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ABSTRACT

Objectives. This work explores characteristics of dispersion and the concentrations of pollutants. The Center of Hydrometeorological Service of the Republic of Uzbekistan (Uzhydromet) monitors air pollution in the cities of the Republic. The monitoring program covers 5 main pollutants: dust (suspended solids), carbon monoxide (carbon monoxide), nitrogen dioxide, sulfur dioxide, nitric oxide. **The aim of the work** is a hygienic assessment of the state of atmospheric air according to the Uzhydromet of the Republic of Uzbekistan. **Materials and methods.** The data of 63 stationary observation posts allows us to analyze the average level of air pollution in the republic and to calculate the atmospheric pollution index, which gives an integral characteristic of the air pollution level for the city over the year. **Results and discussion.** An analysis of the data showed that over the studied period, an increased degree of atmospheric pollution index was observed only in Angren: 2014 - 5.12, 2016 - 5.32, 2017 - 5.30. In other cities of the republic, increased IAP (Index of Atmospheric Pollution) was not observed. **Conclusion.** When assessing the sanitary state of the air environment of the populated areas of Uzbekistan, it should be noted that,

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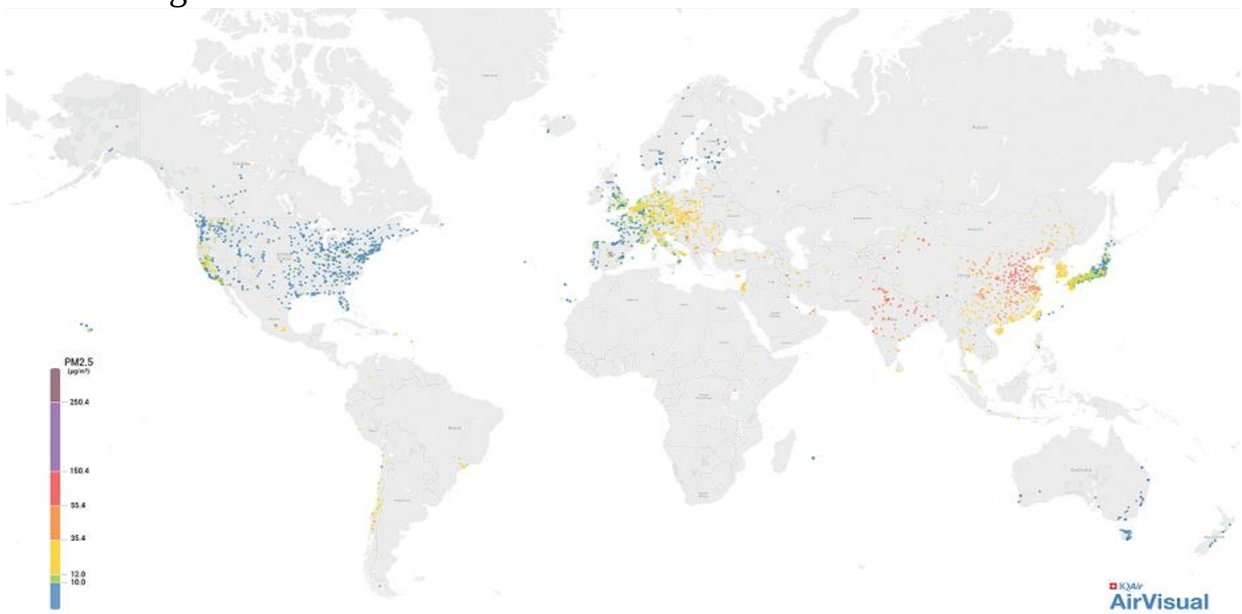
despite the decrease in total emissions of pollutants, it is not accompanied by stabilization and, all the more, improvement in the quality of atmospheric air.

Key words: atmospheric air, Uzhydromet, monitoring of atmospheric air pollution, index of atmospheric pollution, air protection measures.

Introduction

Latest air quality data for 2018 reveals that the majority of the countries of the world breathes unsafe air, far exceeding WHO air quality guidelines - while also highlighting an unequal distribution of PM2.5 pollution and availability of monitoring stations. Today, air pollution presents the world's 4th leading contributing cause of premature deaths, killing more than 7 million people annually. While its impact on everyday lives may not always be apparent, the global economy silently suffers an estimated 225 billion dollars annually from lost labor.[1]

In light of this urgent challenge, for the first time IQ Air Visual presents a compilation of the most recent data from 2018, to give a global overview of our planet's current air quality status. The new 2018 World Air Quality Report and interactive world's most polluted cities ranking is the first report of its kind to reveal the state of particulate matter (PM2.5) pollution in 2018. In assembling worldwide public air quality information in one place, the report highlights a widespread but unequal distribution of PM2.5 pollution and limited access to public information, and also pinpoints some areas of progress where access to data is increasing.



A global view of annual city averages for PM2.5 air pollution in 2018

The data is compiled from both governmental public monitoring sources in addition to public IQAirAirVisual monitoring stations. The report is the first to compile PM2.5 data entirely from 2018 for 3000+ global cities. [2]

86% of countries with available city data failed to meet WHO exposure targets, while half exceed this target by 200+%. While concerning in itself, these numbers are expected to underestimate true global pollution levels, as countries without air quality monitoring resources are not represented, yet may often have high levels of air pollution which go unmeasured or unpublished. Pakistan, a country which lacked public, real-time air pollution data until 2017, is one example of this. New data contributed by a citizen-led network of PM2.5 monitors, included in this report reveals that the country ranks #2 globally, for highest recorded PM2.5 air pollution.

Table 1.

