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## Atmospheric pollution of the Ural Federal District subjects (2016): regional features

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**Abstract:** The article deals with regional characteristics of the atmosphere ecology in the Ural Federal District (UFD). The official Rosstat data is given on total emissions of pollutants into the atmosphere of the Urals. Analytical work was carried out to assess the specific (for 1 person/year and for 1 km<sup>2</sup>/year) total air emissions of pollutants and their distribution by sources of pollution - stationary and mobile. On the basis of data analytics, conclusions are drawn about regional peculiarities of atmospheric pollution in UFD subjects. It is established that atmospheric pollution in the UFD in terms of specific (for 1 person/year and for 1 km<sup>2</sup>/year) indicators significantly exceeds the all-Russian level by almost 2 times. In the subjects of the Ural Federal District, a significant spatial uneven distribution of air pollution is formed. The fact of neglecting the necessity of trapping and neutralizing pollutants is revealed in the Khanty-Mansiysk Autonomous District (Yugra) and the Yamalo-Nenets Autonomous District.

### 1. Introduction

According to the World Health Organization (WHO), the problem of atmospheric pollution is one of the most acute in the field of ecology. According to WHO [1], air pollution caused about 3.7 million deaths in urban and rural areas of the world in 2012. According to Rosstat [2] in 2016, the total emissions of pollutants into the atmosphere in the Russian Federation amounted to 31617.1 thousand tons. Taking into account the population of Russia (on 1.01.2017 - 146804 thousand people [3]), an average of 215.3 kg of air pollutants was accounted for by each Russian in 2016. About 55% of them are products of stationary sources of pollution and 45% are produced by vehicles [2].

In the Ural Federal District (UFD) of Russia - one of the most important industrial clusters of the country - there is an even more threatening ecological situation. Specific (taking into account the population of the district - 12345.8 thousand people as of 01.01.2017 [3]) 416.0 kg of air pollutants was accounted for by 1 person in 2016 in the Ural Federal District [2]. The distribution of emissions between stationary and mobile sources was distributed approximately in a ratio of 75% and 25% [2]. These data illustrate not only the fact of the significant presence of the third and fourth technological industry in the region, but also the relative imbalance, even in comparison with the all-Russian picture, between a fairly new fleet of vehicles and relatively outdated industrial facilities. Within the framework of this article, the problems of spatial unevenness in the distribution of atmospheric air pollution within the boundaries of the Ural Federal District are being studied. The study focused on a



comparative assessment of specific (for 1 person/year and for 1 km<sup>2</sup>/year) emissions of pollutants into the atmosphere in 6 UFD subjects.

## 2. Research

Based on the official data of Rosstat [2], it is necessary to determine a number of indicators that are not reporting. In particular, for the correct assessment of the level of environmental problems in different UFD subjects, the authors calculated the indicators "Specific emissions of pollutants for 1 person/year and for 1 km<sup>2</sup>/year" produced by all sources of pollution, as well as separately stationary and mobile sources.

## 3. Results and discussion

### 3.1. Estimation of the total pollution of atmospheric air (without taking into account its source)

Table 1 shows the official information of Rosstat [2] on the total (from stationary and mobile sources) emissions of pollutants into the atmosphere in 2016 in Russia, in general for the UFD and for 6 subjects of the UFD differentially.

**Table 1.** Total (from stationary and mobile sources) emissions of pollutants into the atmosphere in Russia and UFD in 2016

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere, total, thous. t.	including	
		from stationary sources, thous. t.	from mobile sources, thous. t.
The Russian Federation (RF)	31617.1	17349.3	14267.8
Ural Federal District (UFD)	5136.5	3837.2	1299.3
Kurgan region	103.6	41.7	61.9
Sverdlovsk region	1336.8	906.4	430.4
Tyumen region	2790.4	2291.7	498.7
including:			
Khanty-Mansi Autonomous District - Yugra	1658.5	1428.0	230.5
Yamalo-Nenets Autonomous District	834.1	749.3	84.8
Tyumen Region without AD	297.7	114.3	183.4
Chelyabinsk region	905.8	597.5	308.3

Based on official statistics [2; 3; 4], the values of the indicator "Specific emissions of pollutants into the atmosphere (for 1 person/year - Table 2, for 1 km<sup>2</sup>/year - Table 3) were calculated for Russia, UFD and 6 subjects of UFD" irrespective of the source of pollution.

