

PAPER • OPEN ACCESS

## Atmospheric pollution in cities of Russia: statistics, causes and characteristics

To cite this article: A Petrov and D Petrova 2017 *IOP Conf. Ser.: Earth Environ. Sci.* **72** 012007

View the [article online](#) for updates and enhancements.

You may also like

- [Shared mobility and lifestyles as mechanisms to reduce environmental impacts from passenger transportation](#)  
Ana María Arbeláez Vélez, Diana Ivanova and Konstantin Stadler
- [Edutourism development model in unesco global geopark ciletuh palabuhanratu sukabumi district](#)  
R Arrasyid, F Urfan, Darsiharjo et al.
- [Global anthropogenic emissions in urban areas: patterns, trends, and challenges](#)  
Monica Crippa, Diego Guizzardi, Enrico Pisoni et al.



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

# Atmospheric pollution in cities of Russia: statistics, causes and characteristics

**A Petrov<sup>1</sup> and D Petrova<sup>2</sup>**

<sup>1</sup> Tyumen Industrial University, 72 Melnikaite str., Tyumen, 625000, Russian Federation

<sup>2</sup> Ural Federal University named after the first President of Russia B. N. Yeltsin, 16a Chapaev str., Ekaterinburg, 620002, Russian Federation

E-mail: ArtIgPetrov@yandex.ru

**Abstract.** The article considers the issues of air pollution assessment in Russian industrial regions (2014) and cities (2012). The statistical data is presented both in terms of absolute emissions of pollutants into the atmosphere of Russian cities and relative air pollution calculated for 1 average statistical inhabitant. Classifications of the ecological state of Russian cities on the basis of specific (per inhabitant) air pollution and the air pollution by predominant type source (stationary or non-stationary) are proposed.

## 1. Introduction

A simple idea that sustainable economic development is only possible through continuous improvement of production technology of the gross domestic product closely linked to the concept of technological paradigm, i.e, aggregate of conjugate productions that have a comparable scientific and technological level and develop synchronously.

Today, in the majority of industrialized countries manufacturing industry of the fifth technological stage reached maturity phase, and an urgent task are practical problems of development and production relating to the sixth technological stage. At the same time all around the world, including Russia, there are still existing and functioning productions, based on the achievements not only of the fifth, but the second and the third and the fourth technological stages. It is mainly the steel industry, heavy machinery, petrochemistry. Typically, the geographical location of such enterprises is localized and there are whole clusters of urban areas, with a common history and similar trends and development issues. Vivid examples of such clusters in Russia may be Ural and Kuzbass.

One of the most problematic features of the people living in these regions is a bad environment [1]. Significant parameters of environmental pollution, mainly – from stationary sources [2, 3], are inherent for the entire districts of Sverdlovsk regions, Chelyabinsk regions, Kemerovo regions. Of course, in recent years much has been done to improve the environmental situation in the industrialized regions of the country. Many industries, especially the sphere of mining and processing and metallurgical production, are equipped with filters and cleaning systems of emissions. In general we can say that in recent years in Russian cities emissions of pollutants into the environment has decreased significantly. However, the problem is not completely solved. Emissions of contaminants into the atmosphere in many industrial cities remain relatively high. And in the cities, where the industrial environment has more favorable situation, today the role of the main pollutant of the atmosphere performs road transport [4, 5].



In this article issues of the industrial regions and cities of Russia ranking in terms of “Absolute values of pollutants emissions” and “Unit (per person per year) emissions of pollutants” are considered.

## 2. Basic data

In [6] shows chronologically the most actual statistics, characterizing the actual emissions of pollutants into the atmosphere in the most problematic territories (total 34 areas) from the position of ecology in cities and industrial regions of Russia in 2014.

