

PAPER • OPEN ACCESS

## Ecological conditionality of population's diseases

To cite this article: Z A Danilova 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **320** 012010

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



**IOP | ebooks™**

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the **collection** - download the first chapter of every title for free.

# Ecological conditionality of population's diseases

**Z A Danilova<sup>1</sup>**

<sup>1</sup> Baikal Institute of Nature Management SB RAS, Ulan-Ude, 670047, Russia

E-mail: ziha@mail.ru

**Abstract.** The purpose of this article is to study the impact of polluted atmospheric air on the morbidity and mortality rate of the population. The ecological conditionality of population's diseases and mortality in the Russian Federation has been revealed. The regions of the Russian Federation were ranked into relatively ecologically "clean" and "polluted" areas, on the basis of which the significant difference in indicators of health and mortality of the population have been defined. In environmentally unfriendly areas, lower health outcomes and higher mortality rates have been noted. The correlation between emissions of solid particles, carbon and sulfur oxides, nitrogen dioxide and risks of cardiovascular system diseases, respiratory organs, congenital anomalies, neoplasms in the Russian Federation and the Baikal region has been calculated. In contrast to the country as a whole, the region has higher correlation coefficients of individual diseases and atmospheric pollution. A high degree of correlation between carbon monoxide emissions and diseases of the respiratory system, blood circulation and congenital anomalies in the Irkutsk region has been revealed. There is a positive correlation between emissions of solid particles and congenital anomalies in Buryatia.

## 1. Introduction

In the conditions of today's environmental crisis, the negative impact of polluted atmospheric air (AA) on human health is increasing. Assessment of the role of AA on the human physiological condition remains a pressing problem for environmentally unfavourable territories. The main pollutants of air include emissions of carbon dioxide having the highest concentration in industrialized urban areas and areas of wind erosion in southern Russia, areas of deforestation in Karelia, Siberia, Primorsky Krai, as well as solids, sulphur oxides, nitrogen and others. Despite the fact that in recent years, the indicators of air quality of urban and rural settlements of the Russian Federation have slightly improved, the condition of the air basin in many cities, especially in the Ural, Siberian and Far Eastern federal districts, remains critical. The share of the Urals and Siberia accounts for more than half (58%) of air pollutants [1, pp 65-66]. The atmospheric quality and its pollution is one of the main environmental threats to human health. According to the Bloomberg Agency, Russia ranked 95th out of 100 countries in the list of "healthy" countries in the 2019 health rating [2].

## 2. Models and Methods

Comparative and correlation analysis was carried out in the work, new materials of statistics were included in the scientific circulation. According to the environmental risk assessment methodology, the impact of negative factors on the population was considered, based on the definition of the "dose-effect" or maximum allowable concentrations of harmful substances on human health [3,12]. The assessment of the impact of polluted air on human health is based on indicators of the state of

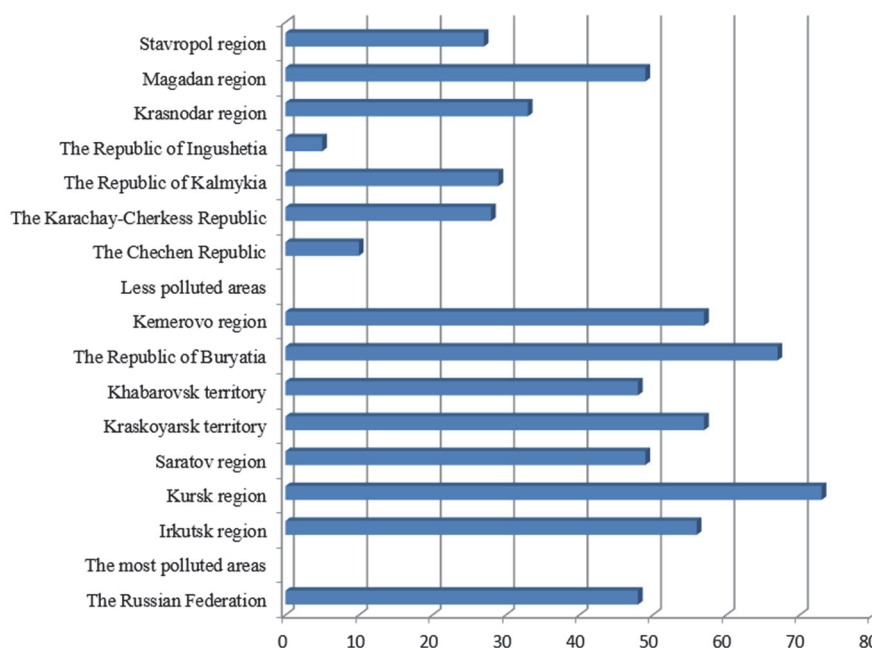


atmospheric air, indicators of morbidity rate, mortality rate of the population from diseases of the respiratory system, blood circulatory system, neoplasms, etc. Complex indicators developed by WHO and the UN, health indices and health risks, including environmental ones, were used.