**Table 2.** Specific emissions (per 1 person/year) into the atmosphere of pollutants (in total, without taking into account the source) in Russia and the subjects of UFD in 2016.

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere, total, thous. t. [2]	Population of Russia, UFD and their subjects, total, thousand people. [3]	Specific emissions of pollutants into the atmosphere without taking into account the source, kg/person/year
The Russian Federation (RF)	31617.1	146804.0	215.4
Ural Federal District (UFD)	5136.5	12345.8	416.0
Kurgan region	103.6	854.1	121.3
Sverdlovsk region	1336.8	4329.3	308.7

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere, total, thous. t. [2]	Population of Russia, UFD and their subjects, total, thousand people. [3]	Specific emissions of pollutants into the atmosphere without taking into account the source, kg/person/year
Tyumen region	2790.4	3660.0	762.3
including:			
Khanty-Mansi Autonomous District - Yugra	1658.5	1646.1	1007.5
Yamalo-Nenets Autonomous District	834.1	536.0	1556.1
Tyumen Region without AD	297.7	1477.9	201.4
Chelyabinsk region	905.8	3502.3	258.6

The value of the indicator "Specific emissions of pollutants into the atmosphere (per person per year)" (in total, without taking into account the source) differs by a factor of 7 times in different regions of the UFD (from 121.3 kg/person/year in Kurgan region to 1556.1 kg/person/year in the Yamal-Nenets Autonomous District).

**Table 3.** Specific emissions (per 1 km<sup>2</sup>/year) of pollutants into the atmosphere (in total, without taking into account the source) in Russia and the subjects of the UFD in 2016.

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere, total, thous. t. [2]	The area of the territory of Russia, UFD and their subjects, total, km <sup>2</sup> . [4]	Specific emissions of pollutants into the atmosphere without taking into account the source per 1 km <sup>2</sup> of the territory, kg/km <sup>2</sup> /year
The Russian Federation (RF)	31617.1	17125191	1846
Ural Federal District (UFD)	5136.5	1818497	2824
Kurgan region	103.6	71488	1449
Sverdlovsk region	1336.8	194307	6879
Tyumen region	2790.4	1464173	1905
including:			
Khanty-Mansi Autonomous District - Yugra	1658.5	534801	3101
Yamalo-Nenets Autonomous District	834.1	769250	1084
Tyumen Region without AD	297.7	160122	1859
Chelyabinsk region	905.8	88529	10231

The value of the indicator "Specific emissions of pollutants into the atmosphere (per 1 km<sup>2</sup>/year)" (in total, excluding the source) differs by 7 times in different regions of the UFD (from 1449 kg/km<sup>2</sup>/year in the Kurgan region to 10231 kg/km<sup>2</sup>/year in the Chelyabinsk region).

### 3.2. Assessment of atmospheric air pollution by stationary sources

Based on the data of Table 1 [2], data on population [3] and area of regions [4], the specific emissions of pollutants from stationary sources into the atmosphere in 2016 (Table 4 and Table 5) were determined for Russia, UFD and 6 UFD subjects.

**Table 4.** Specific emissions (per 1 person/year) into the atmosphere of pollutants from stationary sources in Russia and subjects of the UFD in 2016.

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere from stationary sources, total, thous. t. [2]	Index		Specific weight of emissions from stationary sources in total emissions, %
		Population of Russia, UFD and their subjects, total, thousand people [3]	Specific emissions of pollutants into the atmosphere from stationary sources, kg/person/year	
The Russian Federation (RF)	17349.3	146804.0	118.2	54.9
Ural Federal District (UFD)	3837.2	12345.8	310.8	74.7
Kurgan region	41.7	854.1	48.8	40.3
Sverdlovsk region	906.4	4329.3	209.3	67.8
Tyumen region	2291.7	3660.0	626.1	82.1
including:				
Khanty-Mansi Autonomous District - Yugra	1428.0	1646.1	867.5	86.1
Yamalo-Nenets Autonomous District	749.3	536.0	1397.9	89.8
Tyumen Region without AD	114.3	1477.9	77.3	38.4
Chelyabinsk region	597.5	3502.3	170.6	66.0

The value of "Specific emissions of pollutants into the atmosphere (per person/year)" (from stationary sources) in different regions of the UFD differs by 28 times (from 48.8 kg/person/year in the Kurgan region to 1397.9 kg/person/year in Yamalo-Nenets Autonomous District).