World country/region ranking

Sorted by estimated average PM2.5 concentration (μg/m³)

1	Bangladesh	97.1	26	Chile	24.9	51	Puerto Rico	13.7
2	Pakistan	74.3	27	South Korea	24.0	52	Belgium	13.5
3	India	72.5	28	Serbia	23.9	53	France	13.2
4	Afghanistan	61.8	29	Poland	22.4	54	Germany	13.0
5	Bahrain	59.8	30	Croatia	22.2	55	Japan	12.0
6	Mongolia	58.5	31	Turkey	21.9	56	Netherlands	11.7
7	Kuwait	56.0	32	Macau	21.2	57	Switzerland	11.6
8	Nepal	54.2	33	Mexico	20.3	58	Russia	11.4
9	United Arab Emirates	49.9	34	Czech Republic	20.2	59	Luxembourg	11.2
10	Nigeria	44.8	35	Hong Kong	20.2	60	Malta	11.0
11	Indonesia	42.0	36	Cambodia	20.1	61	United Kingdom	10.8
12	China Mainland	41.2	37	Romania	18.6	62	Spain	10.3
13	Uganda	40.8	38	Israel	18.6	63	Ireland	9.5
14	Bosnia & Herzegovina	40.0	39	Taiwan	18.5	64	Portugal	9.4
15	Macedonia	35.5	40	Slovakia	18.5	65	USA	9.0
16	Uzbekistan	34.3	41	Cyprus	17.6	66	Canada	7.9
17	Vietnam	32.9	42	Lithuania	17.5	67	New Zealand	7.7
18	Sri Lanka	32.0	43	Hungary	16.8	68	Norway	7.6
19	Kosovo	30.4	44	Brazil	16.3	69	Sweden	7.4
20	Kazakhstan	29.8	45	Austria	15.0	70	Estonia	7.2
21	Peru	28.0	46	Italy	14.9	71	Australia	6.8
22	Ethiopia	27.1	47	Singapore	14.8	72	Finland	6.6
23	Thailand	26.4	48	Philippines	14.6	73	Iceland	5.0
24	Bulgaria	25.8	49	Ukraine	14.0			
25	Iran	25.0	50	Colombia	13.9			

Country/region ranking, based on available data from 2018

At a city level, India is home to 8 of the 10 most polluted cities globally. Capital Delhi, whilst ranked as the capital city with highest pollution globally, falls just outside of the top 10 cities overall, ranking 11th. It averages a PM2.5 concentration of 113.5μg/m³, more than 11 times the WHO guideline. For comparison, Capital Beijing averages 50.9μg/m³ for 2018, less than half that of Delhi.Out of 20 most polluted cities in the world, 18 are in India, Pakistan and Bangladesh.

Uzbekistan is on the 16th place in the rank of the most polluted atmospheric air in 2018 and has leading role in the ranking of among yellow indicated countries. This means that the content of harmful substances in the air is

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satisfactory, but the population sensitive to polluted air should be careful about its health.

Atmospheric air pollution is determined by the influx of polluting substances from natural and anthropogenic sources, as well as the physical-geographical and climatic conditions of the territory. A significant part of Uzbekistan is a plain territory belonging to the Turan lowland, open to cold intrusions, which forms sharply continental climate features. Here, western, north-western intrusions of moist air from the temperate latitudes of the Atlantic Ocean are periodically observed, which also affects the formation of qualitative and quantitative characteristics of the atmosphere. The main natural pollutants of the plain territory are natural sources of aerosol emissions into the atmosphere, such as the Karakum and Kyzyl Kum deserts with their frequent dust storms, as well as the Aral Sea zone from the shrunken part of the Aral Sea, from the surface of which large masses of saline dust rise and transfer from the West to the East. Sources of pollutants of anthropogenic origin are transport and enterprises of the leading industries of the Republic: oil and gas refining, energy, metallurgical, construction, chemical and others [6].

The largest specific pollutant emissions are noted in the Tashkent region. The degree of pollution is distributed as follows:

• VOC emissions: increased - in the Andijan region, average - in the Fergana and Khorezm regions, moderate in the Samarkand and Namangan regions, low in the rest regions of the Republic;

• Nitrogen oxide emissions: increased - in the Sirdarya region, average - in the Andijan, Kashkadarya and Fergana, moderate - in the Andijan and Namangan and Khorezm regions, low in the rest of the Republic;

Particulate pollutants: increased - in Navoiy region, average - in Djizak and Fergana, moderate - in Andijan, Namangan and Ferghana regions, low - in the rest of the Republic;

Thus, this analysis clearly shows the complete dependence on the location of industrial and transport facilities on the territory of the Republic,

In 1990, the largest share of air pollutants was associated with stationary industrial sources. With independence of the republic and transition to a market economy, basic industry enterprises were restructured, production declined, and a number of plants were closed. At the same time, there was a transition to new technologies and types of products necessary to maintain competitiveness and environmental standards.

The level of industrial air pollution decreased. But the rapid increase in the number of automobiles led to the increase in traffic congestion and air pollution in large cities. In many settlements, due to the deterioration of the public transport system, the automobile became a more reliable means of transportation, and in areas with a high level of development, a personal transport also became a sign of social status. The contribution of mobile pollution sources, mainly automobiles, to the total air emissions is less than 50% in Kazakhstan and Turkmenistan, up to 70% in Uzbekistan and reaches almost 90% in Tajikistan and Kyrgyzstan [3]. Gross emissions of pollutants into the atmosphere from stationary and mobile sources characterize the general anthropogenic load on the atmospheric air. In the total volume of pollutant emissions in Uzbekistan, the main share is energy (33%), oil and gas (31%) and metallurgy (22%). The main components of all atmospheric emissions in the republic in the first years of independence were carbon monoxide (50%) and hydrocarbons (15%), sulfur dioxide (14%), nitrogen oxides (9%) and particulate matter (8%). In the structure of total gross emissions across Uzbekistan, there have been minor changes in the past twenty-five years. Thus, the content of carbon monoxide and hydrocarbon emissions increased by 2%. At the same time, the content of emissions of sulfur dioxide by 2% and solid particles by 3% decreased. The content of nitrogen oxides in the structure over a given period has not changed. It should be noted that as a result of the implementation of environmental measures in accordance with the "Program of Action for the Protection of the Environment in the Republic of Uzbekistan for 1999-2005" and other programs, as well as the annual implementation of the "Clean Air" operation in the Republic, total emissions into the atmosphere decreased to 2.1 million tons or 2.1 times compared with 1989 [4-6]. Despite the reduction in gross emissions of pollutants into the atmosphere, the state of atmospheric air is not accompanied by stabilization and, especially, improvement in its quality, which prompted the conduct of this study. The purpose of this work is a hygienic assessment of the state of atmospheric air according to the Center of Hydrometeorological Service of the Republic of Uzbekistan (UzHydromet).