It is quite difficult to provide accurate quantitative estimates of the cause-and-effect relationship between air pollution and mortality rates, diseases of the population, because many factors, including personal factors, affect the health and mortality rates of the population and attitude to health is one of the elements of self-preserving behaviour [11, p 90]. However, the factor of unfavourable environment, especially in conditions of environmental risks, in particular the high concentration of harmful substances in the air, becomes a priority when studying the morbidity and mortality of the population. According to the World Health Organization, air pollution causes 25% of adult deaths from heart disease, 24% - from stroke, 43% - from chronic obstructive pulmonary disease, 29% - from lung cancer and 17% of all cases are illness and deaths from acute lower respiratory tract infections [4]. Even by conservative estimates, air pollution reduces average life expectancy in Europe by almost a year, so 7 million years of life are lost annually [10].

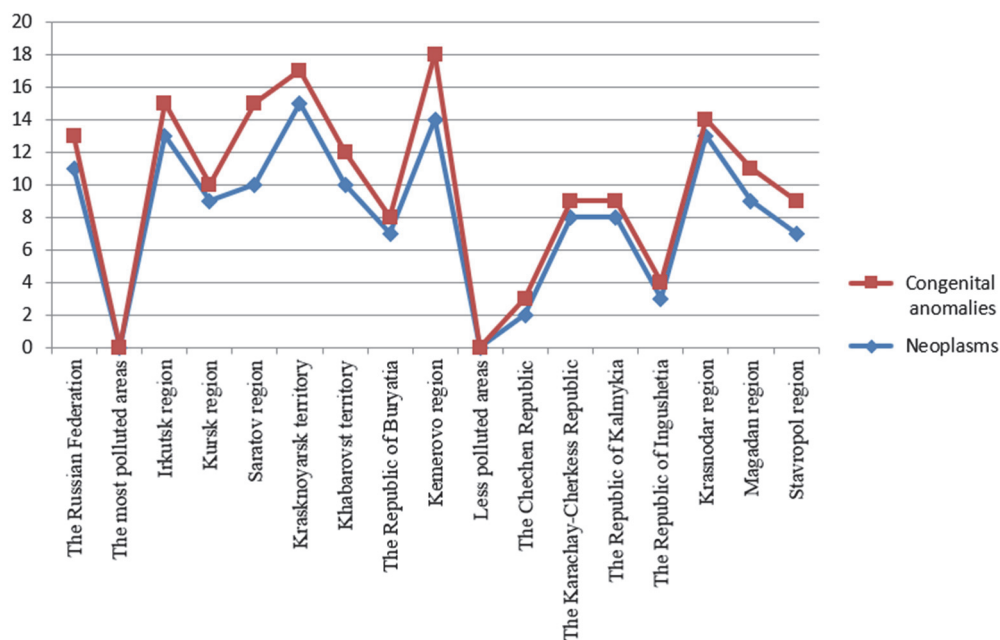
### 3. Results and Discussion

A high level of morbidity and mortality in the environmentally polluted areas of the Russian Federation has been revealed. In order to reflect the impact of the environment at the level of health and mortality rates, 14 areas were ranked as the relatively clean and polluted areas by the maximum permissible concentration (MPC) in the air. The most environmentally polluted territories include Irkutsk, Kemerovo, Kursk, Saratov regions, the Republic of Buryatia, Krasnoyarsk and Khabarovsk Krai, where the excess of the share of samples of MPC of pollutants in the air in 2016 ranged from 2.00 to 5.00 %. In the most polluted areas (Irkutsk, Kemerovo, Kursk and Saratov regions, the Khabarovsk Krai) the mortality rate by respiratory diseases is much higher than the average values in the Russian Federation. In relatively ecologically clean areas (the Karachay-Cherkess Republic, the Republic of Kalmykia, Krasnodar Territory, etc.), where the MPC excess is 0.00 to 0.20% these indicators remain low, especially in the Republic of Ingushetia and the Chechen Republic (Figure 1).



**Figure 1.** Mortality from respiratory diseases in in less and more air polluted territories of the Russian Federation in 2016, 100,000 people. Completed by [5,6].

