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Econometric modeling and forecasting of environmental conditions of cities and population health problems: case study of Navoi and Zarafshan cities

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ABSTRACT

This study explores the connection between atmospheric emissions of harmful substances and population morbidity indicators in Navoi and Zarafshan, two highly industrialized cities in Uzbekistan's arid climate. With industrialization in arid environments presenting unique health risks, the research seeks to deepen scientific understanding of pollution-related health impacts specific to these cities. Identifying the health effects of air pollution in urbanized, dry regions not only advances scientific knowledge but also informs public health policies, contributing to the UN Sustainable Development Goal (SDG) 11.

A review of recent studies shows extensive evidence linking industrial air pollution to adverse health effects, such as respiratory, cardiovascular, and immune system issues. However, few studies focus specifically on the unique challenges faced by industrial cities in arid regions like Navoi and Zarafshan, where pollutant types and environmental interactions may differ significantly. Existing research associates industrial emissions with general morbidity rates, yet it lacks detailed analyses of how pollutants specifically affect health outcomes in arid climates.

Unresolved aspects of the problem include a generalized approach in correlating air pollution with health deterioration without considering how pollutants impact health differently across various climatic and environmental contexts. The effects of pollution in arid regions, with distinct pollutant composition and dispersal patterns, remain underexamined in current environmental health research.

The primary goal of this research is to quantify and evaluate the relationships between industrial air pollutants and morbidity indicators, particularly focusing on respiratory, immune, neurological, and digestive health in Navoi and Zarafshan. By providing actionable data on these connections, the study intends to guide health interventions to reduce health risks associated with industrial emissions in these areas. The purpose is to offer empirical evidence that supports policymakers and public health professionals in developing effective strategies to mitigate pollution-related health challenges in industrialized arid regions.

The findings of this research indicate a strong correlation in Navoi between annual pollutant emissions and increased rates of respiratory, immune, and neurological conditions, suggesting these health issues are particularly sensitive to pollution in the city. In Zarafshan, however, a different pattern is observed, with pollutants more closely associated with digestive diseases. This regional variation suggests that pollution's health impacts may vary significantly depending on local environmental conditions.

In conclusion, the study confirms a significant relationship between environmental conditions and public health, demonstrating that industrial emissions notably impact morbidity rates in arid, urban settings. By establishing these connections, the research supports SDG 11's mission to create sustainable and healthy urban environments, presenting evidence-based recommendations to minimize the health impact of industrial pollution. The proposed measures focus on addressing the primary health challenges–respiratory, immune, neurological, and digestive issues–identified in the Navoi region, promoting healthier urban environments through targeted interventions.

Keywords*: Econometric modeling, Air pollution, Navoi and Zarafshan, ARIMA, SDG's, environmental condition, forecasting, diseases.*

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Introduction. In today's globalized world, the rapid development of industry has led to numerous public health challenges, making it increasingly important to address these issues seriously [3]. The 11th item of the United Nations Sustainable Development Goals (SDGs) is dedicated to the sustainable development of cities. It emphasizes that the chances of breathing clean air for people living in Asian cities are particularly low. Consequently, the need for a comprehensive analysis of the situation, efforts to improve environmental conditions, a swift transition to a green economy, and measures to strengthen public health have become increasingly significant [1; 2].

Monitoring and modeling the current environmental situation are key components of sustainable environmental management. In recent years, researchers such as Muñiz and Sánchez [8], Lakner et al. [6], and Odekanle et al. [9] have underscored the importance of these factors. Uzbekistan, a country located in Central Asia, predominantly features an arid climate. The majority of its landscape consists of plains and lowlands with an elevation ranging from 200 to 400 meters [10]. As a result, the environmental conditions of the cities in this region and the associated public health concerns of their populations are of particular relevance.

This research focuses on the ecological conditions of the industrialized cities of Navoi and Zarafshan in the Navoi region, which is situated in the arid center of Uzbekistan. It also provides forecasts based on econometric modeling of public health problems.

Methodology. ***Study Area.*** The Navoi region, as an administrative unit, ranks second in size among the administrative divisions of Uzbekistan (after the Republic of Karakalpakstan). However, the region is of great significance due to its substantial economic potential. Notably, more than 80% of the region's territory is classified as desert, with a total area of 111,000 square kilometers (Figure 1). The region includes seven cities and 58 towns. Among these, the city of Navoi, founded in 1958 and serving as the administrative center, and the city of Zarafshan, established in 1972 around the Muruntov gold mine and specializing in non-ferrous metallurgy, stand out (Table 1).

Data Analysis. In this study, various methods were employed, including statistical data analysis, sociological surveys, and econometric modeling using R Studio software, to determine the correlation between harmful substances released into the atmosphere and disease groups within the population. This was achieved by using the **ARIMA** method. ***ARIMA Method*** – the Autoregressive Integrated Moving Average (ARIMA) method is a widely used statistical model for analyzing and forecasting time series data. ARIMA combines three components:

Autoregression (AR): A model that uses the dependency between an observation and a certain number of lagged observations.

Integration (I): Represents differencing the data to achieve stationarity, removing trends or seasonality.

Moving Average (MA): A model that incorporates the relationship between an observation and residual errors from previous observations.