On the basis of the data [6] table 1 is made up. Commenting on the data of Table 1 it should be noted that for the comparative assessment of the environmental situation in the cities of the country, with different area, population and other characteristics, it is necessary to use specific indicators, such as “Specific emissions of pollutants (per pers. per year)” SEP (1):

$$SEP = \text{Specific emissions of pollutants} = \left[ \frac{\text{Emission of pollutants} - \text{total}}{\text{Population}} \right], \quad (1)$$

where *Specific emissions of pollutants* – Specific emissions of pollutants, tons/pers./year;

*Emissions of pollutants – total* – Emissions of pollutants – total, thousands, tons/year;

*Population* – Population (2014), pers.

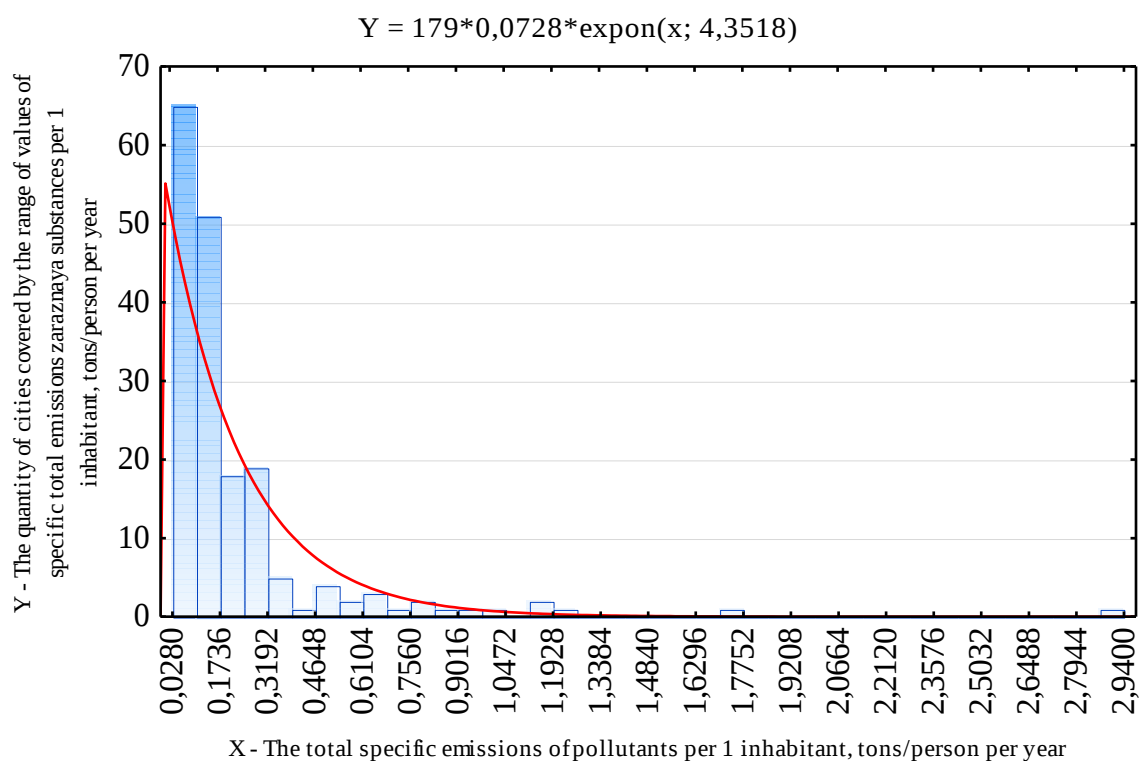
**Table 1.** The ranking of cities of the Russian Federation in terms of actual emissions of pollutants into the atmosphere (2014) [6]

