Air pollution in Penza and its impact on the human health

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Abstract. Atmospheric air is a vital component of the natural environment, an integral part of the habitat of humans, plants, and animals. Atmospheric air is the most significant component (factor) of the human environment, the pollution of which has a pronounced impact on human health and all living things. Most large cities are characterized by extremely high and intense air pollution compared to small towns and villages. On the majority of polluting agents, it is possible to tell with confidence that they, as a rule, exceed maximum permissible concentrations. We will consider the city of Penza as an example.

1. Introduction
The assessment of air pollution levels is expressed through the concentration of impurities by comparing it with hygienic standards. The most common criteria for assessing air quality are the maximum permissible concentrations (MPC) of harmful substances in the environment.

The maximum permissible concentration is the maximum concentration of harmful substances in the air, above which the negative impact on human health and the environment is noted [1].

Most large cities are characterized by intense air pollution. From the impact of most pollutants, it can be said that they tend to exceed the maximum permissible concentrations [2].

As far as the city is concerned, Penza was one of the cleanest cities in the Volga region 15-20 years ago. To a large extent, this was due to both environmental protection measures and historical national economic, and natural features.

In most of our territory, where there are little transport and industrial facilities, the air is clean. The exceptions are major cities such as Penza, Kuznetsk, and Nikolsk. The atmosphere in them is polluted by large factories and, increasingly, by motor vehicles. Residents of Suvorov, Volodarsky, Bakunin, Pushkin, Kirov, and Kalinin streets are particularly affected by exhaust gases.

Air pollution has a large impact on the health of the urban population. The deterioration of the health of urban residents is not only an indicator of the city's ecological condition but also its most important social and economic consequence, which should define the leading directions for improving the quality of the environment [3].

Air pollution in Penza has increased the number of people suffering from cardiovascular diseases, respiratory diseases, allergies, and oncology [2,4,5]. The deteriorating health of the city's residents is not only an indicator of the city's ecological condition but also it's most important social and economic consequence, which should define leading directions for improving the quality of the environment [1,6].
2. Materials and methods
Observations of air pollution in the city of Penza are carried out at four stationary Public Observation Service (POS) stations:

- 14a Tsentralnaya Street – pollution monitoring station (PSN) No. 1;
- the intersection of Dolgova Street and Chekhov Street – EOR No. 3;
- intersection of Belyaeva Street and Rogatka Street – EOR No. 7;
- 37a Stroiteley Avenue – PEZ No. 8.

The degree of air pollution is measured by a dimensionless value called the Air Pollution Index (APCI). The Air Pollution Index is calculated for the five most common harmful substances (dust, sulfur dioxide, carbon monoxide, nitrogen dioxide, and formaldehyde), taking into account their hazard class, quality standard, and average air pollution levels.

Under the existing assessment methods, the level of pollution is considered:

- low if IZA is below 5,
- increased at IZA from 5 to 6,
- high at IZA from 7 to 13,
- very high at IZA over 13.

Penza High Air Pollution Index: IZA5 = 8.9.

3. Results and discussion
According to the state report on natural resources and environmental protection of the Penza region in 2014-2017, the city of Penza has many sources of air pollution (solid, liquid and gaseous). The region's enterprises emit over 300 harmful pollutants into the atmosphere, such as sulfur dioxide, carbon and nitrogen oxides, hydrocarbons and other toxic substances. The most powerful stationary sources of atmospheric air pollution are companies in the energy industry (up to 40% annually in recent years), machine building (up to 10%), the building materials industry (up to 8%), the food industry (up to 20%) and the timber industry, most of which are concentrated in large settlements. In recent years there has been a general trend towards their decline.

In 2014, there was a reduction in emissions from stationary sources, while emissions from vehicles increased slightly. This burden falls mainly on the region's major cities, where main streets were built up several centuries ago and are now unable to pass through all transport, creating traffic jams in which cars are standing in a way that dramatically increases the emission of pollutants into the air.

The main contribution to emissions from stationary sources in 2014 was made by companies in the following economic activities: mechanical engineering, instrumentation, building materials, woodworking, medical instrumentation and medicine, and thermal power plants.

The treatment facilities of the city's enterprises captured and neutralized 4,3 thousand tons of air pollutants, of which 3,4 thousand tons were utilized.

The main contribution to the volume of pollutant emissions from stationary sources in 2014 was made by the following economic activities:

- Transportation of gas and its refined products through pipelines;
- Electricity and heat generation and distribution;
- Production of food products, including drinks and tobacco;
- Production of crude oil and petroleum gas.

In 2014, the purification facilities of the region's enterprises received 22,3 thousand tonnes of pollutants or 50,4% of all stationary sources, and 22,0 thousand tonnes (49,6%) were released into the
atmosphere without treatment. The amount of captured pollutants was 99% of the total amount of pollutants received at the treatment facilities. The number of captured pollutants was 98% in 2013, while in 2015 it was 99% and 91%.