The aim of the work is a hygienic assessment of the state of atmospheric air according to the Uzhydromet of the Republic of Uzbekistan.

Materials and methods. In the Republic of Uzbekistan, data on the state of atmospheric air is generally based on the results of state monitoring, peformed by the State Committee of the Republic of Uzbekistan on Ecology and Environmental Protection (http://www.uznature.uz/), the Center of Hydrometeorological Service at the Cabinet of Ministers of the Republic of Uzbekistan (http://www.meteo.uz/rus/index.php), Ministry of Health of the Republic of Uzbekistan (http://www.minzdrav.uz/). The State Committee of the Republic of Uzbekistan on Ecology and Environmental Protection coordinates the activities of all other state organization in the field of state environmental monitoring in accordance with the "Regulations on State Environmental Monitoring in the Republic of Uzbekistan", approved by the Cabinet of Ministers of the Republic of Uzbekistan dated April 3, 2002 (No. 111).

Uzhydromet has been monitoring air pollution in the cities of the Republic for many years. Observations are conducted in 25 cities and towns. In total, 63 stationary posts operate in the republic. The location for the installation of a stationary post is selected, as a rule, taking into account meteorological conditions for the formation of levels of air pollution. At the same time, a set of tasks is determined in advance, an estimate of the average monthly, seasonal, annual and maximum single concentrations, the probability of occurrence of concentrations exceeding the MAC (Maximum allowable concentrations), etc.

The number of posts in the city depends on the population in the city, the area of the settlement, the terrain, the degree of industrialization.

For settlements with complex terrain and a large number of sources it is recommended to install one post for every 5-10 km^2. To make information about air pollution take into account the peculiarities of the city, it is recommended to put observation posts in various functional areas - residential, industrial and residential. In cities with a high traffic intensity, posts are also established near motorways.

The monitoring program covers 5 main pollutants: dust (suspended solids), carbon monoxide (carbon monoxide), nitrogen dioxide, sulfur dioxide, nitric oxide. Other parameters are added to the measurement programs depending on the composition of industrial emissions and the characteristics of the nearest cities and adjacent territories (ammonia, phenol, formaldehyde, ozone, chlorine, solid fluorides, hydrogen fluorides). Observation of the state of atmospheric air is carried out daily with a frequency of 3 times a day [4-5].

Assessment of air quality in the city is carried out according to the methodology set out in GD 52.04.186-89 (Guidance document. Guidelines for the control of atmospheric pollution), which is the fundamental guide for Hydromet systems in the CIS countries. The number of posts in the city (according to RD) depends on the population in the city, the area of the settlement, the terrain, and the degree of industrialization.

Sampling of air at mobile stations is performed by technicians using air intakes by specific programs. Samples are delivered to laboratories where they are analyzed by chemical methods.

According to the data of the Uzhydromet, air pollution in Uzbekistan is caused by emissions of harmful substances from stationary and mobile sources, as well as by the high (in most regions of the republic) climatic potential of air pollution [5].

The information obtained from 63 stationary observation posts allows us to judge the average level of air pollution in the republic as a whole and calculate the index of atmospheric pollution (hereinafter - IAP), which gives an integral characteristic of the level of air pollution for the city for the year.

The complex index of atmospheric pollution (hereinafter - IAP5) is calculated for five substances with the highest normalized MPC values taking into account their hazard class. The IAP calculation does not involve values for ozone, since this impurity is not monitored for the whole year and not in all cities, and for formaldehyde, because the method determines the amount of aldehydes (under the definition of “formaldehyde”, the concentrations of aldehydes are given without comparison MPC).

Air pollution is determined by the concentration of impurities. The degree of pollution is evaluated by comparing actual concentrations with hygiene standards - the maximum allowable concentration of impurities in the air. There are 4 gradations of air pollution degree: from “low” to “very high” (Table 2).

Table 2

Assessment of the air pollution degree

Air pollution degree	Index of air pollution	Assesment
Low	IAP	0-4
Increased	IAP	5-6
High	IAP	7-13
Very high	IAP	14

Results and its discussion. Analysis of the data obtained from the air monitoring network in 2011-2015 showed that the average annual concentrations of the main and specific pollutants in the controlled cities of Uzbekistan were below the established quality standards. Average annual concentrations of sulphur dioxide, carbon monoxide, nitrous oxide in atmospheric air practically did not change and were within the limits of Permissible Concentrations (PC) values. (Picture 1-3).