The ARIMA model is typically denoted as ARIMA(p, d, q), where:

p is the number of lag terms (autoregressive terms),

d is the number of differencing operations required to make the time series stationary,

Table 1

General information about cities in the Navoi region

Cities	The year it received the status of a city	Population (thousand people)
Navoi	1958-year	150611
Zarafshan	1972- year	85636
Uchkuduk	1978- year	30528
Kyziltepa	1979- year	12602
Nurata	1976- year	36014
Yangirabot	1996- year	18782
Gazgan	2019- year	8945

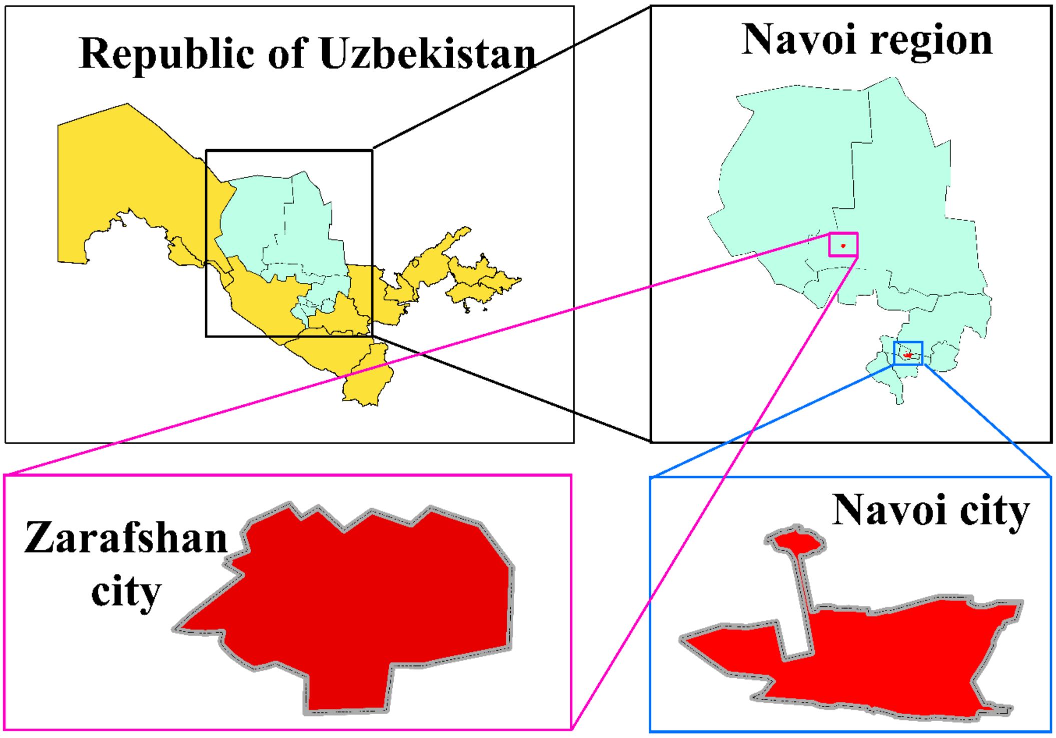


Fig. 1. Study area

q is the order of the moving average.

ARIMA models are used for forecasting future data points based on past values and patterns within a time series.

Student's t-Test. The Student's t-test is a statistical test used to determine whether there is a significant difference between the means of two groups or whether a sample mean significantly differs from a known population mean. It is commonly applied when the sample size is small and the population variance is unknown. There are two main types:

Independent t-test: Compares the means of two independent groups.

Paired t-test: Compares the means of the same group at different times or under different conditions.

The test calculates the t-statistic, which is then compared to critical values from the t-distribution to determine statistical significance. If the calculated t-value exceeds the critical value, the null hypothesis (that there is no difference) is rejected.

Data Collection. Econometric models, which provide a scientific basis for addressing specific socio-economic problems, have become increasingly important. Based on our observations and available statistical data, we developed an econometric model using the examples of Navoi and Zarafshan, two leading cities in the Navoi region [5]. The primary objective of this model is to scientifically substantiate the existence (or lack thereof) of a correlation between harmful substances released into the atmosphere and major disease groups among the population. This model forecasts the impact of changes in atmospheric pollution levels on population morbidity rates. Specifically, it analyzes how the morbidity rate fluctuates when the amount of harmful substances released into the atmosphere increases or decreases by one unit (i.e., by one ton). This analysis is crucial for informing decision-making, as it highlights key considerations for policymakers (Komilova & Latipov [4]; Tulchinsky & Varavikova [11]).

First, we examine the econometric analysis of the relationship between the most common diseases in Navoi and Zarafshan and one of the key factors affecting them—namely, the various harmful substances released into the atmosphere. We also present future forecasts based on this analysis [7]. To perform the econometric analysis, we use a series of observations over the years. Table 2 lists the most common diseases observed in Navoi from 2011 to 2022. Table 3 presents data on the quantity of harmful gases released into the atmosphere in Navoi (in tons) over the same period. Similarly, Table 4 provides the annual distribution of harmful gases released in Zarafshan, while Table 5 shows the distribution of diseases by year.

Results and Discussion. Using the data presented above, econometric analyses were conducted to examine whether the harmful gases released into the atmosphere in the cities of Navoi and Zarafshan are correlated with the six most common types of diseases in these areas. These analyses also generated forecast values for both cities, projecting trends up to the year 2028.