| No. of ranking | Cities and industrial areas of Russian Federation | Population (2014), pers. | Emissions of pollutants – total, thousands, tons/year | Specific emissions of pollutants, tons/pers./year |
|----------------|---------------------------------------------------|--------------------------|-------------------------------------------------------|---------------------------------------------------|
| 1              | Norilsk                                           | 176559                   | 1841.3                                                | 10.428                                            |
| 2              | Reftinskiy industrial area                        | ≈ 66800                  | 315.8                                                 | 4.727                                             |
| 3              | Cherepovets                                       | 316758                   | 313.7                                                 | 0.990                                             |
| 4              | Lipetsk                                           | 509719                   | 291.1                                                 | 0.571                                             |
| 5              | Usinsk                                            | 39831                    | 289.8                                                 | 7.275                                             |
| 6              | Novokuznetsk industrial area                      | ≈ 600000                 | 276.4                                                 | 0.461                                             |
| 7              | Magnitogorsk industrial area                      | ≈ 633700                 | 227.7                                                 | 0.359                                             |
| 8              | Vorkuta                                           | 61638                    | 191.1                                                 | 3.100                                             |
| 9              | Omsk                                              | 1166092                  | 174.3                                                 | 0.149                                             |
| 10             | Ufa                                               | 1096702                  | 148.2                                                 | 0.135                                             |
| 11             | Nizhny Tagil                                      | 357280                   | 145.7                                                 | 0.407                                             |
| 12             | Chelyabinsk industrial district                   | ≈ 1250000                | 140.2                                                 | 0.112                                             |
| 13             | Krasnoyarsk                                       | 1035528                  | 129.8                                                 | 0.125                                             |
| 14             | Bratsk                                            | 238825                   | 119.3                                                 | 0.499                                             |
| 15             | Novocherkassk                                     | 173464                   | 108.7                                                 | 0.627                                             |
| 16             | Astrakhan                                         | 530863                   | 104.4                                                 | 0.196                                             |
| 17             | Novosibirsk                                       | 1547910                  | 102.6                                                 | 0.066                                             |
| 18             | Mezhdurechenskiy industrial area                  | ≈ 110000                 | 100.8                                                 | 0.916                                             |
| 19             | Kachkanarsky industrial area                      | 40260                    | 77.8                                                  | 1.932                                             |
| 20             | Myskoskiy industrial area                         | ≈ 43000                  | 70.2                                                  | 1.632                                             |
| 21             | Kaltanskiy industrial area                        | ≈ 22000                  | 69.2                                                  | 3.145                                             |
| 22             | Irkutsk                                           | 612973                   | 68.0                                                  | 0.111                                             |

| No. of ranking | Cities and industrial areas of Russian Federation | Population (2014), pers. | Emissions of pollutants – total, thousands, tons/year | Specific emissions of pollutants, tons/pers./year |
|----------------|---------------------------------------------------|--------------------------|-------------------------------------------------------|---------------------------------------------------|
| 23             | Novotroitsk                                       | 93578                    | 65.5                                                  | 0.700                                             |
| 24             | Serov industrial area                             | 106572                   | 65.3                                                  | 0.612                                             |
| 25             | Verkhneufaley industrial area                     | 33366                    | 64.0                                                  | 1.918                                             |
| 26             | Polysayevskiy industrial area                     | ≈ 29500                  | 63.7                                                  | 2.159                                             |
| 27             | Tula                                              | 490508                   | 62.7                                                  | 0.127                                             |
| 28             | Belovsky industrial area                          | ≈ 75000                  | 62.5                                                  | 0.833                                             |
| 29             | Surgut                                            | 332313                   | 57.5                                                  | 0.173                                             |
| 30             | Kostomuksha industrial area                       | 29586                    | 56.0                                                  | 1.892                                             |
| 31             | Sterlitamak                                       | 277048                   | 53.8                                                  | 0.194                                             |
| 32             | Troitsky industrial district                      | 77176                    | 53.8                                                  | 0.697                                             |
| 33             | Nazarovo                                          | 51437                    | 51.2                                                  | 0.995                                             |
| 34             | Stary Oskol industrial area                       | 257128                   | 51.0                                                  | 0.198                                             |

More extensive information about specific (per pers. per year) emissions of air pollutants in the cities of Russia is shown in [7] as in 2012. It should be noted that this document provides information on the actual specific emissions (t/pers./year) in an atmosphere of 180 cities of the Russian Federation.