**Table 5.** Specific emissions (per 1 km<sup>2</sup>/year) of pollutants into the atmosphere from stationary sources in Russia and the UFD subjects in 2016.

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere from stationary sources, total, thous. t. [2]	Index		Specific weight of emissions from stationary sources in total emissions, %
		The area of the territory of Russia, UFD and their subjects, total, km <sup>2</sup> . [4]	Specific emissions of pollutants into the atmosphere from stationary sources, kg/person/year	
The Russian Federation (RF)	17349.3	17125191	1013	54.9
Ural Federal District (UFD)	3837.2	1818497	2110	74.7
Kurgan region	41.7	71488	583	40.3
Sverdlovsk region	906.4	194307	4665	67.8
Tyumen region	2291.7	1464173	1565	82.1
including:				
Khanty-Mansi Autonomous District - Yugra	1428.0	534801	2670	86.1
Yamalo-Nenets Autonomous District	749.3	769250	974	89.8
Tyumen Region without AD	114.3	160122	714	38.4
Chelyabinsk region	597.5	88529	6749	66.0

The value of the indicator "Specific emissions of pollutants into the atmosphere (per 1 km<sup>2</sup>/year)" (from stationary sources) in different regions of UFD varies by 11.5 times (from 583 kg/km<sup>2</sup>/year in the Kurgan region to 6749 kg/km<sup>2</sup>/year in the Chelyabinsk region).

### 3.3. Assessment of air pollution by mobile sources

Based on the data of Table 1 [2], the corresponding values of specific emissions into the atmosphere in 2016 of pollutants from mobile sources were defined (Table 6 and Table 7).

**Table 6.** Specific emissions (per 1 person/year) to the atmosphere of pollutants from mobile sources in Russia and the UFD subjects in 2016.

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere from mobile sources, total, thous. t. [2]	Index		Specific weight of emissions from mobile sources in total emissions, %
		Population of Russia, UFD and their subjects, total, thousand people. [3]	Specific emissions of pollutants into the atmosphere from mobile sources, kg/person/year	
The Russian Federation (RF)	14267.8	146804.0	97.2	45.1
Ural Federal District (UFD)	1299.3	12345.8	105.2	25.3
Kurgan region	61.9	854.1	72.5	59.7
Sverdlovsk region	430.4	4329.3	99.4	32.2
Tyumen region	498.7	3660.0	136.2	17.9
including:				
Khanty-Mansi Autonomous District - Yugra	230.5	1646.1	140.0	13.9
Yamalo-Nenets Autonomous District	84.8	536.0	158.2	10.2
Tyumen Region without AD	183.4	1477.9	124.1	61.6
Chelyabinsk region	308.3	3502.3	88.0	34.0

The indicator "Specific emissions of pollutants into the atmosphere (per person/year)" (from mobile sources) in different regions of the UFD differs slightly more than 2-fold (from 72.5 kg/person/year in the Kurgan region to 158.2 kg/person/year in the Yamal-Nenets Autonomous District).

**Table 7.** Specific emissions (per 1 km<sup>2</sup>/year) into the atmosphere of pollutants from mobile sources in Russia and UFD in 2016.

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere from mobile sources, total, thous. t. [2]	Index		Specific weight of emissions from mobile sources in total emissions, %
		The area of the territory of Russia, UFD and their subjects, total, km <sup>2</sup> . [4]	Specific emissions of pollutants into the atmosphere from mobile sources, kg/km <sup>2</sup> /year	
The Russian Federation (RF)	14267.8	17125191	833	45.1
Ural Federal District (UFD)	1299.3	1818497	714	25.3
Kurgan region	61.9	71488	865	59.7
Sverdlovsk region	430.4	194307	2215	32.2
Tyumen region	498.7	1464173	341	17.9

