Analysis of Industrial Enterprises' Impact on Atmospheric Emissions

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Abstract. The article analyzes the scientific basis and chemical properties of the environmental problem arising during production at industrial enterprises of the country, sources of its occurrence and damage to the environment. At Eini time, the minimization of emissions into the atmosphere by industrial enterprises, the econometric assessment of the impact of CO_2 emissions per capita on CO_2 emissions in the country, the development of environmental processes resulting from the development of the industry, ways to improve the protection of the environment and ways to eliminate the damage were analyzed.

Keywords: industrial enterprises, environmental processes, elimination of damage, CO_2 emissions per capita.

1 Introduction

Due to the introduction of technological advances in a number of economic sectors, changes in the parameters of the ecological system due to technological advances, various fluctuations in the concentration of pollutants in the atmosphere are observed. The uncontrolled use of the Earth's natural resources has led to the deterioration of the human habitat, changes in climatic conditions, a decrease in the amount of stratospheric ferrozone, the destruction of forests and a widespread desertification process. According to calculations made at the same time, maintaining current growth rates indicates that in 2030 the population of the Earth will exceed 9 billion people.

On the other hand, the extraction of large hydrocarbon reserves and the processing of mining ores have a serious impact on the physicochemical and biological characteristics of the environment and create conditions for air pollution. For this reason, the environmental problem has attracted the attention of scientists around the world, the range of research

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projects aimed at monitoring air pollution has expanded, significant achievements have been made in the creation of new technical means, the development of complexes and the commissioning of technological lines.

Currently, since the state policy in Azerbaijan pays attention to the issue of environmental protection and the widespread use of automated systems in various sectors of the economy, the implementation of a dissertation devoted to the creation of a software package for monitoring and forecasting air pollution is of particular relevance. Currently, gas analyzers and chromatographs of various designs are widely used in world practice for the qualitative and quantitative assessment of pollutants in the atmospheric air.

Despite the fact that such measuring devices operate on different physical principles, in most cases they allow determining the concentration of many pollutants simultaneously, performing calibration in automatic mode, as well as storing a sufficient amount of information in memory and, if necessary, transmitting it to an external computer. Along with this, it is necessary to measure meteorological parameters characterizing the spread of pollutants in the atmosphere - wind speed and direction, air temperature and pressure, as well as humidity. At the same time, a number of tools and software have been created in world practice that perform the following functions to assess the ecological state of the environment, including monitoring air pollution:

- a set of transmitters that measure the concentration of atmospheric pollutants, as well as the main parameters of the environment;
- programs for collecting, visualizing and storing received data; programs for modeling the processes under study;
- forecasting programs based on the obtained models;
- research results presentation programs;
- methods of direct monitoring, data collection, storage, processing and presentation;
- modeling and forecasting models of atmospheric pollution.

At the same time, it should be noted that the placement of the above-mentioned measuring devices on mobile means allows monitoring in different cities and regions, the measurement data is transmitted to the computer through special programs and primary processing. Along with these data, status and navigation data are transmitted to the computer, and through other software, these data form part of the database of geographic information systems (GIS).

Taking into account all that has been said, it is necessary to carry out the dissertation work devoted to the creation of a single automated system that allows monitoring, modeling and forecasting of atmospheric pollution by summing up existing measuring devices, methods and programs.

2 Results and discussions

In modern times, the study of the state parameters of the atmosphere in most countries of the world has been posed as a matter of particular importance. The main components of the composition of the atmosphere are nitrogen (78.08%), oxygen (20.95%), argon (0.93%), carbon dioxide (0.03%) and other gases (0.01%). It should be noted that the parameters of the atmosphere do not always remain stable, and its condition changes regularly due to impurities from various sources of natural and anthropogenic nature. Usually the change in the level of pollution of the atmosphere is not so rapid due to time and in some ways forms the background. Dust, smog, smoke caused by forest fires, volcanic gases, flora and fauna products and others belong to the natural origin mixtures. At the same time, due to anthropogenic sources, the level of pollution changes more quickly and becomes quantitatively high. As an example, in the case under consideration, industrial enterprises, thermal power plants, vehicles running on an internal combustion engine can be attributed to the main sources of anthropogenic pollution.