Figure 1 shows a histogram of the distribution of cities in Russia (2012) in groups depending on the value of specific total emissions of air pollutants per inhabitant per year.



**Figure 1.** The histogram of distribution of cities in Russia (2012) in groups depending on the value of specific total emissions of air pollutants per inhabitant per year

### 3. Results and Discussion

Analysis shows that the cities can be classified into groups depending on the value of this parameter (table 2).

**Table 2.** The frequency characteristic of Russian cities classification (2012) on the basis of “Specific total emissions of air pollutants per inhabitant per year”

| Indicator                   | Groups of cities on the basis of “Specific total emissions of air pollutants per inhabitant per year”, tons/pers./year |             |             |             |         |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------|-------------|-------------|-------------|---------|
|                             | I                                                                                                                      | II          | III         | IV          | V       |
| Range of values             | 0.028–0.100                                                                                                            | 0.101–0.173 | 0.174–0.246 | 0.247–0.319 | > 0.319 |
| Quantity of cities in group | 65                                                                                                                     | 52          | 18          | 18          | 27      |

Almost two thirds of the number of examined cities (117 of 180) refer to classification groups I and II, i.e. to relatively safe from the point of city ecology. At the same time the existence of large number of cities, where for 1 person annually 200 kg or more air pollutants are thrown is a demonstrative example of complex environmental situation.

Table 3 shows the rating of Russian cities with the most polluted atmosphere. Analysis of the table 3 data shows that in 2014 in some Russian cities some progress in reducing the emission of pollutants into the atmosphere has been achieved. Thus, positive changes were observed in almost all the cities of the Russian Federation, for which there is relevant statistics, with the exception of Vorkuta. At the same time, emissions statistics in Norilsk is so shocking that the positive developments in 2014 in comparison with 2012 seem to be very insignificant.

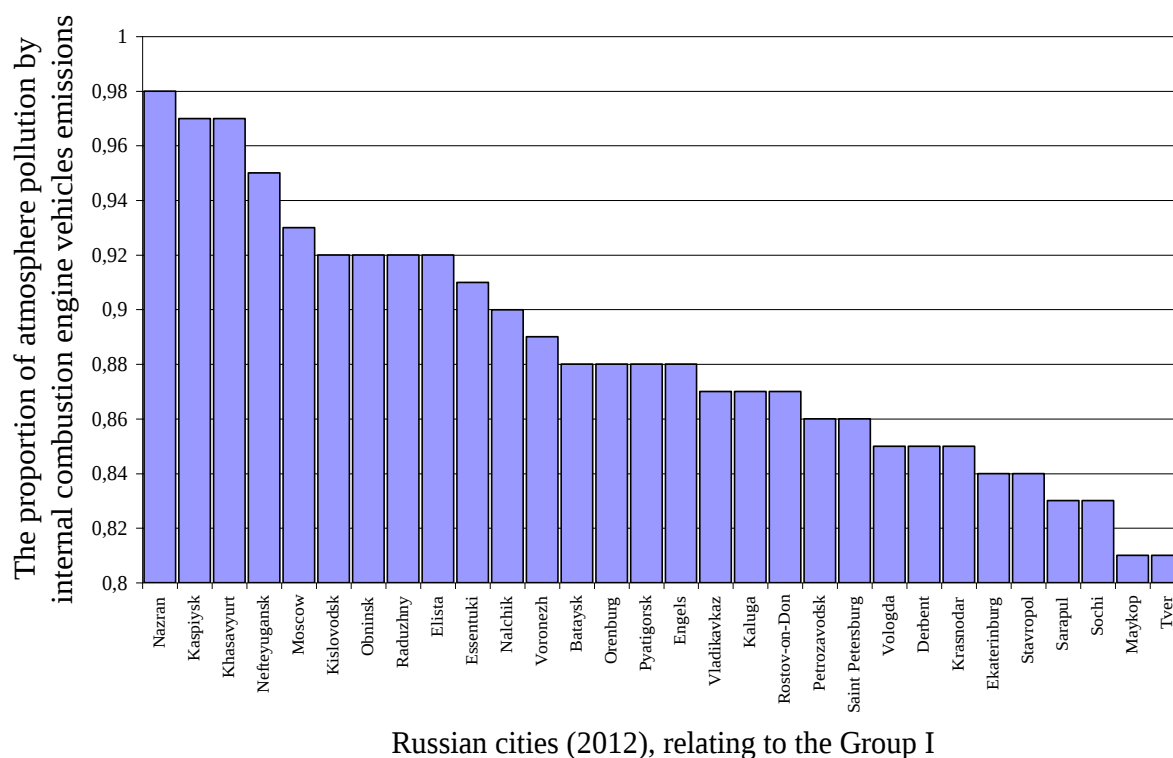
**Table 3.** The ranking of Russia's most polluted cities (2012/2014) in terms of “Specific total emissions of air pollutants per inhabitant per year” (Group V in 2012) [6, 7]