During 2014, the air condition at 53 sites was examined. Measurements were made at 172 sites, where 633 samples were taken and 633 analyses were carried out.

About 2 million was spent by enterprises and organizations in the region on measures to reduce air pollutant emissions.

The leading air pollutants above the maximum permissible factors are nitrogen dioxide, sulfur, carbon, suspended solids and formaldehyde.

In 2013-2014, 3936 samples were taken in the Penza Region, of which 153 (3.9%) did not meet sanitary requirements. The following substances were found to exceed the MPC up to two times: nitrogen, sulfur and carbon dioxide, suspended solids, lead, formaldehyde; exceeding five MPCs – two suspended solids samples in 2013.

In 2015, Penza may be classified as a risk area for high levels of air pollution. Up to 500 thousand residents of the regional center are exposed to harmful substances that exceed hygienic standards (maximum one-time MPC).

A survey of the enterprises was conducted to check compliance of their emissions to the regional air pollution standards. Air with approved maximum permissible standards, as well as checks on the efficiency of the dust and gas treatment plants (PGU) used. Several enterprises were surveyed to clarify actual air emissions to develop draft maximum allowable emission standards (MPE).

A decrease in cleaning efficiency is caused by irregularities in operation technology (untimely cleaning, non-sealing and other malfunctions), as well as low initial concentration of pollutants due to reduced loading of the equipment being maintained.

The main reason for the increase in emissions is the large volume of repair work on the region's gas pipelines.

Over the period 2013-2015, the specific gravity of air samples that do not meet hygienic standards has decreased from 2% to 0,2% in the Penza Oblast as a whole. Between 2014 and 2016, the proportion of samples that do not meet hygienic standards decreased from 2% to 0,1% in urban areas and from 0,8% to 0,5% in rural areas.

The main contribution to the volume of pollutant emissions from stationary sources in 2016 was made by enterprises of the following economic activities: transportation of gas and its products by pipelines, generation and distribution of electricity and heat, production of food products, including beverages and tobacco, production of crude oil and petroleum gas.

In 2016, the air basin of Penza Region received 33,5 thousand tonnes of pollutants (17,9% more than in 2013) from 16166 stationary sources available to 341 enterprises (legal entities and individual entrepreneurs) that were subject to accounting. Emissions of solids increased 2,7 by times (by 5,600 tonnes), gaseous and liquids by 2% (by 0,5 thousand tonnes). The Company's treatment facilities received 224,900 tonnes of pollutants or 8,4% of the total amount of pollutants from all stationary sources, and 26,600 tonnes (10,6%) were released to the atmosphere without treatment. The catch rate of emissions received for purification was 97% and the utilization rate of captured substances – 96% (corresponding figures for 2015 – 98% and 78%).

The most significant emissions of pollutants into the atmosphere have been recorded at the following economic activities: transportation of gas and its products through pipelines (8,4 thousand tonnes); cement, lime and gypsum production (6,2 thousand tonnes); production of food products, including beverages and tobacco (2,6 thousand tonnes); production, transmission and distribution of electricity (2,2 thousand tonnes); collection and processing of other wastes (2,1 thousand tonnes) and production, transmission and distribution of steam and hot water (1,7 thousand tonnes) [4].

The contribution of emissions to the atmosphere indicates an increasing influence of mobile sources on air quality according to the State Reports in 2016 and 2017. Motor vehicles play a significant role in atmospheric air pollution, accounting for approximately 70% of all carbon monoxide emissions.
In the cities of the Penza Region, the condition of the air is monitored on the streets with heavy traffic in the residential development area. In 2014, 954 studies were conducted, of which 0.2% did not meet hygienic standards. Over the 3 years from 2014 to 2016, the proportion of air samples not meeting hygienic standards on streets with heavy traffic decreased from 8.8% in 2014 to 0.2% in 2015.

The condition of atmospheric air at the border of sanitary protection zones and residential areas of 34 facilities was examined. At the same time, 221 samples were taken and 273 analyses were carried out.

The reasons for exceeding the standards are a decrease in the efficiency of dust and gas trapping installations and a violation of technological regimes (application of source materials and loads not provided for in the development of MAE, as well as an increase or decrease in the volume of gas and air mixture removed, suction or beating out when PGU is leaky).