In econometric analysis, multicollinearity am-

Table 2

Incidence rate of main types of diseases in Navoi city

Years	Diseases related to respiratory organs	Digestive diseases	Diseases of the eye and its accessories	Diseases of the blood and blood-forming organs and the immune system	Diseases of the circulatory system	Diseases of the nervous system
2011	44218	17346	6548	5057	5197	5127
2012	42166	16204	5470	4871	4521	4766
2013	40374	14585	5144	4369	4311	4416
2014	37305	13790	4680	4259	3887	4094
2015	36455	13311	4585	3782	3570	3740
2016	35718	12623	4365	3656	3324	3692
2017	30449	13837	4716	3711	3016	3856
2018	31058	16342	4943	4348	2953	3091
2019	27269	11964	4574	3245	3093	3106
2020	31594	8588	4516	3374	3056	2289
2021	20694	7188	3999	3927	2710	3107
2022	30684	23950	8895	4242	7459	4716

Note: The table data was compiled by the author based on the data of the Statistics Agency of the Republic of Uzbekistan

Table 3

The number of harmful substances released into the atmosphere in the city of Navoi (in thousands of tons)

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
40.8	39.7	39.2	38.2	40.1	27.6	22.9	27.6	17.6	21.3	24.1	20.2

Table 4

The number of harmful substances released into the atmosphere in the city of Zarafshan (in thousands of tons)

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
0.3	0.3	0.2	0.4	0.2	0.4	0.5	0.8	0.9	1	1	1.2

Note: The table information was compiled by the author based on the information of the Navoi Region Statistics Department

Table 5

Incidence rate of the main types of diseases in the city of Zarafshan

Years	Diseases related to respiratory organs	Digestive diseases	Diseases of the eye and its accessories	Diseases of the blood and blood-forming organs and the immune system	Diseases of the circulatory system	Diseases of the nervous system
2011	23520	11639	3137	3264	3043	3247
2012	21533	10142	2637	2944	2540	2833
2013	20183	8462	2469	2789	2366	2754
2014	17277	7705	2160	2677	2043	2455
2015	15201	7613	1930	2575	1744	2296
2016	14803	7225	1710	2403	1631	2250
2017	14948	9142	2029	2087	1954	2619
2018	14904	10728	1972	2037	1788	3134
2019	13428	11424	875	1447	1415	2475
2020	17505	10445	963	1009	1441	1928
2021	25838	11748	833	1010	1666	1835
2022	23428	17960	1510	1785	2052	2582

Note: The table data was compiled by the author based on the data of the Statistics Agency of the Republic of Uzbekistan.

ong factors can arise when constructing multifactor regression equations. Multicollinearity refers to a high degree of linear correlation between independent variables (factors), which can make the results of the regression model unreliable. To assess multicollinearity, a matrix of pairwise correlation coefficients is generated. This matrix helps to determine the degree of direct or inverse relationships between the factors.

Several software programs can be employed to address econometric issues, including MS Excel, Stata, Minitab, and R Studio, which can also display results in graphical form (Komilova et al., 2021). In our case, it is reasonable to expect that harmful gases released into the atmosphere would lead to diseases that pose a threat to public health. Therefore, for the cities of Navoi and Zarafshan, it is essential to assess whether these harmful emissions are closely related to the six types of diseases analyzed in this study. This relationship can be determined using software programs such as MS Excel and Stata 14.2 by creating a matrix of pairwise correlation coefficients (Tables 6 and 7).

As we mentioned above, the density or strength of the connection between variables in the studied events and processes is estimated by r_{xy} – linear pair correlation coefficient. For linear regression, the value of the correlation coefficient $(-1 \leq r_{xy} \leq 1)$ lies in the interval. As we know, usually the degree of connection density according to the correlation coefficient is interpreted according to the following scale coefficients (Tables 8).

So, if we look at the correlation matrix in Table 6 that we created, there are very strong, medium, and weak direct and inverse correlations between the 6 most common types of diseases in Navoi city and various harmful gases released into the atmosphere in Navoi city over the years. From the values in the green and red cells of Table 6, we can see that there is a very strong positive correlation between respiratory diseases and air pollutants at a value of approximately (0.82). There is a strong positive correlation of 0.70 between blood and blood-forming organs and diseases of the immune system and air pollutants. Also, this case has a correct correlation between the diseases of the nervous system and harmful substances released into the atmosphere with a value equal to the average (0.60). The values of the rest of the inversely related elements of the constructed correlation matrix can be considered almost insignificant due to their density below the average, which can lead to very large deviations from the current situation, i.e. unreliable forecasts, after performing our forecasting procedure. In addition, all the remaining elements of the matrix, which showed a correct connection, are only between diseases, so we can consider them to be unimportant because the possibility of the occurrence of other diseases due to one disease is an inevitable phenomenon. If we analyze the matrix in Table 7 for the city of Zarafshan, we will continue our econometric analysis with these values in the next stages, as the cells highlighted in green are strongly and very strongly connected, respectively.

Table 6

Pairwise correlation matrix between harmful substances and diseases in Navoi city

	Harmful substances released into the atmosphere	Diseases related to respiratory organs	Digestive diseases	Eye diseases	Diseases of the blood and blood-forming organs and the immune system	Diseases of the circulatory system	Nervous system diseases
Harmful substances released into the atmosphere	1.00						
Diseases related to respiratory organs	0.82	1.00					
Digestive diseases	0.16	0.41	1.00				
Eye diseases	-0.02	0.24	0.89	1.00			
Diseases of the blood and blood-forming organs and the immune system	0.69	0.65	0.56	0.47	1.00		
Diseases of the circulatory system	0.15	0.37	0.86	0.96	0.53	1.00	
Nervous system diseases	0.60	0.69	0.73	0.64	0.79	0.74	1.00

Note: Factors marked in green are correlated, while those in red are unrelated

Table 7

Pairwise correlation matrix between harmful substances and diseases in Zarafshan city

	Harmful substances released into the atmosphere	Diseases related to respiratory organs	Digestive diseases	Eye diseases	Diseases of the blood and blood-forming organs and the immune system	Diseases of the circulatory system	Nervous system diseases
Harmful substances released into the atmosphere	1.00						
Diseases related to respiratory organs	0.19	1.00					
Digestive diseases	0.74	0.54	1.00				
Eye diseases	0.77	0.16	-0.24	1.00			
Diseases of the blood and blood-forming organs and the immune system	0.86	0.04	-0.36	0.95	1.00		
Diseases of the circulatory system	0.52	0.54	0.10	0.89	0.79	1.00	
Nervous system diseases	0.37	0.02	0.12	0.78	0.69	0.72	1.00

Note: Factors marked in green are correlated, while those in red are unrelated.