The main components of pollution are non-toxic compounds of carbon dioxide (CO2) and water vapor (H2O). However, harmful substances such as carbon dioxide (carbon monoxide), soot, sulfur, and nitrous oxide are also emitted into the atmosphere. An increase in their concentration in the atmosphere can lead to negative consequences. Carbon monoxide (CO), for example, when inhaled, forms strong complex compounds with hemoglobin in human blood and prevents oxygen from entering the blood. Carbon monoxide is formed as a result of incomplete combustion of oil or other hydrocarbon reserves, various gases, and certain types of fuel extracted from the subsoil. Long-term exposure to sulfur dioxide (SO2) first leads to shortness of breath, and then to inflammation or pulmonary edema, heart failure, poor circulation, and respiratory arrest. In addition, this gas is one of the main sources of acidic sediments. The table below also presents Table 1 Generation, use and disposal of hazardous industrial waste (thousand tons) by country.

Table 1. Creation and use of hazardous industrial waste and decontamination (thousand tons).

Years	Amount of hazardous waste generated	Amount of hazardous waste used	Amount of hazardous waste neutralized
2009	131.8	18.7	10.4
2010	140.0	5.5	58.4
2011	185.4	3.6	37.1
2012	297.0	6.3	113.9
2013	202.7	0.6	86.4
2014	456.6	3.2	111.3
2015	191.7	5.2	210.9
2016	632.6	47.8	25.9
2017	266.0	5.4	35.8
2018	338.7	5.7	64.2
2019	296.9	13.4	66.2
2020	283.5	15.9	61.4
2021	245.2	5.8	102.5
2022	337.1	37.2	55.0
2023	232.9	44.6	60.1

The increase in demand for gas production in the world economy has contributed to an increase in the volume of gas production, and, consequently, to an increase in the volume of CO_2 emitted into the atmosphere. It should be noted that the increase in the volume of CO_2 emissions negatively affects human health, increasing the volume of emissions per person. In this regard, the interaction of the volume of CO_2 emissions in the country with CO_2 emissions per capita is of great importance. This information is reflected in the graph below.

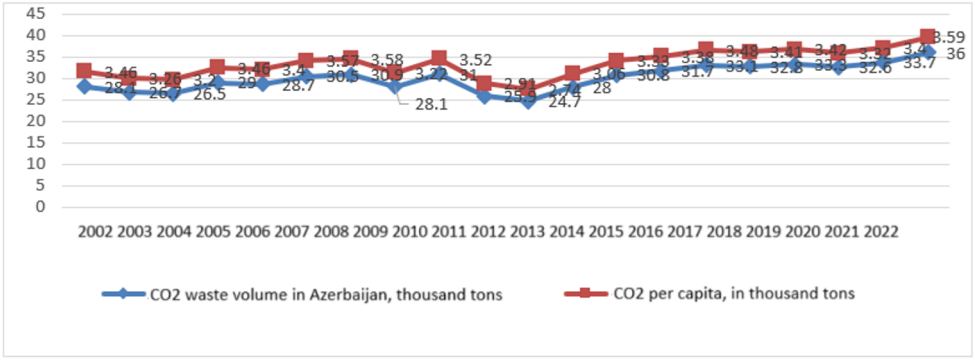

Fig. 2. Waste volume and waste volume per capita within two-decade period.

Dynamics of CO_2 emissions and CO_2 emissions per capita in the Republic of Azerbaijan for 2000-2022, thousand tons.

Source: compiled by the author on the basis of data from the State Statistics Committee of Azerbaijan.

Using graph 2 data to examine the impact of the increase in CO_2 emissions in the Republic of Azerbaijan on CO_2 emissions per capita.

The EViews program package can be used as a ready-made mathematical software package for the regression analysis of the dependence of the increase in CO_2 emissions in the Republic of Azerbaijan on CO_2 emissions per capita. For this purpose, using the Eviews software package, we will get the following result based on the above table data.

Table 1.