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere from mobile sources, total, thous. t. [2]	Index		Specific weight of emissions from mobile sources in total emissions, %
		The area of the territory of Russia, UFD and their subjects, total, km <sup>2</sup> . [4]	Specific emissions of pollutants into the atmosphere from mobile sources, kg/km <sup>2</sup> /year	
including:				
Khanty-Mansi Autonomous District - Yugra	230.5	534801	431	13.9
Yamalo-Nenets Autonomous District	84.8	769250	110	10.2
Tyumen Region without AD	183.4	160122	1145	61.6
Chelyabinsk region	308.3	88529	3482	34.0

The indicator "Specific emissions of pollutants into the atmosphere (per km<sup>2</sup>/year)" (from mobile sources) in different regions of the UFD differs slightly by a factor of 31 (from 110 per 1 km<sup>2</sup>/year in the Yamalo-Nenets Autonomous District to 3482 per 1 km<sup>2</sup>/year kg/person/year in the Chelyabinsk region).

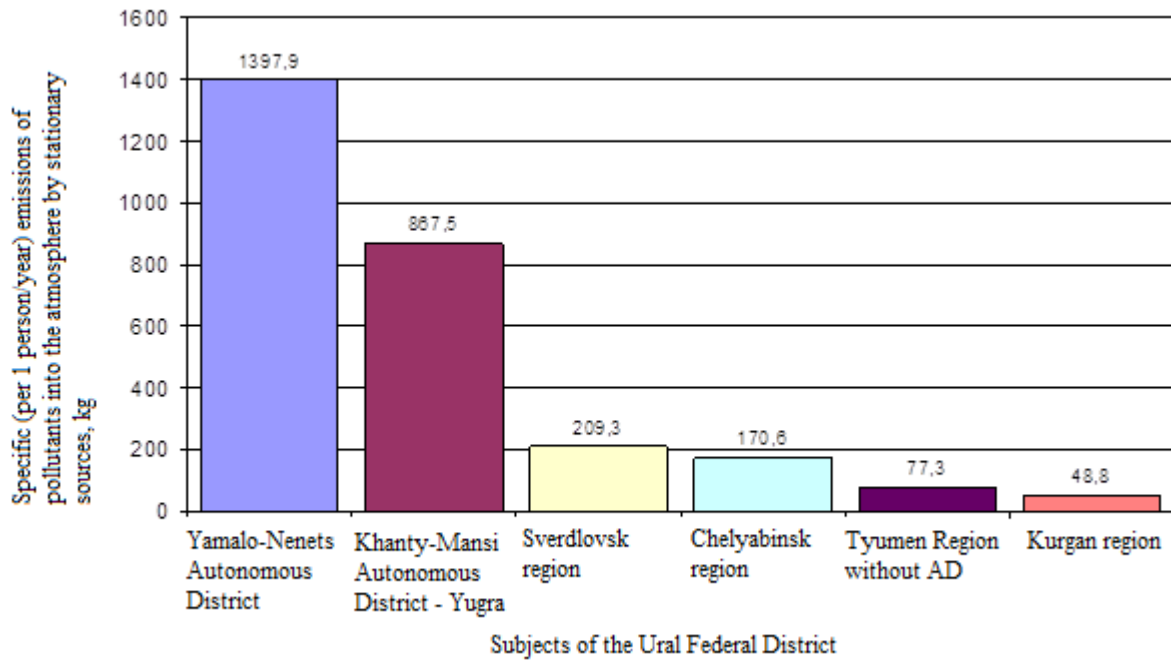
### 3.4. Summary data table

Table 8, Figures 1...4 present the data illustrating the distribution of air pollutants in the regions of the UFD by source type.