For example, in Chechnya, respiratory diseases in children are recorded 5.7 times, the adult population is 2.5 times and the mortality from respiratory diseases is 4.6 times lower than the average in Russia. While in ecologically polluted subjects of the Russian Federation there is a high level of morbidity of adults and children with diseases of the respiratory system. Also a high level of neoplasms and congenital anomalies in the most polluted territories of the Russian Federation was also revealed (Figure 2). The level of congenital anomalies among children and adolescents (0-14 years old) is much higher than among adults.



**Figure 2.** Level of congenital anomalies, neoplasms in less and more air polluted territories of the Russian Federation, 2016, 1,000 people. Compiled by: [5,6].

The greatest excess of maximum permissible concentrations of harmful substances in the air is observed in the Irkutsk region, where there are higher rates of respiratory diseases, as well as mortality. A high level of excess of MPC in the air is also observed in the Kursk region, where the mortality rate by main categories of causes, which include diseases of the circulatory system, neoplasms, was the highest among the contaminated areas of the Russian Federation. Mortality from respiratory diseases in the Kursk region was 73.1, in Buryatia - 67.2, in the Krasnoyarsk Territory - 57.8 per 100 thousand people, which is much higher than the average values in the Russian Federation.

The ecological conditionality of diseases and mortality of the population of the Russian Federation and the Baikal region is determined. In the aggregate, the dependence between environmental pollution and the risk of cardiovascular diseases, respiratory organs, congenital anomalies and neoplasms is most obvious. As an example of this dependence, the Baikal region (the Irkutsk region, the Republic of Buryatia) was selected, where the level of air pollution in many cities (Bratsk, Angarsk, Irkutsk, Ulan-Ude, Selenginsk, etc.) annually exceeds the critical limit and the administrative centers of the regions are the dirtiest cities of Russia in terms of air pollution [5, p 19].

The coefficients of correlation between emissions of harmful substances into the atmosphere from stationary sources and the relative morbidity of the population in the Baikal region for 2010-2016 calculated by the author showed a fairly high dependence between individual values in comparison with the country as a whole. If the correlation coefficient of ground air pollution with carbon dioxide and respiratory diseases in the country was negative (-0.487), it was positive in Irkutsk region (0.772). During this period, there was a direct correlation between carbon dioxide discharges into the atmosphere and diseases of the circulatory system (0.935), as well as congenital anomalies (0.957). In Buryatia,

these coefficients also had high and medium positive values, amounting to 0.727 and 0.439, respectively. The highest correlation coefficient, equal to 0.828, indicates a high degree of correlation between emissions of solids and respiratory diseases of the population of Irkutsk region.

Both in the country as a whole and in the Baikal region, a high correlation between carbon dioxide emissions and an increase in diseases of the cardiovascular system, congenital anomalies is observed (Table 1). The growth of cancer in the Irkutsk region is significantly affected by emissions of solids, carbon monoxide, sulfur dioxide.

**Table 1.** The correlation coefficients between emissions of harmful substances from stationary sources and the morbidity of the population in the Russian Federation and the Baikal region for 2010-2016<sup>a</sup>.

| <b>Emissions in atmosphere</b> | <b>Neoplasm</b> | <b>Respiratory diseases</b> | <b>Cardiovascular diseases</b> | <b>Congenital anomalies</b> |
|--------------------------------|-----------------|-----------------------------|--------------------------------|-----------------------------|
| <i>Solids</i>                  |                 |                             |                                |                             |
| The Russian Federation         | -0.579          | -0.748                      | 0.570                          | 0.411                       |
| The Republic of Buryatia       | -0.043          | 0.301                       | 0.349                          | 0.715                       |
| Irkutsk region                 | 0.399           | 0.828                       | 0.482                          | 0.439                       |
| <i>Carbon monoxide</i>         |                 |                             |                                |                             |
| The Russian Federation         | -0.264          | -0.487                      | 0.221                          | 0.503                       |
| The Republic of Buryatia       | 0.236           | -0.595                      | 0.727                          | 0.439                       |
| Irkutsk region                 | 0.472           | 0.772                       | 0.935                          | 0.957                       |
| <i>Sulfur dioxide</i>          |                 |                             |                                |                             |
| The Russian Federation         | -0.585          | -0.661                      | 0.525                          | 0.278                       |
| The Republic of Buryatia       | -0.091          | -0.356                      | 0.112                          | -0.295                      |
| Irkutsk region                 | 0.341           | -0.170                      | 0.331                          | 0.305                       |
| <i>Nitrogen oxides</i>         |                 |                             |                                |                             |
| The Russian Federation         | -0.024          | 0.265                       | 0.021                          | 0.569                       |
| The Republic of Buryatia       | -0.495          | 0.296                       | 0.357                          | 0.557                       |
| Irkutsk region                 | -0.244          | -0.427                      | -0.191                         | -0.009                      |

<sup>a</sup> Compiled by: [7, p.476, 523; 8, pp. 53-68; 9].