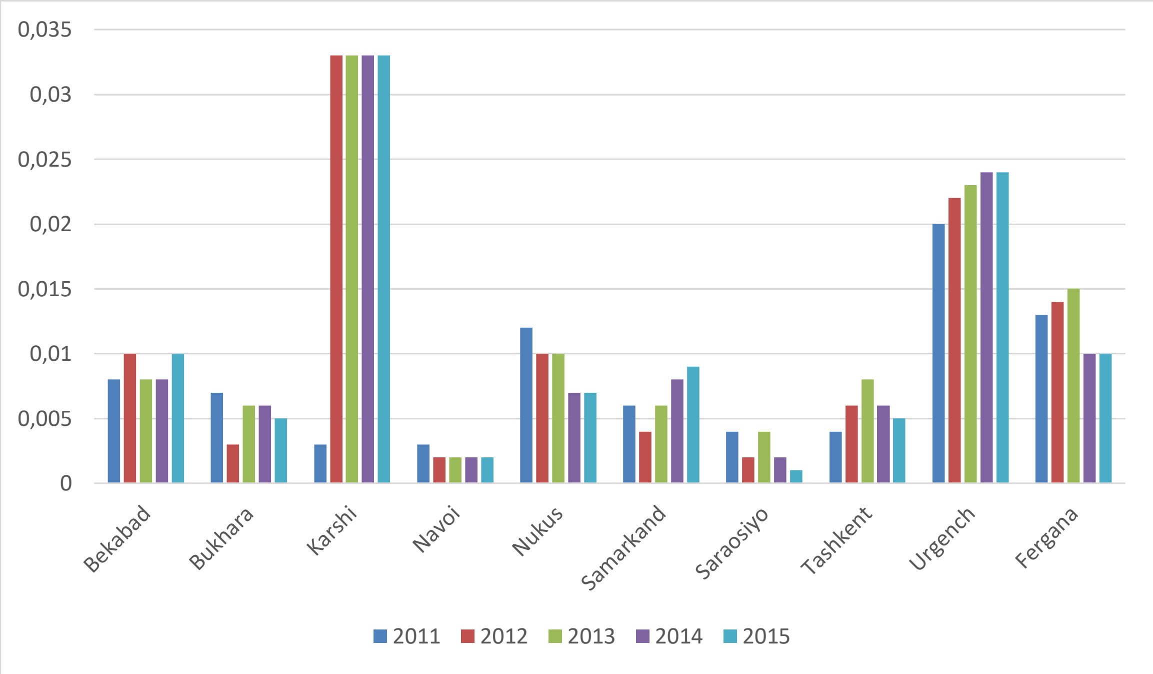

Fig.1 The average annual concentration of sulphur dioxide in the atmospheric air in the cities of Uzbekistan in 2011-2015. in PC fractions (PC - 0,05 mg/m^3)

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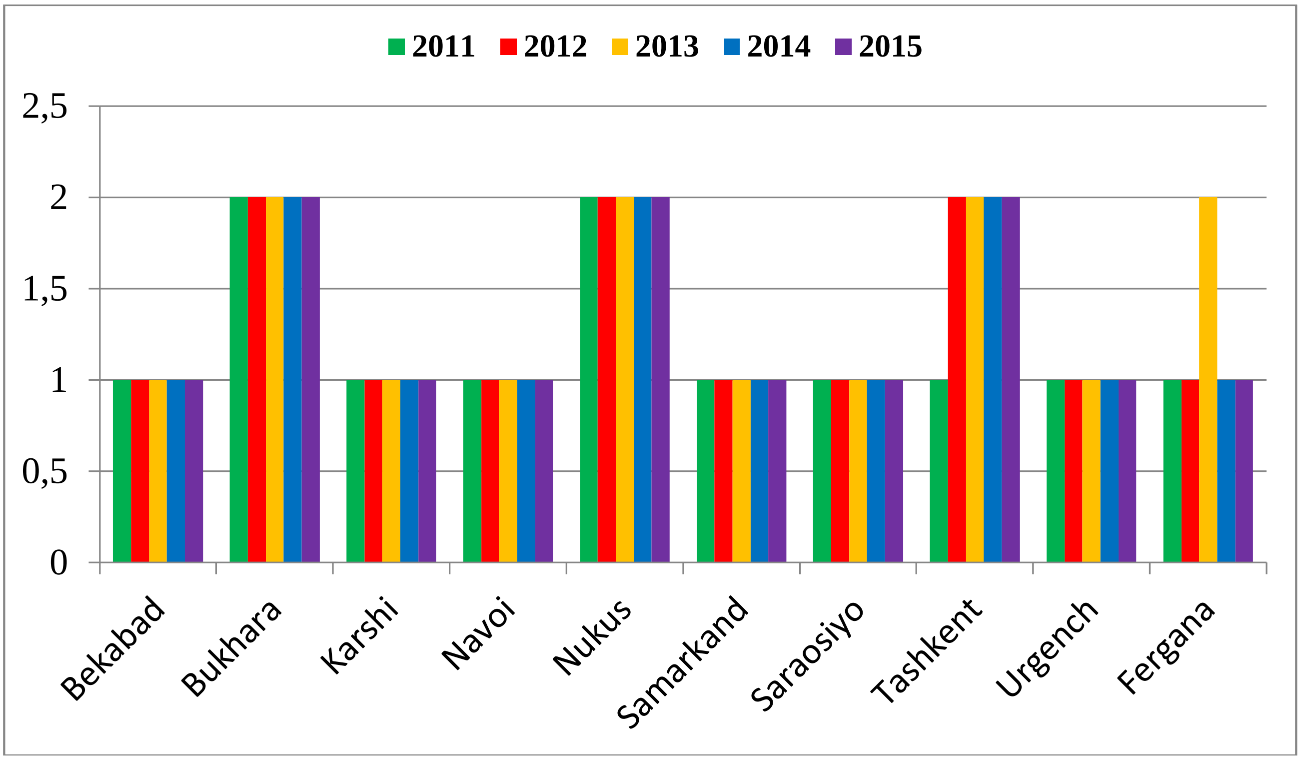
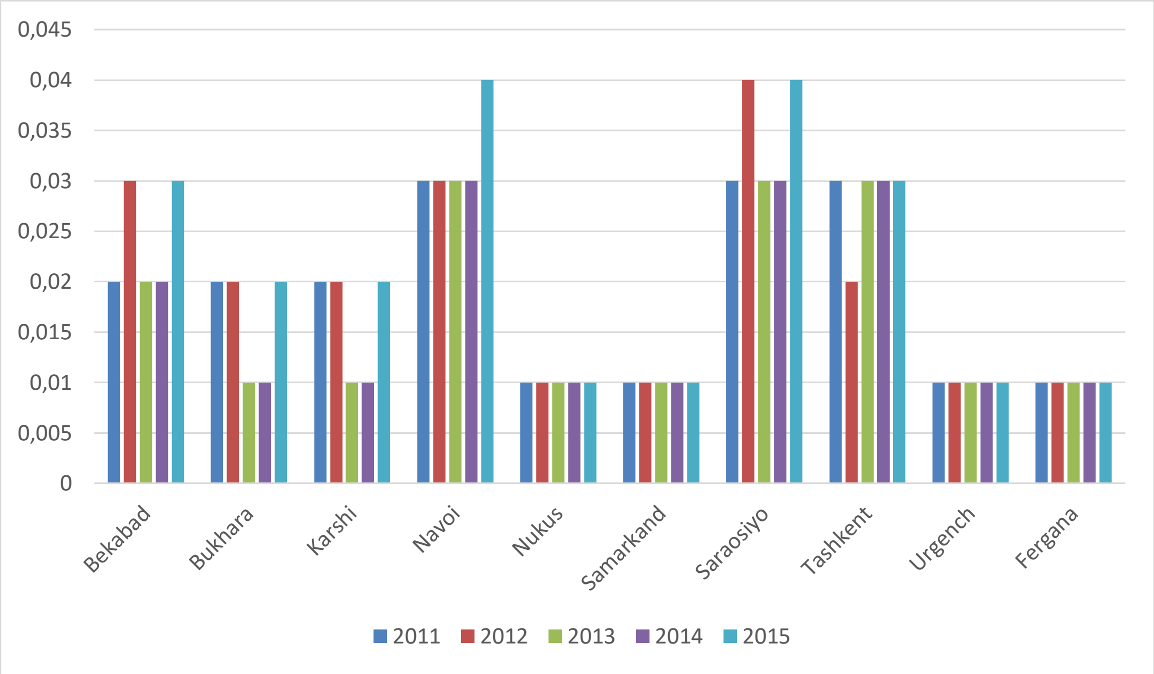