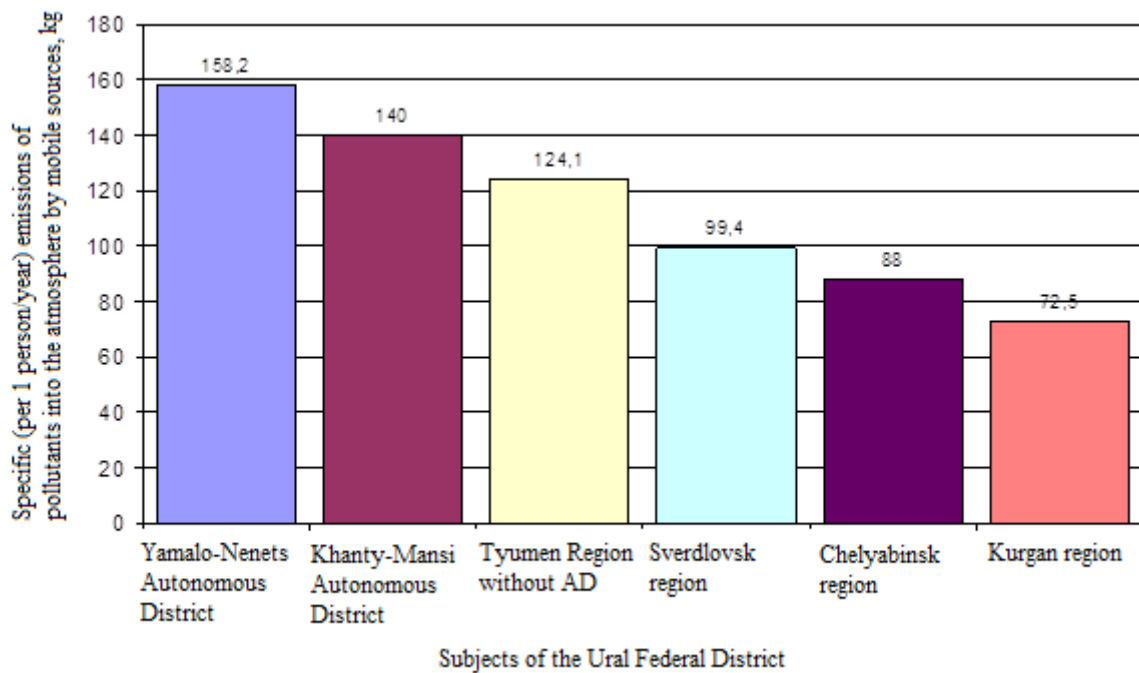
**Table 8.** Summary data table on the distribution of air pollutants emissions in Russia and the subjects of the UFD in 2016 by source type.

Russia, UFD and their subjects	Specific emissions of pollutants per 1 person/year, kg/person/year		Specific emissions of pollutants per 1 km <sup>2</sup> /year, kg/km <sup>2</sup> /year	
	Stationary	Mobile	Stationary	Mobile
The Russian Federation (RF)	118.2	97.2	1013	833
Ural Federal District (UFD)	310.8	105.2	2110	714
Kurgan region	48.8	72.5	583	865
Sverdlovsk region	209.3	99.4	4665	2215
Tyumen region	626.1	136.2	1565	341
including:				
Khanty-Mansi Autonomous District - Yugra	867.5	140.0	2670	431
Yamalo-Nenets Autonomous District	1397.9	158.2	974	110
Tyumen Region without AD	77.3	124.1	714	1145
Chelyabinsk region	170.6	88.0	6749	3482

Comparative analysis of the data of Table 1 and Table 8 shows that the ranks of the regions in terms of contribution to the atmospheric pollution of the Ural Federal District are not the same in absolute and specific dimensions. In absolute figures, the hierarchy of regions in terms of pollution is as follows: KhMAD, Sverdlovsk, Chelyabinsk regions, YNAD, Tyumen and Kurgan regions. For specific indicators (for 1 person/year) the hierarchy of regions is reconstructed as follows: YNAD, KhMAD, Sverdlovsk, Chelyabinsk, Tyumen and Kurgan regions. Specific analogue at the rate of 1 km<sup>2</sup>/year makes Chelyabinsk and Sverdlovsk regions the leaders in atmospheric pollution.