There are high correlation coefficients between particulate matter pollution (dust, smoke, soot) and congenital anomalies in Buryatia (0.715), in the Russian Federation and Irkutsk region they are lower. In the Russian Federation, including the Baikal region, the greatest dependence is noted between the emissions of these substances and cardiovascular diseases, as well as congenital anomalies. There is a positive correlation in almost all of these values.

Over the years in the RF the highest negative correlation or its absence has been revealed between emissions of solids and respiratory diseases (-0.748). Low correlation coefficients in the country as a whole were noted between atmospheric pollution with sulfur dioxide and bronchopulmonary diseases (-0.661).

In recent years, the country has been reducing emissions of pollutants into the atmosphere, but in the Irkutsk Region and Buryatia there has been an increase. In the Irkutsk region, carbon monoxide emissions in 2010 increased from 141.1 thousand tons to 205.3 thousand tons in 2016, sulfur dioxide from 198.3 to 204.4 thousand tons, respectively.

#### 4. Conclusion

The results of the study indicate a significant contribution of the environmental factor to the morbidity and mortality of the population. The calculations of the correlation coefficients and the ranking of the

territory of the Russian Federation for relatively “clean” and “polluted” indicate a high level of correlation between emissions of harmful substances into the atmosphere and the risks of morbidity of the population. In areas with a high concentration of harmful substances in the atmosphere, lower health indicators and high mortality rates have been identified. If in Russia as a whole, in recent years there has been a reduction in emissions of pollutants into the atmosphere, then in ecologically unfavorable areas they are increasing and there are higher rates of risk to public health. A certain dependence has been established between air pollution by suspended particles, oxides of nitrogen, sulfur, etc., and the risks of morbidity and mortality of the population from diseases of the respiratory system, blood circulation, congenital anomalies, and neoplasms. The environmental conditionality of diseases and pathologies leads to a weakening of the physiological reserves of the body, a reduction in life expectancy due to an accelerated aging process and earlier mortality.

### Acknowledgments

The work was prepared in the framework of the budget project "Transformation of the natural environment in the zone of influence of the Great Silk and Tea Roads in the context of globalization and climate change".

### References

- [1] Gilmundinov V M et al. 2012 *Bulletin of the NSU. Series: Socio-economic sciences* **3** 63-74
- [2] Russia ranked 95th out of 100 in the list of healthy countries in the world. URL: <http://www.pora.ru/health/beauty/news/26675.html>
- [3] Filippov V L 2010 *Donosology and healthy lifestyle* **2** 43-50
- [4] Air Pollution: Health Effects URL: <https://www.who.int/airpollution/ambient/health-impacts/ru/>
- [5] On the state of sanitary and epidemiological welfare of the population in the Russian Federation in 2017: State report 2018 (Moscow Federal Service for Supervision of Consumer Rights Protection and Human Welfare) p 268
- [6] Health in Russia 2017: Appendix to the handbook 2018 (Online application [http://www.gks.ru/wps/wcm/connect/rosstat\\_main/rosstat/ru/statistics/publications/catalog/doc\\_1139919134734](http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1139919134734))
- [7] Regions of Russia. Socio-economic indicators 2017: Statistical handbook 2018 (Moscow: Federal state statistics service) p 1402
- [8] Key indicators of environmental protection: Statistical Bulletin 2017 (Moscow: Federal state statistics service) p 114
- [9] Information about the protection of atmospheric air in 2017 Statistical Bulletin URL: [http://www.gks.ru/wps/wcm/connect/rosstat\\_main/rosstat/ru/statistics/publications/catalog/5e901c0042cb5cc99b49bf307f2fa3f8](http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/5e901c0042cb5cc99b49bf307f2fa3f8)
- [10] Koolen C D and Rothenberg G 2019 *ChemSusChem* **12** (1) 164-72
- [11] Danilova Z A 2015 *Studies on Russian Economic Development* **26** (1) 84-90
- [12] Theodore L *Air Pollution Control Equipment Calculations* 2008 (New Jersey: John Wiley & Sons Hoboken National Academy Press) p 348