Fig.2 Average annual concentrations of carbon monoxide in the atmospheric air in the cities of Uzbekistan in 2011-2015 in PC fractions (PC - 3,0 mg/m^3)



Pic.3 The average annual concentration of nitrous oxide in the atmospheric air in the cities of Uzbekistan in 2011-2015. in PC fractions (PC - 0,06 mg/m^3)

Dust is represented as a particulate matter, dispersed and component`s structure of which depends on their origin (natural or produced by human activities). It contains mineral salts, metall oxides and organic compounds. On the territory of Uzbekistan there are large natural dust sources of polluting to the atmosphere - poorly fixed sandy soils of the Karakum salty Kizilkum and Aralkum deserts (drained area of the Aral Sea).

The bare seabed formed the Aralkum salt desert, that spreads a large amount of salt and dust with sand particles every year. The mass of dry rest is changing in average from 500 to 2702 kg per a hectare per year. The composition of this dust content sulphate salts reaches 25-48%, chloride -18-30%, and carbonate-10-20%. The main amount of dust and gas transfer occurs within 300 km of the coastal strip. The amount of dust settled on the soil in the Southern Aral Sea region is ten times more than in the irrigated zone. In the cities of Bukhara, Urgench and Nukus, exceedances of average daily PCs of total solid particles were observed 1.3, 1.3 and 2.7 times, respectively (Fig. 4).

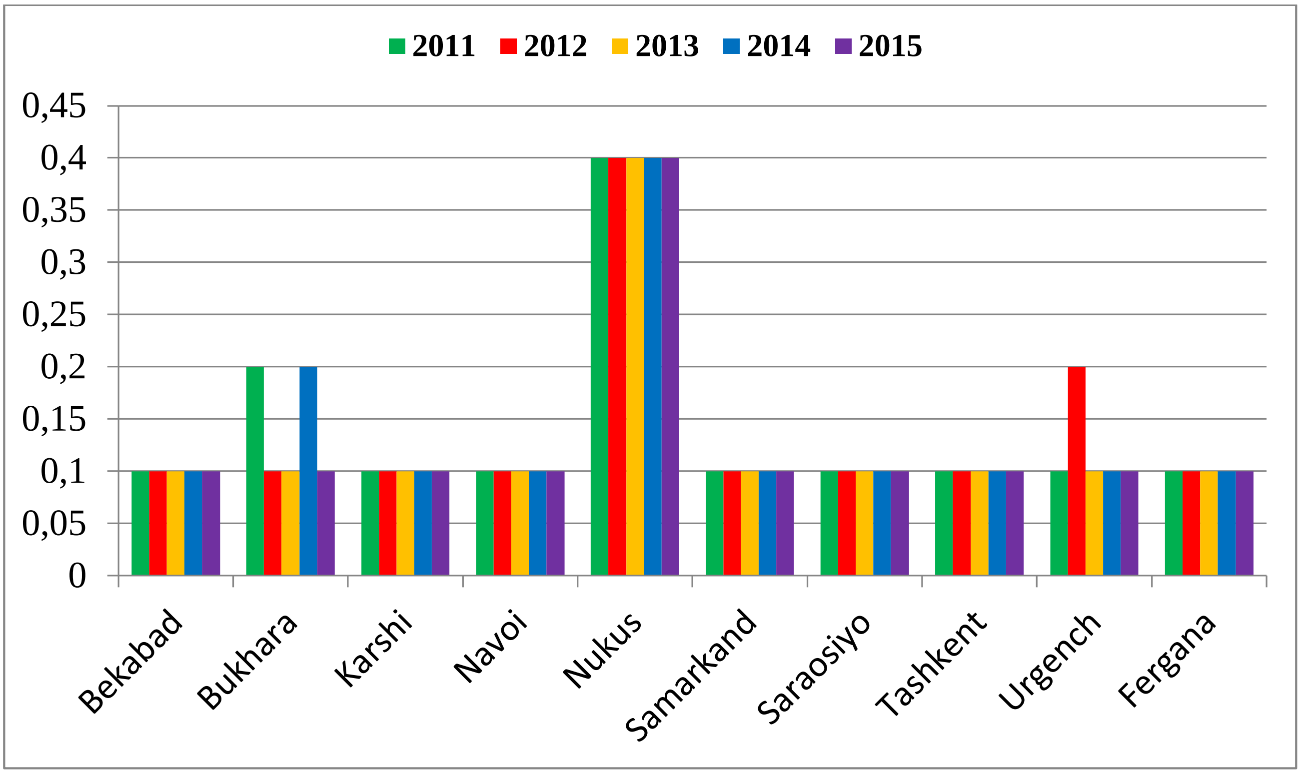


Fig.4 Average annual concentrations of total solids in the atmospheric air in cities of Uzbekistan in 2011-2015 in fractions of maximum concentration limit (maximum concentration limit - 0,15 mg / m3)

The complex indicator characterizes the level of air pollution by the components with the highest concentration considering their hazard class is the Index of Atmosphere Pollution (IAP).