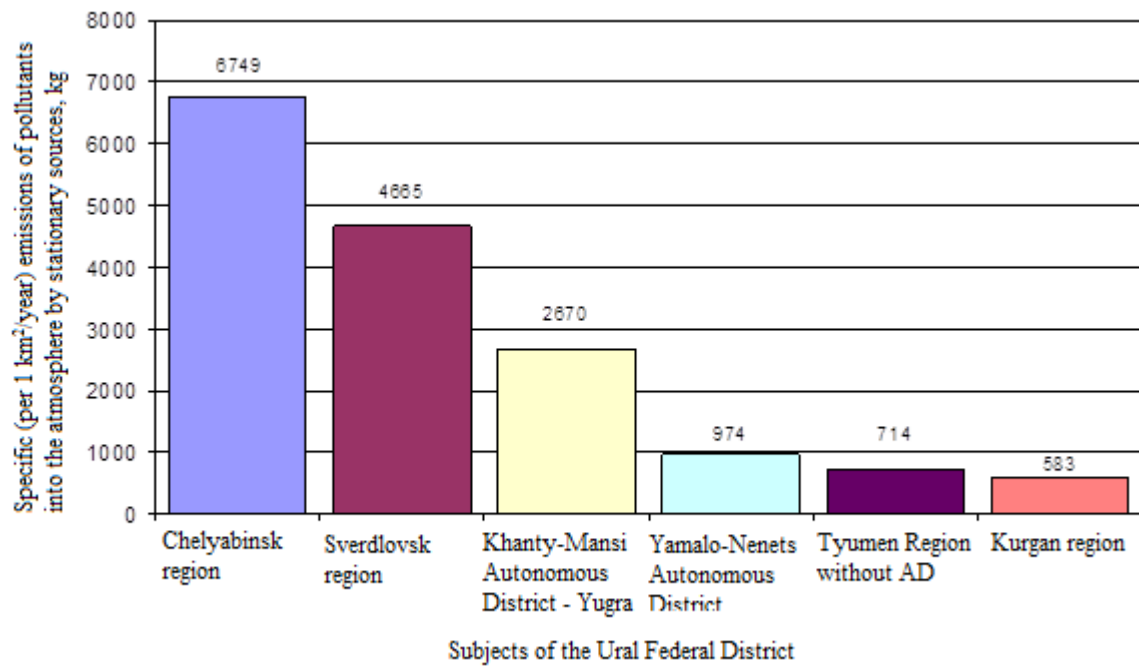


**Figure 1.** Comparative diagram of atmospheric pollution in UFD subjects at the rate of 1 person/year, formed by stationary sources.