| No. of ranking | Russian city of group V in environmental classification | Value of indicator “Specific total emissions of air pollutants per inhabitant per year”, tons/pers./year |         |
|----------------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------|
|                |                                                         | 2012                                                                                                     | 2014    |
| 1              | Norilsk                                                 | 11.054                                                                                                   | 10.428  |
| 2              | Vorkuta                                                 | 2.940                                                                                                    | 3.100   |
| 3              | Krasnouralsk                                            | 1.707                                                                                                    | No data |
| 4              | Angarsk                                                 | 1.198                                                                                                    | No data |
| 5              | Cherepovets                                             | 1.158                                                                                                    | 0.990   |
| 6              | Krasnoturinsk                                           | 1.156                                                                                                    | No data |
| 7              | Novodvinsk                                              | 1.042                                                                                                    | No data |
| 8              | Monchegorsk                                             | 0.907                                                                                                    | No data |
| 9              | Rezh                                                    | 0.864                                                                                                    | No data |
| 10             | Serov                                                   | 0.797                                                                                                    | 0.612   |
| 11             | Novocherkassk                                           | 0.774                                                                                                    | 0.627   |
| 12             | Zarinsk                                                 | 0.735                                                                                                    | No data |
| 13             | Lipetsk                                                 | 0.636                                                                                                    | 0.571   |
| 14             | Magnitogorsk                                            | 0.624                                                                                                    | 0.359   |
| 15             | Kstovo                                                  | 0.614                                                                                                    | No data |
| 16             | Novokuznetsk                                            | 0.584                                                                                                    | 0.461   |
| 17             | Bratsk                                                  | 0.553                                                                                                    | 0.499   |
| 18             | Orsk                                                    | 0.517                                                                                                    | No data |

| No. of ranking | Russian city of group V<br>in environmental classification | Value of indicator “Specific total<br>emissions of air pollutants per inhabitant<br>per year”, tons/pers./year |         |
|----------------|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|---------|
|                |                                                            | 2012                                                                                                           | 2014    |
| 19             | Achinsk                                                    | 0.514                                                                                                          | No data |
| 20             | Okha                                                       | 0.510                                                                                                          | No data |
| 21             | Noyabrsk                                                   | 0.477                                                                                                          | No data |
| 22             | Nizhny Tagil                                               | 0.415                                                                                                          | 0.407   |
| 23             | Anadyr                                                     | 0.392                                                                                                          | No data |
| 24             | Gubkin                                                     | 0.378                                                                                                          | No data |
| 25             | Stary Oskol                                                | 0.363                                                                                                          | 0.198   |
| 26             | Artem                                                      | 0.337                                                                                                          | No data |
| 27             | Surgut                                                     | 0.331                                                                                                          | 0.173   |

Researcher of urban environment atmosphere is interested in the question of the source of contamination. All sources can be classified into stationary and mobile (vehicles) [8]. Information about sources of pollution in urban areas has been obtained in [7] and presented as a classification in Table 4.

