and strengthening local associations and community groups for social and environmental activities aimed at restoring vegetation and preventing soil erosion. 8) participation in local planning: encouraging the public to participate in environmental decision-making and developing local strategies to combat dust storms. 9) planting native trees: conducting extensive programs for planting native, drought-resistant trees in vulnerable areas. 10) preservation and restoration of wetlands: protecting local wetlands as a natural resource that can contribute to controlling dust storms. 11) water resource management: implementing water conservation methods, such as using drip irrigation systems and collecting rainwater. 12) forest protection: combating deforestation and encouraging reforestation and forest restoration efforts. 13) protection of habitats: safeguarding natural areas and wildlife habitats through the establishment of national parks and protected areas.

Compliance with Ethical Guidelines

All ethical principles have been considered in this article, and participants were informed of the purpose of the research and its implementation steps.

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Author’s Contributions

This article is based on Abbas Sayyahi’s master's thesis at Maragheh University, who was responsible for conducting the research, collecting, and analyzing the data; and the second author, Omid Mobaraki, was responsible for the design and supervision, and Ali Valigholizadeh was responsible for the methodology. However, Omid Mobaraki was responsible for correspondence and editing the final manuscript submitted to the journal.

Conflict of Interests

The authors declare no conflict of interest.

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