Thus, Tables 6 and 7 show the dynamics of the previous years with our factors of direct and inverse correlation determined for two cities (Fig. 2), the view of the model corresponding to the dynamics and the parameters of the resulting one-factor linear regression model forecasting until the next year 2028. we can determine whether it is reliable (Table 9).

In Figure 2, linear regression models in the form of $y=a+bx$ and their coefficients of determination (R^2) were calculated using Excel for both cities, based on the correlation pairs selected from Tables 6 and 7.

Table 8

Interpretation of the scale of correlational connection

Degree of correlation	**Interpretation**
0.91 to 1.00 (-0.90 to -1.00)	Very strong positive (negative) correlation;
0.71 to 0.90 (-0.70 to -0.90)	Strong positive (negative) correlation;
0.51 to 0.70 (-0.50 to -0.70)	Average positive (negative) correlation;
0.31 to 0.50 (-0.31 to -0.50)	Weak positive (negative) correlation;
0.00 to 0.30 (0.00 to -0.30)	Insignificant positive (negative) correlation;

In the next stage of the analysis, we can verify whether the unknown parameters *a* and b of these regression models are statistically significant—whether they lie within the confidence intervals or not—using the Student's t-test in MS Excel.

The R^2 value, shown in Figure 2, represents the coefficient of determination, which indicates the strength of the relationship between the two factors being analyzed. While researchers often aim for a high R^2 when conducting econometric analyses, this is not always a desirable practice. Overly high values during the forecasting period can lead to unreliable projections, which may result in significant errors and potential damage in various respects.

In our study, the coefficient of determination indicates that approximately 67.86% of the variation in the dependent variable *y* (respiratory diseases) is explained by the variation in the independent variable *x* (harmful substances released into the atmosphere).

Here:

$y=a+bx$ – linear regression model,

x – refers to various harmful substances released into the atmosphere (free variable),

y – the name of urban diseases respectively (involuntary variable).

The parameters *a* and *b* in the regression equations represent the coefficients that indicate the levels of the factors. We now test the statistical significance and confidence intervals of these coefficients using the Student's t-test for each pair shown in Figure 2.

During the analysis, the unknown parameters *a*

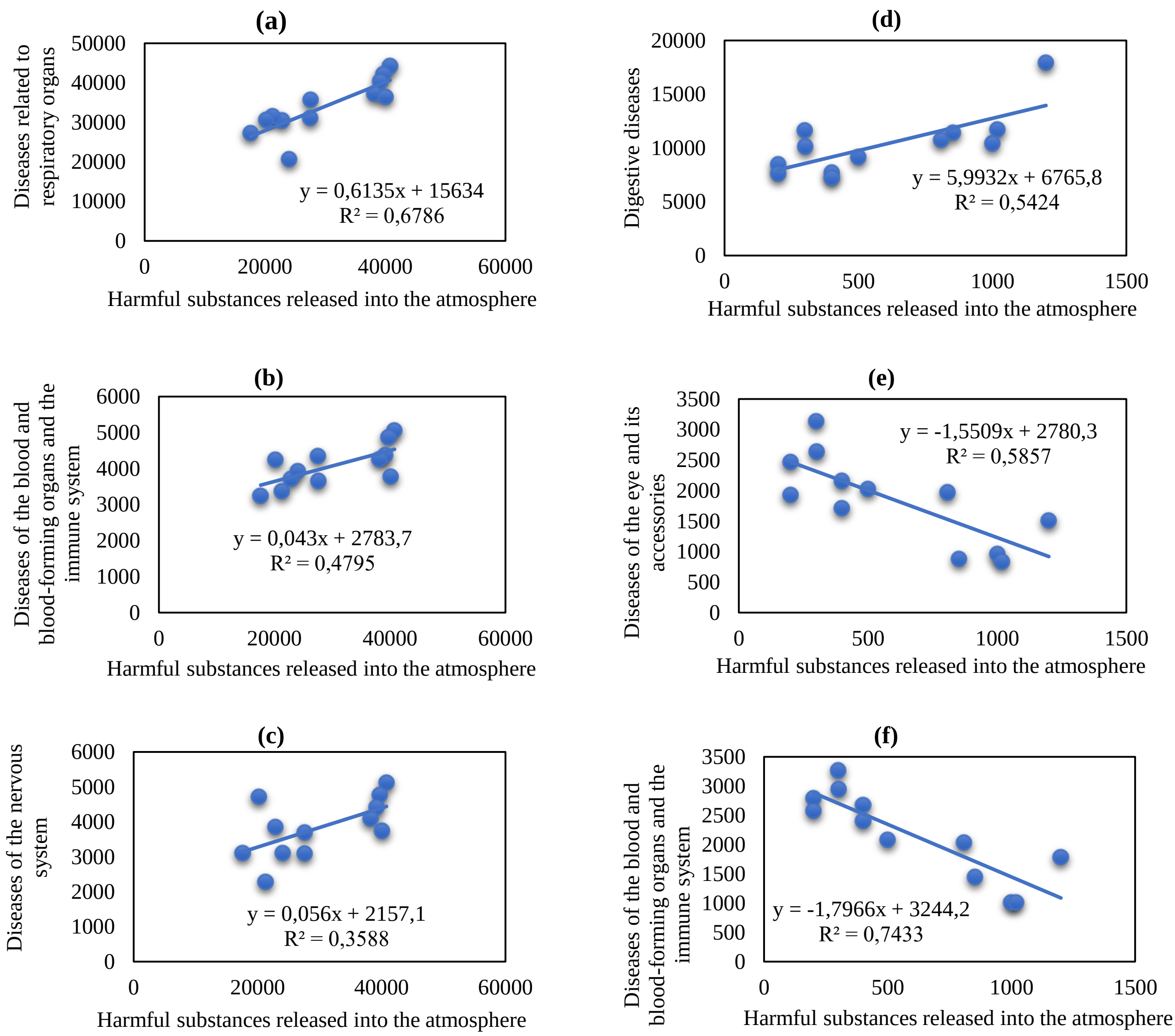


Fig. 2. Dynamic interaction between various harmful substances and diseases in the cities of the Navoi (a,b,c) and Zarafshan (d,e,f)