DependentVariable: Y				
Method: LeastSquares				
Date: 09/27/24 Time: 13:02				
Sample: 2000 2022				
Includedobservations: 20				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	0.053474	0.011992	4.459007	0.0003
C	1.725654	0.362742	4.757242	0.0002
R-squared	0.524850	Meandependentvar		3.335500
Adjusted R-squared	0.498452	S.D. dependentvar		0.222154
S.E. ofregression	0.157329	Akaikeinfocriterion		-0.766310
Sumsquaredresid	0.445546	Schwarzcriterion		-0.666736
Loglikelihood	9.663096	Hannan-Quinncriter.		-0.746872
F-statistic	19.88274	Durbin-Watsonstat		0.927251
Prob(F-statistic)	0.000303			

Source. The Eviews application was developed by the author based on the software package.

Based on the Eviews application software package, the regression equation based on the result obtained will be as follows:

Estimation Command:

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LS Y X C

Estimation Equation:

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Y = C (1) *X + C (2)

Substituted Coefficients:

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$$Y = 0.0534743869455*X + 1.72565358101 \quad (1)$$

As can be seen from the data of the Eviews application software package, there is an average correlation between the variables Y and X, expressed by the model Y = 0.0535 * x + 1.726 (R2 = 0.524850). So, the degree of dependence between indicators according to the Cheddock scale, the quantitative indicator of the contact shallow in the range of 0.3-0.5 means that the qualitative characteristic of the strength of the contact dependence is average [3]. According to this relationship equation, it can be concluded that one unit increase in CO_2 emissions in the Republic of Azerbaijan leads to an increase in CO_2 per capita by 1.73 units, which causes serious consequences for human health. As can be seen, according to the table

taken according to the Eviews application software package (1) model statistic is significant. This materiality is explained primarily by the fact that the coefficient of the free variable X is higher than that of the free limit C, their standard error.

Since it is important to check the adequacy of the established model, this adequacy can be determined using the F-Fischer criterion as one of the traditional methods. In order to check the statistical significance of the Model (2) expressing the whole set regression equation, the F - Fischer criterion should be compared with the value of $F_{capular}$ (a; m; n-m-1) [3]. Table with the result of the Eviews software package 3.1. based on its data, F - statistics (Fischer criterion) =19,88 if we determine the value of the table F in EXCEL with the help of the formula $f_{capular}$ (a; m; n-m-1)f spread,

$$F_{capular}(a; m; n\text{-}m\text{-}1) = F_{spread}(0.05; 1; 18) = 4.41$$

When comparing the F-Fischer criterion with the value of $F_{capular}$ (a; m; n-m-1), it appears that the F-Fischer criterion>$F_{capular}$ (19.88>4.41). This means that the regression equation as a whole has a statistic significant character [3]. And this means the adequacy of the constructed (1) model. The conclusion on the presence or absence of autocorrelation in the model is based on the EViews application software package received Table 1.-it can be determined based on Darbon-Watson statistics. As can be seen from the table, it is equal to DW=0.927. In this case, for the observation of the explanatory variable $\alpha = 0{,}05$ and N=4 to the level of materiality m=1, Darbon-Watson's crisis points will be as follows n=20 [3].

$$d_l = 0.902, \qquad d_u = 1.118$$

$$d_l = 0.902 < DW = 0.927 < d_u = 1.118$$

Since the conclusion about the existence of autocorrelation has not been established [3]. This means that the regression equation as a whole is statistically significant, and the constructed Model Y =0.0535*x +1.726 is adequate. The values and standard errors of CO_2 per capita per year in the Republic of Azerbaijan found by the regression equation obtained according to the Eviews application software package, as well as a number of characteristics of using the equation for forecast purposes are shown in the graph below.