Figure 2 ... 3 shows charts of values of indicator “Proportion in the total volume of pollution emissions into urban atmosphere of the internal combustion engine emissions” in the cities of I and V classification groups (Table 4). Note that cities of I group are cities where practically no industrial enterprises, implementing emissions of pollutants into the atmosphere (cities of resort specialization), or large in terms of population and the level of the city motorization, where the problem of cities' significant pollution by car takes rampant.



**Figure 2.** Russian cities (2012), relating to the Group I of classification on the basis of indicator “The proportion of atmosphere pollution by internal combustion engine vehicles emissions”



**Figure 3.** Russian cities (2012), relating to the Group V of classification on the basis of indicator “The proportion of atmosphere pollution by internal combustion engine vehicles emissions”

**Table 4.** The frequency characteristic of the classification of Russian cities on the basis of “Proportion in the total volume of pollution emissions into urban atmosphere of the internal combustion engine emissions”

| Indicator                   | Groups of cities on the basis of “Proportion in the total volume of pollution emissions into urban atmosphere of the internal combustion engine emissions” |             |             |             |          |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|-------------|----------|
|                             | I                                                                                                                                                          | II          | III         | IV          | V        |
| Range of values             | 0.81...1.00                                                                                                                                                | 0.61...0.80 | 0.41...0.60 | 0.21...0.40 | 0...0.20 |
| Quantity of cities in group | 30                                                                                                                                                         | 47          | 37          | 32          | 34       |

Cities of V group are mainly monotown of industrial specialization, in which pollution is formed in large quantities by stationary sources. Atmospheric pollution of automobile origin in such cities cannot compete with emissions from industrial manufactures.

Cities of intermediate II, III and IV groups have mixed (in different proportions) signs of cities of I and V groups. By belonging of the city to any group on the basis of “Proportion of the internal combustion engine emissions in pollution emissions into urban atmosphere” you can make basic conclusions about the specialization of city's production and the leading role of productions of certain technological paradigm in the city's economy.

#### 4. Conclusion.

In conclusion, the following points should be noted.

1. Generally in recent years in most cities of Russia a slight improvement in air pollution can be noted.

2. Air pollution of Russian cities varies in a wide range of values (from 0.03 to 11.05 tons/person/year).
3. Russian cities can be classified according to the degree of air pollution into 5 groups. 27 of the 180 examined cities in the country refers to the most problematic fifth group.
4. In different cities of the country priority sources of air pollution are cars and stationary pollution sources.

## Reference

- [1] State Report 2015 On the state of protection of population and territories of Russian Federation from natural and technogenic emergency situations in 2014 (Moscow: Emercom of Russia. Federal State Budgetary Institution) p 352
- [2] Bityukova V R 2011 *Regional Research of Russia* **1** (4) p 416–20
- [3] Bityukova V and Kasimov N 2012 *Geofizika* **29** p 39
- [4] Cole T B 2004 *The Journal of American Medical Association* **291** (21) p 2531
- [5] Molina M J and Molina L T 2004 *Journal of the Air & Waste Management Association* **54** p 644
- [6] Main indicators of environment in 2015 Available from: [http://www.gks.ru/wps/wcm/connect/rosstat\\_main/rosstat/ru/statistics/publications/catalog/doc\\_1140094699578](http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1140094699578) [Accessed 30<sup>th</sup> April 2017]
- [7] Main indicators of environment in 2013 Available from: [http://www.gks.ru/wps/wcm/connect/rosstat\\_main/rosstat/ru/statistics/publications/catalog/doc\\_1140094699578](http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1140094699578) [Accessed 30<sup>th</sup> April 2017]
- [8] Chainikov D, Chikishev E, Anisimov I and Gavaev A 2016 *IOP Conference Series: Materials Science and Engineering* **142** 012109