and *b* of the linear regression models in the form $y=a+bx$ were tested using the Student's t-test. Based on the test results, all three correlation pairs highlighted in green for Navoi city have t-values greater than the critical values from the Student's t-distribution table, indicating statistical significance. In Zarafshan, however, only one of the three correlation pairs under consideration met the conditions of the Student's t-test. The regression equations for the two correlation pairs highlighted in red in Zarafshan were found to be statistically insignificant.

Having determined the levels of correlation between factors through the creation of a correlation matrix and regression equations, we now proceed with the econometric analysis. We focus on the correlation pairs highlighted in green for both cities and generate their expected forecast results up to 2028 based on the regression equations. As mentioned earlier, the forecast results for future observations can be generated using various models through computer programs. Time series data, which are based on observations, typically satisfy the property of stationarity, meaning they have non-random time-dependent components. If the random residuals of a time series form a stationary series, then the time series itself is non-stationary.

To model such series, an Autoregressive Integrated Moving Average (ARIMA) model is applied. ARIMA models allow for integrated time series analysis. In the ARIMA (p, d, q) model, *p* represents the order of autoregression (the number of lagged observations), *d* represents the degree of differencing (the difference in harmful gases and diseases, or the order of first differences), and *q* represents the moving average order. Since the values and types of factors vary by year, we use different forms of ARIMA (p, d, q) models to capture the data's characteristics.

By applying the ARIMA model, we generate forecasts for harmful substances and diseases in the regions of Navoi and Zarafshan using R Studio software, as shown in Table 9.

To forecast harmful substances and diseases released into the atmosphere in the cities of Navoi and Zarafshan, the maximum likelihood estimation (log-likelihood), Akaika (AIC) and Bayes (BIC) criteria were used in the proposed models. These criteria are used to select the models with the least error in forecasting the harmful substances and diseases released in the cities of the Navoi region.

So, based on the statistical criteria for evaluating the quality of the econometric models obtained in the results of the lower, middle, and upper forecasts obtained in the 95 percent confidence interval of the diseases and harmful substances released into the atmosphere in the cities of Navoi and Zarafshan are presented in Tables 10 and 11 below.

Table 9

Econometric models used in forecasting

Navoi city		
№	**Type of harmful gases and diseases**	**The type of model selected for the forecast**
1	Diseases of respiratory organs	ARIMA (0,1,0)
2	Diseases of the blood and blood-forming organs and the immune system	ARIMA (1,2,0)
3	Diseases of the nervous system	ARIMA (0,1,0)
4	Harmful substances released into the atmosphere	ARIMA (0,1,0)
Zarafshan city		
№	**Type of harmful gases and diseases**	**The type of model selected for the forecast**
1	Digestive diseases	ARIMA (0,2,0)
2	Harmful substances released into the atmosphere	ARIMA (0,1,0)

**Note:* The ARIMA models selected for the forecast in Table 11 were selected as the best models based on the data in the given factors using R studio software

Table 10

Prognostic values of selected disease groups in Navoi city

Navoi city									
Years	**Diseases related to respiratory organs**			**Diseases of the blood and blood-forming organs and the immune system**			**Diseases of the nervous system**		
№	lower	medium	high	lower	medium	high	lower	medium	ihigh
2011		44218			5057			5127	
2012		42166			4871			4766	
2013		40374			4369			4416	
2014		37305			4259			4094	
2015		36455			3782			3740	
2016		35718			3656			3692	
2017		30449			3711			3856	
2018		31058			4348			3091	
2019		27269			3245			3106	
2020		31594			3374			2289	
2021		20694			3927			3107	
2022		30684			4242			4716	
2023	25706	29454	33201	3951	4377	4803	2496	3042	3589
2024	22924	28223	33523	3933	4636	5338	2096	2869	3641
2025	20502	26993	33484	3672	4809	5945	1749	2695	3641
2026	18268	25763	33258	3467	5041	6615	1428	2521	3614
2027	16153	24532	32912	3139	5233	7326	1126	2347	3569
2028	14122	23302	32481	2814	5452	8091	835	2174	3512