The analysis of the data shows that over the studied period, the increase in index of the atmospheric pollution was observed only in Angren (Fig.5). The integrated pollution indicator was 5.12 in 2014, 5.32 in 2016 and 5.30 in 2017, which corresponds to the II degree, characterized by the increased level of atmospheric pollution, which leads to deterioration of the living conditions of the population.

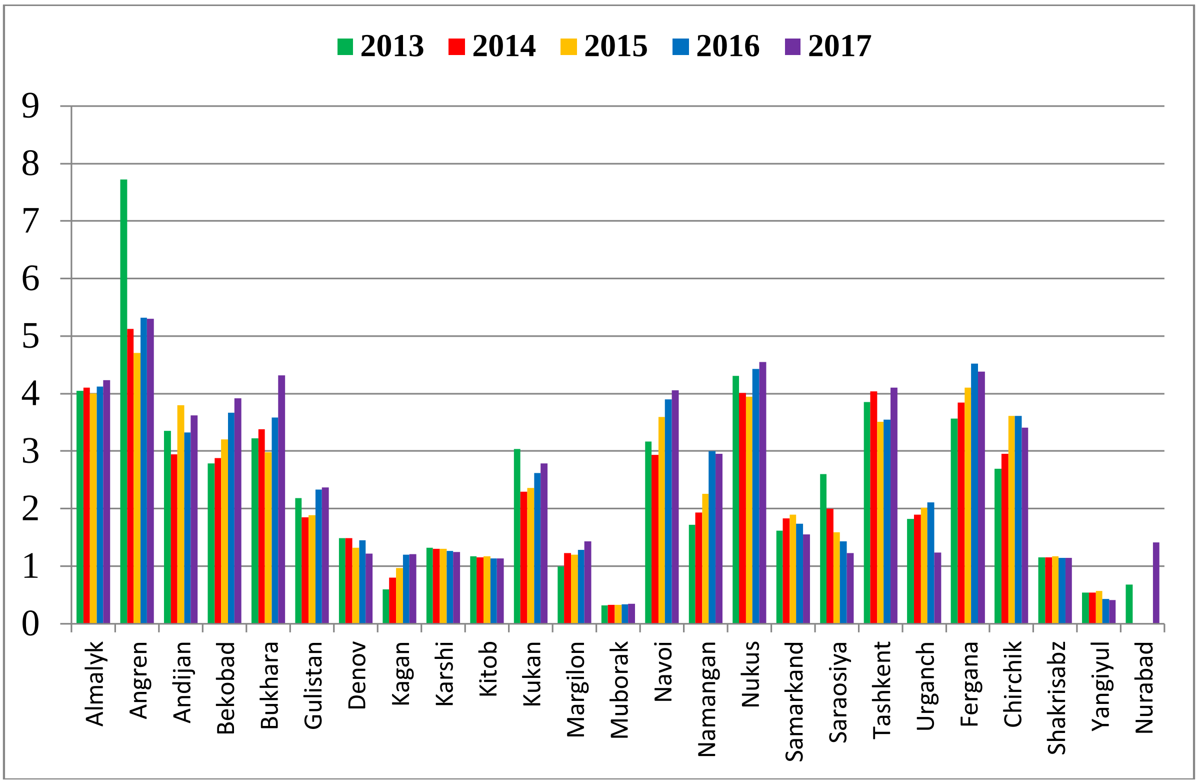


Fig 5. - Indexes of atmospheric pollution index (API) for cities of the Republic of Uzbekistan for the last 5 years (2013-2017)

In other cities of the republic, an increased IAP was not observed. It can be assumed that these indicators were achieved as a result of measures to reduce harmful emissions into the atmosphere through the construction and reconstruction of capture and dust-cleaning systems of individual workshops and production.

Emissions of pollutants consist of two components: stationary and moving sources. At the same time, information on emissions from stationary sources uses data from state statistical reporting, and emissions of pollutants from moving sources are calculated on the basis of the amount of fuel consumed by vehicles in circulation in the country.

For the period from 2005 until 2011, emissions of major pollutants from stationary sources increased: carbon monoxide by 7.1%, nitrogen oxides by 45%, and hydrocarbons by 89% (Table 3). However, it should be noted that relative to 2005, the volumes of sulphur dioxide and solid particles entering the atmosphere are characterized by a decrease (by 5.1% and 3.1% respectively). Most of the pollutant emissions from stationary sources are related to the fuel and energy complex and metallurgical industry, contributing to total emissions on average 65 and 14%, respectively.

Fig. 3

Emissions of atmospheric pollutants from stationary sources in the Republic of Uzbekistan in 2005-2011.

Harmful substances	Emissions of harmful substances, thousand tons per year						
	2005 г.	2006 г.	2007 г.	2008 г.	2009 г.	2010 г.	2011г.
Carbon monoxide	61,92	49,42	58,131	64,455	60,292	62,486	66,287
Sulphur dioxide	266,721	213,787	237,479	212,698	214,927	229,72	253,115
Nitrogen oxides	57,541	54,713	63,883	68,172	56,681	52,353	83,418
Hydrocarbons	144,191	150,086	233,492	263,708	236,676	273,331	272,601
Solids	112,306	75,388	109,013	100,766	109,358	99,599	108,775
Including:							
Cadmium	-	-	-	-	-	-	-
Lead	0,0022	0,0031	0,0025	0,0039	0,004	0,003	
Mercury	-	-	-	-	0,001	-	
Other	39,013	39,542	35,9	13,803	12,006	11,212	3,920
Including:							
Ammonia	2,334	2,312	2,447	2,575	2,671	4,910	
Hydrogen fluoride	0,073	0,072	0,061	0,037	0,035	0,039	
TOTAL:	681,692	582,936	737,898	723,602	691,940	728,701	788,116

Source: State Committee of the Republic of Uzbekistan on Ecology and Environmental Protection (http://www.uznature.uz/).