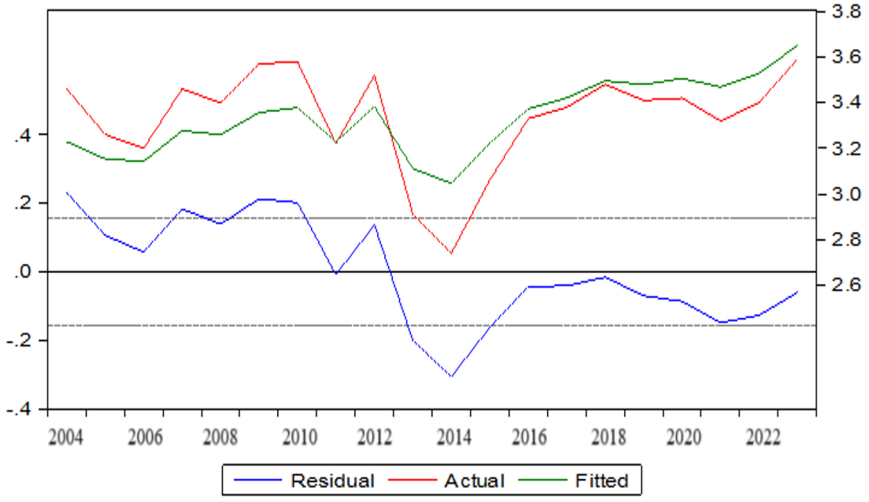

Fig.3. Prices of CO_2 per capita in the Republic of Azerbaijan by years, standard errors, characteristics for forecast.

It should be noted that using the graph, one can also determine the expected forecast prices for CO_2 per capita in the Republic of Azerbaijan. The assessment of the increase in the volume of CO_2 emissions in the Republic of Azerbaijan by the coefficient of elasticity of the CO_2 level per person of the population is also of great importance. As a result of the study, it is possible to determine how many percent the result factor will change due to causal factors by calculating the coefficient of elasticity for the linear regression equation above (1), which expresses how many percent change of the dependent variable as a result of a change of 1% of the free variable. This coefficient is calculated according to the following Formula [2].

$$E = \frac{\propto_i \times \bar{x}_i}{\bar{y}} \quad (2)$$

Where, are the coefficients of the relationship equation shown above. x is the average of the volume of CO_2 emissions for the studied periods, y is the average of the level of CO_2 per person of the population in the Republic of Azerbaijan for the studied periods. These indicators will be as follows according to the model with the calculated elasticity coefficients.

$$E_{\text{CO2 emissions}} = \frac{\propto_1 \times \overline{x_1}}{\bar{y}} = \frac{0.0535 \times 30.105}{3.3355} = 0.482871$$

The calculations showed that the increase in CO_2 emissions in the Republic of Azerbaijan by 1% leads to an increase in CO_2 levels per capita in the Republic of Azerbaijan by 0.483%. Calculations carried out for 2000-2022 show that according to the Eviews software package with the level of CO_2 per person of the population in the Republic of Azerbaijan, the graph of the change in CO_2 emissions in the Republic of Azerbaijan was obtained as follows.

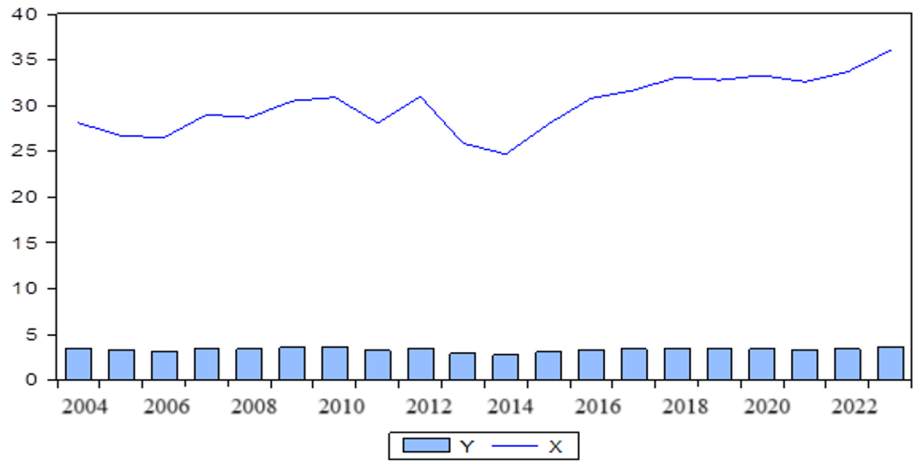

Fig. 4. dynamic change in CO_2 emissions by CO_2-level per capita in the Republic of Azerbaijan for 2000-2022.