Note: This forecast data was developed by the author

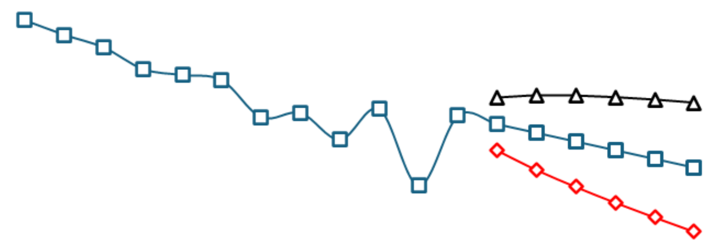
Table 11

Prognostic values of selected disease groups in Zarafshan city

Zarafshan city							Navoi city		
Years	Digestive diseases			Harmful substances released into the atmosphere			Harmful substances released into the atmosphere		
№	lower	medium	high	lower	medium	high	lower	medium	high
2011		11639			300			40800	
2012		10142			302			39700	
2013		8462			200			39200	
2014		7705			400			38200	
2015		7613			200			40100	
2016		7225			400			27600	
2017		9142			500			22900	
2018		10728			808			27559	
2019		11424			853			17615	
2020		10445			1000			21300	
2021		11748			1019			24057	
2022		17960			1200			20200	
2023	12249	14554	16859	1085	1282	1478	12667	18327	23987
2024	10802	15957	21112	1086	1364	1642	8450	16455	24459
2025	8735	17360	25985	1105	1445	1786	4779	14582	24385
2026	6137	18763	31389	1134	1527	1920	1389	12709	24029
2027	3070	20166	37262	1170	1609	2048	2376	10836	19296
2028	4927	21569	38211	1210	1691	2172	1665	8964	16262

Note: This forecast data was developed by the author

In Tables 10 and 11 above, the dynamic expectations of the forecasts obtained for the diseases associated with gases released into the atmosphere in the cities of Navoi and Zarafshan are presented in the following figures, respectively:



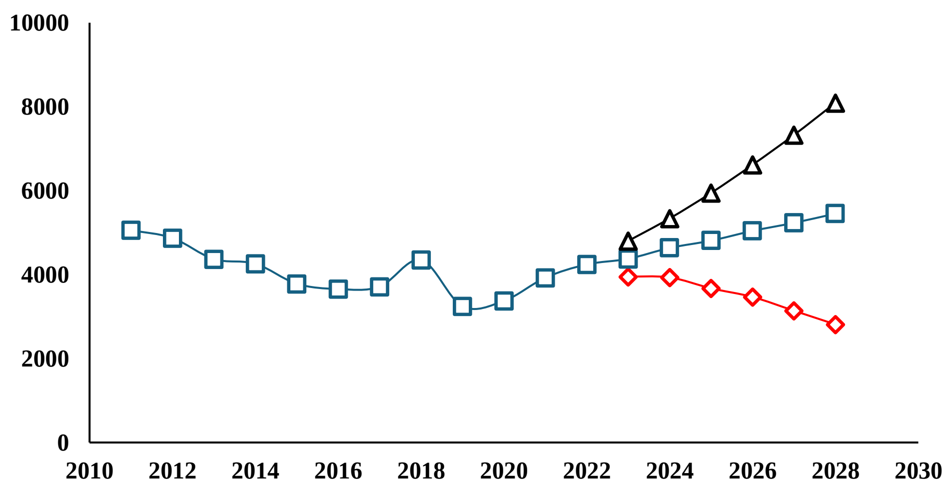


Fig. 3. Forecast of respiratory diseases in the city of Navoi until 2028

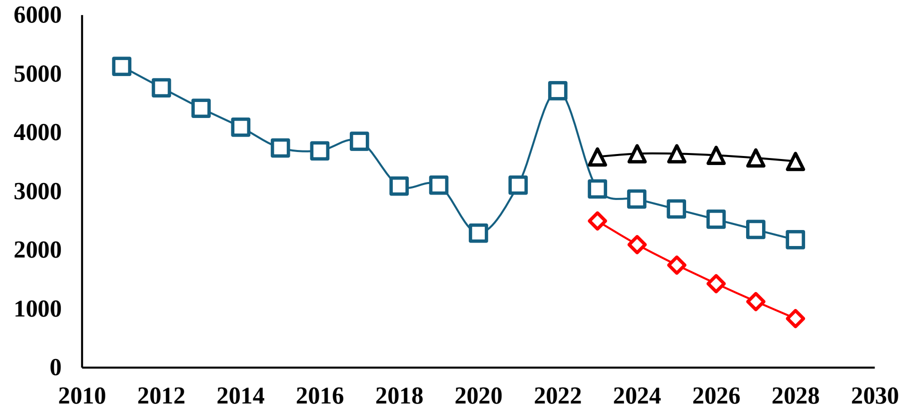


Fig. 4. Forecast of blood and blood-forming organs and diseases of the immune system in the city of Navoi until 2028