The state of air pollution in Penza in 2017 did not improve compared to the previous year. The air basin of the Penza Region received 38,9 thousand tonnes of pollutants (16.1% more than in 2016) from 16197 stationary sources subject to accounting. Emissions of solids increased by 38.1% (by 3.4 thousand tonnes), gaseous and liquid emissions by 8.1% (by 2 thousand tonnes). The Company's treatment facilities received 332,600 tonnes of pollutants or 92% of all stationary sources, while 28,700 tonnes (8%) were released into the atmosphere without treatment. The catch rate of emissions received for purification was 97% and the catch rate was 98.8% (the corresponding figures for 2015 were 97% and 96.4%).

The most significant volumes of emissions of pollutants into the atmosphere have been noted at the following types of economic activities: transportation of gas and its products through pipelines (10 thousand tonnes); production of non-metallic mineral products (9.9 thousand tonnes); production of food products, including beverages and tobacco (2.6 thousand tonnes); production, transmission and distribution of electricity (2.4 thousand tonnes); waste collection and treatment (2.1 thousand tonnes); production, transmission and distribution of steam and hot water (1.9 thousand tonnes). The results of hygienic monitoring served as the basis for analyzing the current situation and establishing priority indicators of air pollution in various cities of the Penza Region and was became from the State Report on State of Natural Resources and Environmental Protection of the Penza Oblast in 2017.

Most enterprises have been reducing their emissions in recent years, mainly as a result of reduced production and installation of cleaning equipment. However, in addressing the problems of environmental management we have to proceed from the recognition that it is impossible to completely prevent the impact on the natural environment at present and in the foreseeable future, even if production and other areas of human activity are improved [6,7].

Therefore realization of the system of the measures directed on maintenance of rational interaction between the activity of the person and the environment, providing preservation and restoration of natural resources should take first place.

Penza's industrial enterprises annually emit more than 50% of the total amount of pollutants into the atmosphere in the region.

Over the period 2015-2017, the specific gravity of air samples that do not meet hygienic standards decreased from 0.6% to 0.2% in Penza Oblast as a whole. The proportion of samples not meeting hygienic standards decreased from 0.3% to 0.2% in urban settlements and from 2.4% to 1.2% in rural settlements.

For the city of Penza in 2017, all samples met hygienic standards. Compared to 2016, all samples met hygienic standards.

In 2016, the specific gravity of samples in the city Penza decreased from 0.3% to 0%.

Over the 3 years from 2015 to 2017, there has been a downward trend in the proportion of air samples not meeting hygienic standards on heavy traffic streets from 1.1% in 2014 to 0% in 2016 [3].

390 surveys have been conducted in Penza, of which all samples are in compliance with the following criteria to hygienic standards. This is due to the significant renewal of the vehicle fleet over the last year, which has a markedly lower contribution to air pollution.
At 116 enterprises in the Penza region, laboratory monitoring of atmospheric air research at the borders of sanitary protection zones is conducted. 5,954 air tests have been carried out on the borders of sanitary protection zones, of which 0.2% do not meet hygienic standards.

Penza Region is considered to be a relatively prosperous Russian region in terms of the number of pollutant emissions into the atmosphere. The insignificant level of pollutant emissions into the atmosphere is due to the consistently low volumes of products manufactured by industrial facilities and the sufficient ecological efficiency of city facilities.

Environmental problems in the Penza Region are mainly related to the concentration of major sources of air emissions in a relatively limited area, including industrial enterprises of power engineering, mechanical engineering, industry and construction materials, and food industry.

The air is adversely affected by periodic mass incineration in autumn and spring, during traditional cleaning operations.

Penza is considered to be a relatively prosperous Russian city in terms of the number of pollutant emissions into the atmosphere. The annual amount of pollutants entering the city air from stationary sources is about fourteen kilograms per inhabitant. In terms of emissions of solid pollutants and the dynamics of emissions, Penza is classified as an “ecologically clean” region. The insignificant level of pollutant emissions into the atmosphere is due to the consistently low volumes of industrial output and the sufficient ecological efficiency of city facilities. Specialists predict that insignificant volumes of emissions to the atmosphere will remain at the same level due to funds invested in environmental protection measures. Penza is among the leaders in terms of investment in environmental improvement. The transport situation in the city, despite the relatively high level of motorization of the population, is not critical. Most car owners prefer to use public transport or get to work on foot. Public transport in Penza is trolleybuses, buses and taxis [6,8].

Most companies have been reducing their emissions in recent years, mainly due to reduced production and the installation of efficient cleaning equipment. However, when addressing environmental management problems, we have to proceed from the recognition that it is impossible to completely prevent the impact on the natural environment now and in the foreseeable future, even if production and other areas of human activity are improved [2,8].

4. Conclusions
Thus, in urban conditions, people are affected by a complex of pollutants in various concentrations, and to ensure environmental safety and reduce the risk of the population living in an urbanized area, reliable information on the state of the air is required. This will enable more targeted use of financial resources to improve the environmental situation in the city and prevent further growth of pollution levels.

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