It should be noted that to assess the density of the relationship between the studied indicators, the linear coefficient of double correlation is calculated. This coefficient is determined according to the following Formula [3, p. 136].

$$r_{xy} = \frac{\sum(y-\bar{y})(x-\bar{x})}{\sqrt{\sum(y-\bar{y})^2 \sum(x-\bar{x})^2}} \quad (3)$$

The value of the coefficient varies in the range [-1; 1].the proximity of the r_{xy}-coefficient to the unit indicates the presence of a close correlation dependence between these indicators. and the fact that $r_{xy} = 0$ indicates that there is no linear dependence. The fact that the coefficient is equal to zero can be in nonlinear dependence, despite the absence of linear dependence between the objects of study. The degree of dependence between indicators is determined mainly according to the Cheddock scale. It should be noted that the linear coefficient of double correlation also determines the direction of cause and effect indicators. If so, if_$r_{xy} > 0$ there is a straight relationship between the indicators. That is, with an increase in the causal factor(x), the value of the result indicator (y) increases. If, $r_{xy} < 0$then in this case, among the indicationscontact is present. That is, with an increase in causality(x), the value of the result indicator(y)decreases. To determine the linear coefficient of double correlation, the correlation statistical function is used. According to table.2 data from the Eviews application software package, R^2=0.525 means that the corresponding regression equation is explained by 52.5% variance result indicators and 47.5% by the influence of other factors.

According to the Eviews application software package with the regression equation of the constructed model (2), the dynamics of the received (Fitted) and actual (Actual) values, as well as the balances between them (Residual) on the studied indicators are presented in the following graph [3].

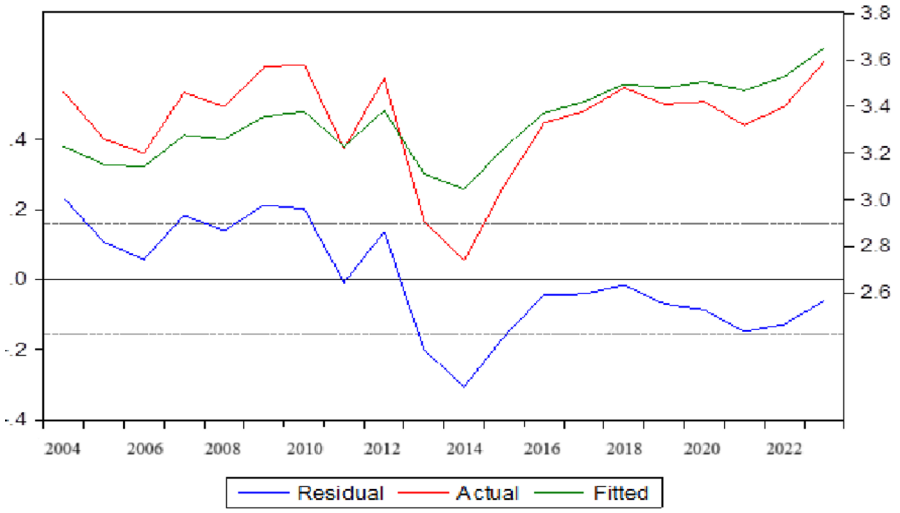

Fig. 5. Dynamics of received and actual prices and balances between them by the regression equation.

In the Republic of Azerbaijan, there is an average correlation between the level of CO_2 per capita and CO_2 emissions, expressed by the linear reress equation day:

$$Y = 0.0535*X + 1.726$$

3 Conclusion

Based on the research, it was established that there is an average correlation between CO2 levels and CO2 emissions per capita in the Republic of Azerbaijan, expressed by the linear regression equation: Y = 0.0535*X + 1.726.

The increase in the volume of CO_2 emissions in the Republic of Azerbaijan by 1% results in the CO_2 level per capita in the Republic of Azerbaijan by 0.483%; based on the coefficient

of elasticity was determined, as a result of the study, according to the Eviews application software package, the prices and standard errors of CO_2 levels per capita Treatment plants used to treat waste gases generated during the processing of industrial products cannot meet modern requirements, causing both environmental and major economic damage. The restoration of the "self-purification" property of ground and surface waters contaminated with oil products remains an urgent problem. Calculation of economic damage caused by environmental pollution during the processing of petroleum products was carried out by advanced calculation methods.

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