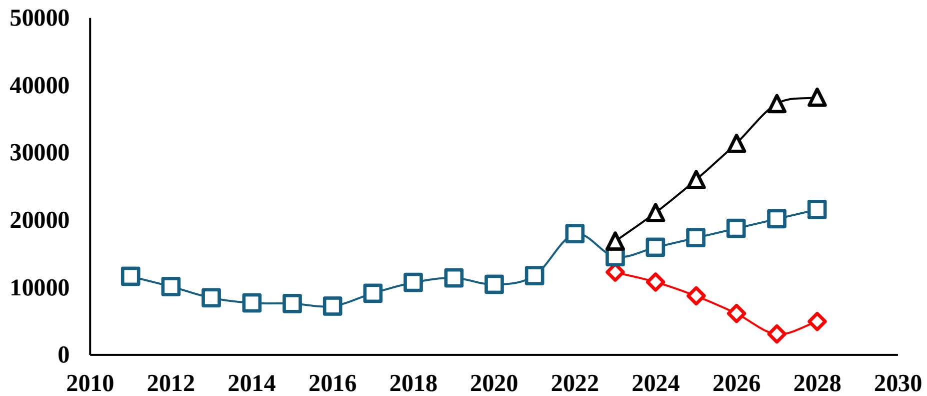


Fig. 5. Forecast of nervous system diseases in Navoi until 2028

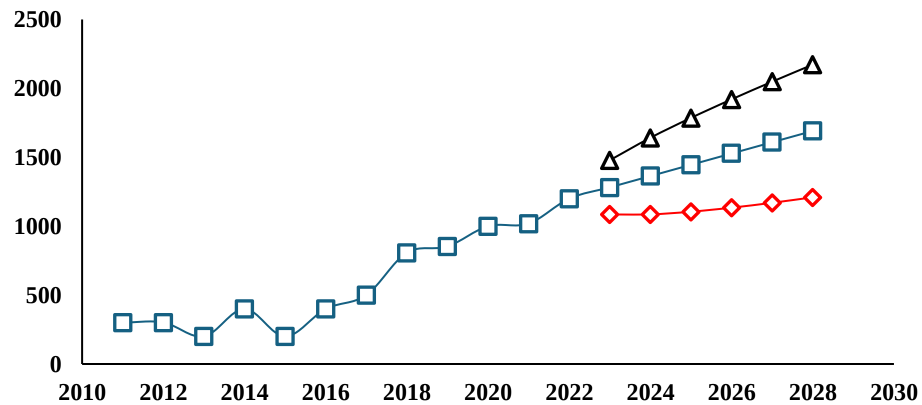


Fig. 6. Forecast of digestive diseases in Zarafshan until 2028

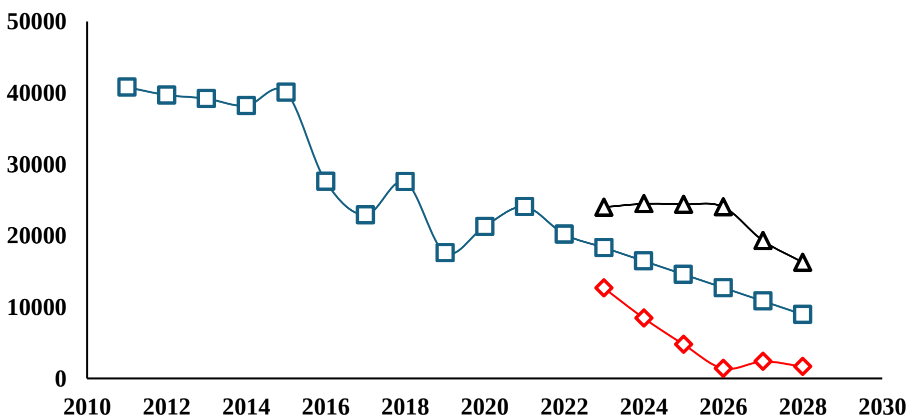


Fig. 7. Forecast of harmful substances released into the atmosphere in the city of Zarafshan until 2028

From the above pictures, we can see that the values of all the forecasted diseases and factors in the coming years will change in different ways. It should be noted that all the forecast values performed in the above tables were performed in *R studio.*

As we noted during our econometric analysis, using each of the forecast results obtained the dynamics of the relationship between *diseases* in the cities of Navoi and Zarafshan and *harmful substances* released into the atmosphere in 2023-2028, its statistical significance and errors in the MS Excel program $y=a+bx$ We check by constructing a linear regression equation in the form and we can make a general conclusion for diseases in the cities of Navoi and Zarafshan as follows.

Here:

$y=a+bx$ – linear regression model,

x – harmful substances released into the atmosphere (free variable),

y – the name of diseases present in the city, respectively (involuntary variable).

Also, parameters a and b are coefficients that indicate the level of the factors.

If we look at the data generated in the above tables, the green cells mean the coefficients check of the regression models constructed using the forecast values, that is, the values in the green cells satisfy the condition of the student t-test.

Now, we perform the step of calculating the mean error of approximation of the regression models constructed with the values of coefficients in green, which are considered statistically significant in the cities of Navoi and Zarafshan, and the values of the Fisher-F test, which evaluates the quality of the model, using MS Excel and R studio programs.

The average error of approximation calculated in these tables means the average deviation of the estimated values of the resulting regression equation from their true values and should not be statistically significant greater than 10%. In our study, this indicator is 6.97%, 8.73% and 8.84% in Navoi and Zarafshan cities, respectively, and this means that the model is built reliably. In addition, the Fisher F-test method calculated in these tables is one of the methods for evaluating the quality of the regression equation. Usually, this method involves testing the H0 hypothesis that the regression equation and link density indicator are not statistically significant. For this, the table Ftab values of Freal and Fisher -criterion are compared. If Freal> Ftab, the hypothesis H0 is rejected, and the regression is recognized as statistically significant, or vice versa. This F-test method performs very well for our analysis in the tables above, and we can assume that our model is statistically significant.

Conclusion. In the econometric model developed for the cities of Navoi and Zarafshan, we can come to the following conclusions:

As the average error of approximation of the regression models constructed for our observations in Navoi and Zarafshan cities, Fisher-F test values evaluating the quality of the model all correspond to statistical criteria, there are the following relationships between the studied diseases in Navoi and Zarafshan cities and the total harmful substances released into the atmosphere, namely:

a) in Navoi city: $y(x)=18277.14+0.537*x$, (1)

here, x – factor refers to substances released into the atmosphere;

$y(x)$ – the factor means diseases related to the respiratory system.

This regression model (1) implies that a one-unit change in the x factor leads to a 0.537-fold change in the y factor, i.e., a one-unit change in atmospheric emissions leads to a 0.537-fold change in respiratory diseases. Therefore, we should reduce harmful substances released into the atmosphere as much as possible.

b) in Navoi city: $y(x)=1776.34+0.067*x$, (2)

x – factor refers to substances released into the atmosphere;

$y(x)$ – the factor means diseases of the nervous system.