In Uzbekistan, main part of motor vehicles in the total amount of anthropogenic emissions makes more than 60%. In a number of large cities, such as Tashkent, Samarkand, Bukhara, Fergana, more than 80% of the total emissions come from moving sources. First, it is connected with the growth and concentration of individual vehicles in cities. Secondly, the operation of vehicles is often associated with violations of environmental safety in the Republic. If from 1996 to 2000 there was an increase in pollutant emissions from 1,316 thousand tons to 1,593 thousand tons, then from 2011 there is an annual reduction in emissions from motor transport by an average of 3-5%.

In the Republic, measures are implemented on the transfer of motor automobiles to alternative fuels. Currently, automobiles are being successfully converted to compressed natural gas and liquefied petroleum gas. Emissions of pollutants from moving sources have been decreasing since 2008 (Figure 6).

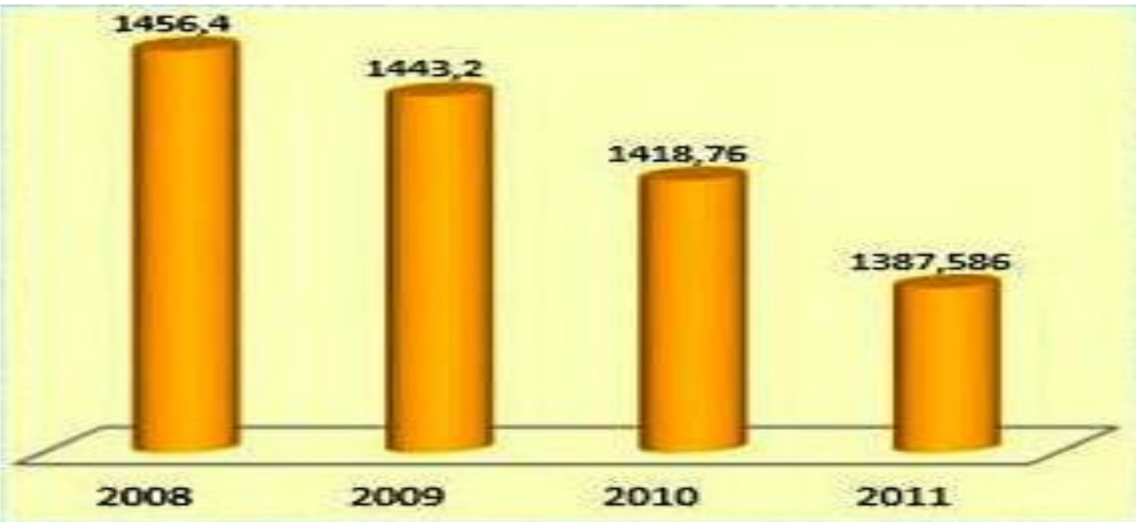


Fig. 6 Emissions of pollutants into the atmosphere from automobiles in the Republic of Uzbekistan in 2008-2011

In terms of regions, the largest amount of emissions from moving vehicles falls on Tashkent, the Tashkent and Fergana regions, and the smallest to the Sirdarya and Djizak regions (Fig. 7).

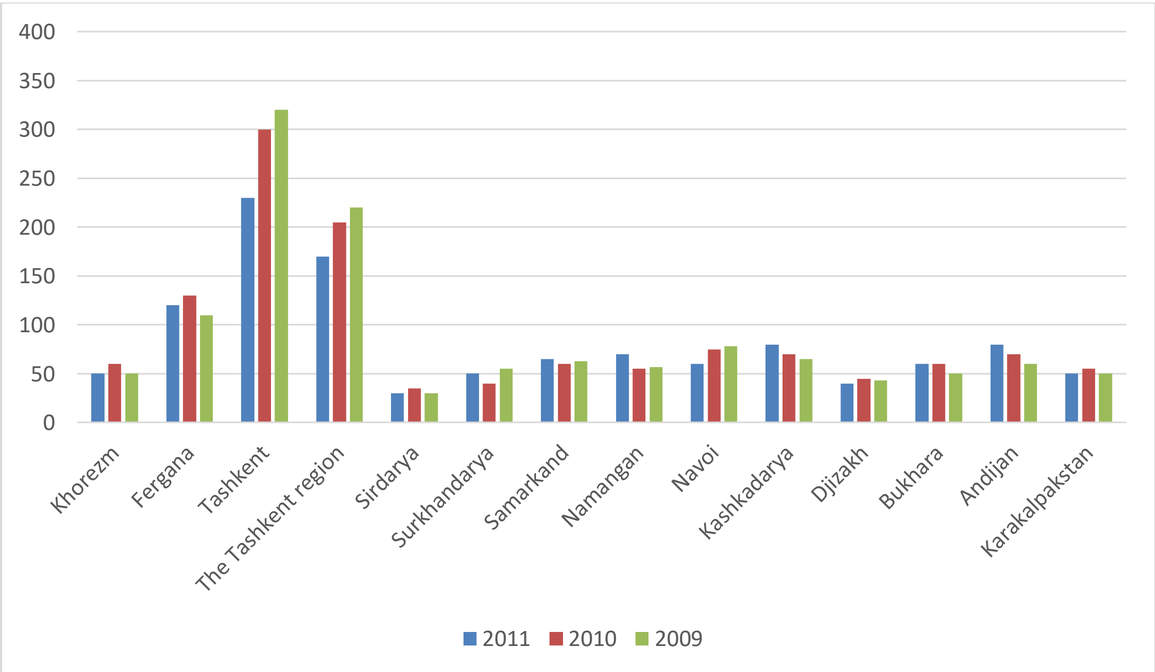


Fig.7. Emissions of pollutants to the atmosphere by region of the Republic of Uzbekistan in 2009-2011

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The total emissions of acidifying pollutants SO2 and NOx, produced by stationary and moving sources, decreased from 584.282 thousand tons (2000) to 447.035 thousand tons (2012), i.e. by 23% (Fig. 8).