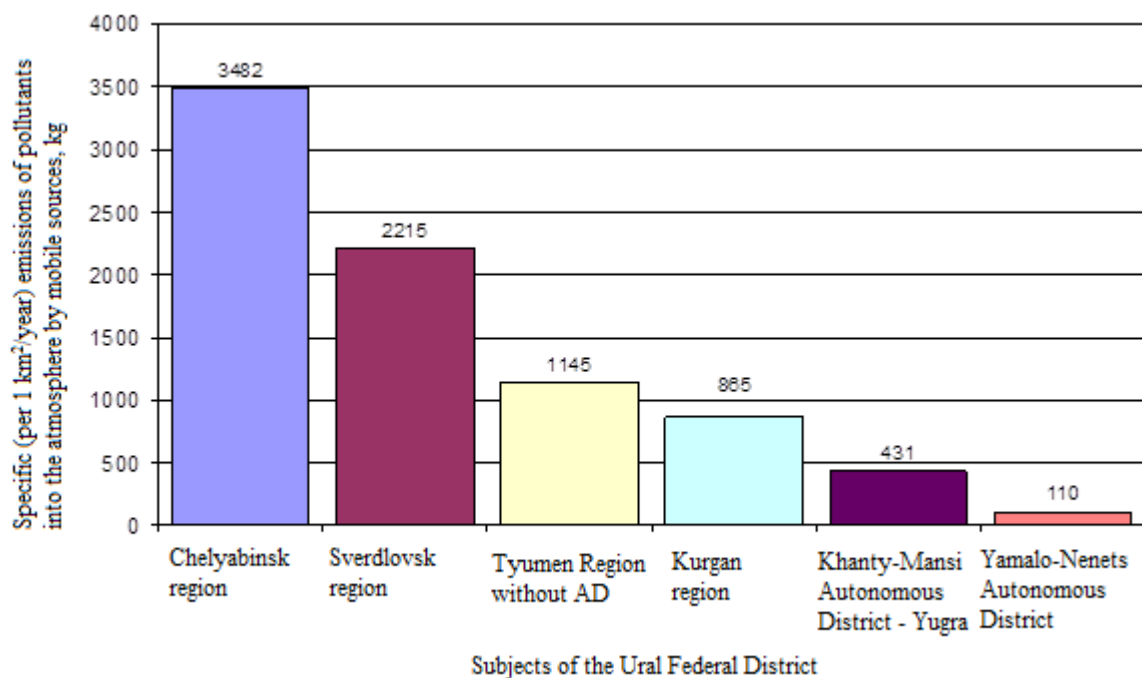


**Figure 2.** Comparative diagram of atmospheric pollution in UFD subjects at the rate of 1 person/year, formed by mobile sources.





**Figure 3.** Comparative diagram of atmospheric pollution in the UFD subjects based on 1 km<sup>2</sup>/year, generated by stationary sources.



**Figure 4.** Comparative diagram of atmospheric pollution in the UFD subjects based on 1 km<sup>2</sup>/year, generated by mobile sources.

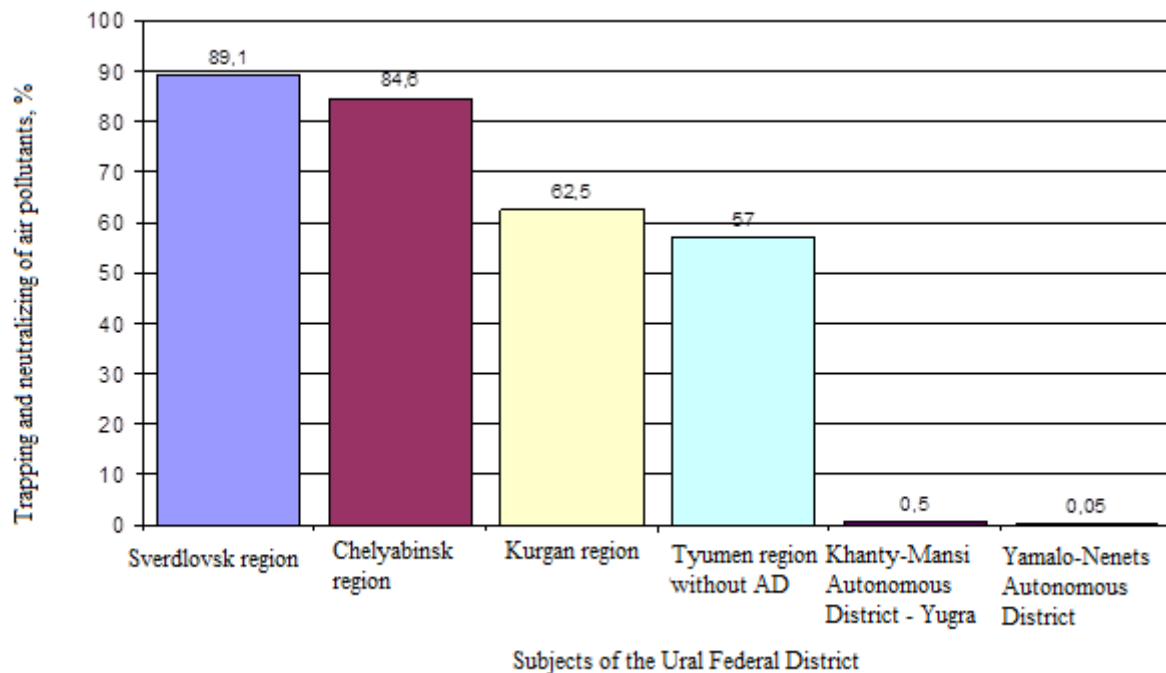
### 3.5. Assessment of regional successes in the sphere of ecology of the atmosphere in the Ural Federal District subjects

If over the reduction of emissions into the atmosphere of pollutants by vehicles, both the producers and operators and control organizations work in the complex, serious work still remains to be done in the sphere of improving environmental supervision over industrial production. This is evidenced by the data [2], presented in Table 9. Figure 5 presents a diagram clearly illustrating the data of Table 9.