This regression model (2) implies that a one-unit change in the x factor leads to a 0.067-fold change in the y factor, which means that a one-unit change in atmospheric emissions leads to a 0.067-fold change in the incidence of nervous system diseases.

in Zarafshan city: $y=5684.077+8.092*x$, (3)

x – factor refers to substances released into the atmosphere;

$y(x)$ – factor means diseases related to the digestive system;

This regression model (3) means that a one-unit change in the x factor leads to an 8.092-fold change in the y factor, that is, a one-unit change in the harmful substances released into the atmosphere leads to a 8.09-fold change in the number of digestive diseases in Zarafshan city.

Recomendation. Based on the econometric models developed for Navoi and Zarafshan cities, which link atmospheric emissions to various health outcomes, here are some suggestions based on the model results:

Reducing Atmospheric Emissions: The models indicate that reducing harmful substances released into the atmosphere could significantly mitigate health risks associated with respiratory, nervous system, and digestive diseases. Specifically:

For Navoi city:

Respiratory Diseases (Model 1): A one-unit reduction in atmospheric emissions could potentially decrease respiratory diseases by 0.537 units, suggesting a direct benefit from reducing air pollution.

Nervous System Diseases (Model 2): Similarly, a reduction in emissions could lower nervous system diseases by 0.067 units, emphasizing the broader health benefits of cleaner air.

For Zarafshan city:

Digestive System Diseases (Model 3): The significant coefficient (8.092) indicates a strong positive relationship between atmospheric emissions and digestive diseases. Therefore, reducing emissions could have a substantial impact on reducing digestive health issues in Zarafshan.

Policy Recommendations: *Environmental Regulations:* Strengthen regulations on industrial emissions and vehicular pollution in both cities to limit the release of harmful substances into the atmosphere.

Investment in Clean Technologies: Encourage industries to adopt cleaner technologies and practices to minimize emissions.

Public Health Awareness: Increase public awareness campaigns about the health risks associated with air pollution and promote actions individuals can take to reduce their exposure.

Monitoring and Research: Continue monitoring air quality and health outcomes to further refine policies and interventions.

Collaboration and Coordination: Foster collaboration between local governments, industries, healthcare providers, and environmental experts to develop and implement effective strategies for reducing air pollution and improving public health.

By implementing these suggestions, Navoi and Zarafshan can work towards creating healthier environments for their residents, reducing the burden of diseases linked to air pollution, and promoting sustainable development practices.

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Економетричне моделювання та прогнозування екологічного стану міст та проблем здоров'я населення: тематичні дослідження міст Навої та Зарафшану

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У цій роботі досліджується зв’язок між викидами шкідливих речовин в атмосферу та показниками захворюваності населення в Навої та Зарафшані, двох високоіндустріалізованих містах у посушливому кліматі

Узбекистану. Оскільки індустріалізація в посушливих середовищах створює унікальні ризики для здоров'я, дослідження спрямоване на поглиблення наукового розуміння впливу забруднення на здоров'я, характерного для цих міст. Виявлення впливу забруднення повітря на здоров'я в урбанізованих посушливих регіонах не лише покращує наукові знання, але й інформує про політику громадського здоров'я, сприяючи досягненню 11-ої Цілі сталого розвитку (ЦСР) ООН. Основною метою цього дослідження є кількісна оцінка зв'язків між промисловими забруднювачами повітря та показниками захворюваності, особливо зосереджуючись на респіраторному, імунному, неврологічному та травному здоров'ї в Навої та Зарафшані. Надаючи дієві дані про ці зв'язки, дослідження має на меті скерувати втручання в охорону здоров'я, щоб зменшити ризики для здоров'я, пов'язані з промисловими викидами в цих областях. Мета полягає в тому, щоб запропонувати емпіричні докази, які підтримають політиків і спеціалістів у сфері охорони здоров'я в розробці ефективних стратегій пом'якшення проблем здоров'я, пов'язаних із забрудненням, у промислово розвинених посушливих регіонах. Результати цього дослідження вказують на сильну кореляцію в Навої між річними викидами забруднюючих речовин і підвищенням рівня респіраторних, імунних і неврологічних захворювань, що свідчить про те, що ці проблеми зі здоров'ям особливо чутливі до забруднення в місті. У Зарафшані, однак, спостерігається інша картина, де забруднювачі тісніше пов'язані із захворюваннями травної системи. Ця регіональна варіація свідчить про те, що вплив забруднення на здоров'я може значно відрізнятися залежно від місцевих екологічних умов. На завершення дослідження підтверджує значний зв'язок між умовами навколишнього середовища та здоров'ям населення, демонструючи, що промислові викиди значно впливають на рівень захворюваності в посушливих міських умовах. Встановлюючи ці зв'язки, дослідження підтримує місію ЦСР 11 щодо створення сталого та здорового міського середовища, представляючи науково обґрунтовані рекомендації щодо мінімізації впливу промислового забруднення на здоров'я.

***Ключові слова**: економетричне моделювання, забруднення повітря, Навої та Зарафшан, ARIMA, SDG, екологічний стан, прогнозування, захворювання.*

Внесок авторів: Латіпов Нормурод і Махмудов Баходіржон: концепція та дизайн дослідження, збір даних, аналіз та/або інтерпретація даних, складання рукопису, затвердження версії рукопису для публікації; Комілова Нілуфар: концепція та дизайн дослідження, збір даних, аналіз та/або інтерпретація даних, складання рукопису, критичний перегляд рукопису на предмет важливого інтелектуального вмісту, затвердження версії рукопису для публікації; Бердієв Хайріддін: складання рукопису та затвердження версії рукопису для публікації; Мехрдад Мослемзаде, Чуллієв Сухроб: концепція та дизайн дослідження, збір даних, аналіз та/або інтерпретація даних, складання рукопису, критичний перегляд рукопису щодо важливого інтелектуального вмісту

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