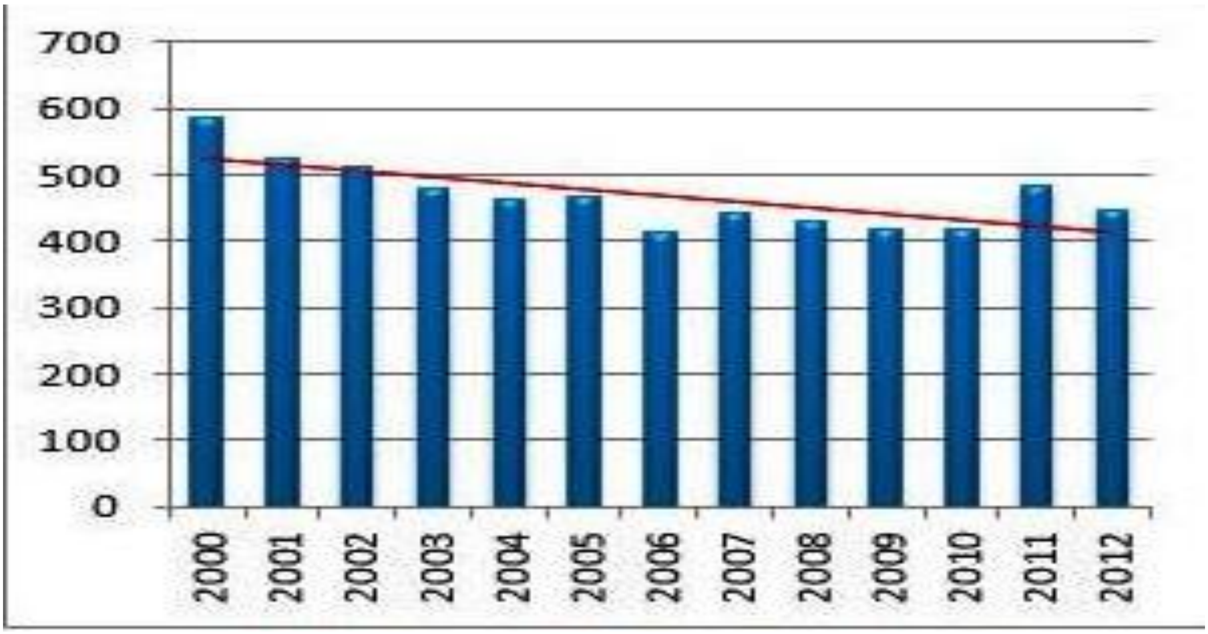

Fig.8. Total emissions of pollutants (SO2 and NO) to the atmosphere of the Republic of Uzbekistan in 2000-2012

Over the past twenty-five years there has been a trend of reducing harmful substances from stationary sources (from 1.3 to 0.7 million tons) [6].

These indicators are achieved as a result of measures to reduce harmful atmospheric emissions at the largest enterprises of the Republic in the cities of Almalyk (AGMK), Bekabad (APO Uzmetkombinat), Navoi (cement plant, NMMC) through the construction and reconstruction of capture systems and dust-gas cleaning systems of individual shops and production in accordance with the decision of the Government dated October 20, 1999 No. 469 "Program of Actions for the Environmental Protection of the Republic of Uzbekistan for 1999-2005", according to which:

- measures were carried out on the implementation of oxy-bubble smelting at OJSC “AGMK” (in KBP-2), when it is expected to reduce emissions of pollutants by 119.033 thousand tons;

- reconstruction of dust collection and purification systems from electric arc furnaces at the Uzmetkombinat AJCP was completed. The new electric steel-smelting furnace DSP-100 UMC started operation together with the integrated steel processing unit. As a result, pollutant emissions were reduced by more than 900 tons;

- reconstruction and modernization of foundry air purification systems at the machine-building plant of the NMMC in Navoi was carried out, dust and gas-cleaning equipment was put into operation in the foundry. The annual emissions of pollutants into the atmospheric air decreased after the installation of FDA-20 by 24.8 tons per year, and PVMS-40 by 48 tons per year;

- a control system for burning fuel in rotary kilns at the Navoi cement plant was installed with gas detectors installed on carbon monoxide, sulfur and nitrogen oxides. As a result, a reduction of pollutant emissions into the atmosphere by 80 tons per year was achieved.

Alongside with mentioned above, work continues in the republic on the transfer of motor vehicles to alternative fuels. Currently, the adaptation of vehicles to compressed natural gas and liquefied petroleum gas is being successfully carried out.

Conclusion

The analysis of the UzHydromet data on the state of atmospheric air determined the following:

- The state of atmospheric air in the cities of Uzbekistan is quite good, where the average annual concentrations of the main pollutants in most cities are below the PC. Excess rates for one or two pollutants were recorded only in some cities;
- In almost all cities of the country, the atmospheric pollution index is characterized as "low" (API is less than 5). Increased IAP values (more than 5) were noted only in 2014, 2016-2017 in the atmospheric air of Angren;
- The average content of sulfur dioxide and carbon monoxide in all localities of the Republic of Uzbekistan does not exceed Threshold Level Value continuous exposure (TLVCE);
- Throughout the analyzed period, the level of atmospheric dust pollution was noted in the cities of Bukhara, Urgench, Nukus, that is associated with natural and climatic conditions;
- as a result of taking air protection measures carried out by enterprises and organizations of the Republic, emissions of pollutants in the country, as a whole, were reduced by 34,876 thousand tons. Due to the implementation of measures on stationary sources of emissions into the atmosphere, emissions decreased by 13,439 thousand tons, on mobile sources - by 21,439 thousand tons.

Assessing the sanitary condition of the air in populated areas of Uzbekistan, it should be noted that, despite the reduction in gross emissions of pollutants, it is not accompanied by stabilization and, especially, improvement in the quality of atmospheric air.

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