**Table 9.** Assessment of regional (UFD) successes in the field of capture and neutralization of atmospheric pollutants at stationary facilities in 2016. [2]

Russia, UFD and their subjects	Emissions of pollutants into the atmosphere from stationary sources, total, thous. t	Production of air pollutants, thous. t		Capture and neutralization of pollutants, thous. t.	
		total	in% of the total amount of waste pollutants	total	in% of the total amount of waste pollutants
The Russian Federation (RF)	17349.3	66586.2	100.0	49236.9	73.9
Ural Federal District (UFD)	3837.2	14751.7	100.0	10914.5	74.0
Kurgan region	41.7	111.3	100.0	69.6	62.5
Sverdlovsk region	906.4	8308.6	100.0	7402.2	89.1
Tyumen region	2291.7	2450.3	100.0	158.6	6.5
including:					
Khanty-Mansi Autonomous District - Yugra	1428.0	1434.6	100.0	6.6	0.5
Yamalo-Nenets Autonomous District	749.3	749.6	100.0	0.3	0.05
Tyumen Region without AD	114.3	266.0	100.0	151.7	57.0
Chelyabinsk region	597.5	3881.6	100.0	3284.1	84.6

The data of Table 9 allow us to state that if in industrial regions such as Sverdlovsk and Chelyabinsk, 85...89% of industrial waste are trapped and neutralized, then in KhMAD-Yugra and YaNAD, this indicator tends to zero. In the Tyumen and Kurgan regions, only about 60% of the waste pollutions are trapped and neutralized.



**Figure 5.** Comparative diagram of estimation for trapping and neutralizing air pollutants by regions of the UFD.

#### 4. Conclusion

In 2014, Federal Law № 219-FZ "On Introducing Amendments to the Federal Law "On Environmental Protection" was issued and certain legislative acts of the Russian Federation. In [5], developed for the purpose of successful implementation of the Federal law, 160 pollutants are presented, which must be carried out with respect to the work of monitoring and gradual elimination of emissions. To be sure, this work is carried out with a certain measure of success. Thus, official data [2] and the corresponding calculations [6] show that year after year the air emissions of pollutants in Russian cities are gradually decreasing. Nevertheless, in some cities of Russia atmospheric pollution can be characterized as catastrophic [6].

The results of the assessment of atmospheric pollution of the UFD subjects can be briefly characterized as follows.

1. In the UFD in 2016, atmospheric pollution by specific indicators significantly exceeds the all-Russian level: at the rate of 1 person/year, the excess is 93.5%; at the rate of 1 km<sup>2</sup>/year, the excess is at the level of 52.9%.
2. According to the absolute indicators of atmospheric pollution, the worst indicators in 2016 are characteristic for the Khanty-Mansiysk Autonomous District (1658.5 thousand tons); the best - in the Kurgan region (103.6 thousand tons).
3. Based on the calculation for 1 person/year, the leader among the subjects of the UFD in atmospheric pollution is the Yamalo-Nenets Autonomous District; at the rate of 1 km<sup>2</sup>/year, the Chelyabinsk region is the leader in air pollution among the subjects of the UFD.
4. The most favorable is the environmental situation in the Kurgan region. Indicators of pollution of its atmosphere are much lower than in neighboring regions.
5. The analysis of data on disposal and neutralization of pollutants allows asserting that in the Sverdlovsk and Chelyabinsk regions there is a great deal of organizational work to improve the ecology of the atmosphere. In these regions, in 2016, 85...89% of industrial waste was captured and neutralized. In Khanty-Mansiysk and Yamalo-Nenets autonomous districts, on

the contrary, these works are practically not carried out (no more than 1% of industrial waste discharged into the air is trapped and neutralized).

6. Analysis of economic and geographical features of the distribution of atmospheric pollution in the Ural Federal District makes it possible to conclude that atmospheric pollution correlates with the level of industrial development of regions. In the Kurgan region, where the ecology of the atmosphere is maximally favorable, production is rather weak. On the contrary, in the industrialized regions of the Ural Federal District, the overall situation in the sphere of ecology is much worse. On the general background, the Sverdlovsk and Chelyabinsk regions stand out in terms of work on improving the ecological situation. In the Khanty-Mansiysk and Yamalo-Nenets Autonomous District, environmental issues need to be given much more effort than is done today.

### References

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