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City as an Object of Ecological and Economic Researches: the Example of Russian Cities

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ABSTRACT
The growth of environmental pollution especially in big cities dictates the need to search for the reasons of this trend, most of which refer to the economic sphere. The aim of this work is not only to describe the state of environment in Russian cities with the population of 100 thousand inhabitants and more, but also to reveal the main economic factors that influence on the intensity of their environmental pollution. The ecological and economic analysis of Russian cities, fulfilled in this work, helped to identify the most unfavourable of them in terms of the level of environmental impact. The low quality of environment in these cities is largely due to natural and climatic conditions (bad conditions for contaminants dispersion) and specifics of their economic development: functioning of large industrial enterprises of ferrous and non-ferrous metallurgy, petro chemistry, construction industry. The conclusion is that to improve the environmental quality in these cities comprehensive social, environmental and economic solutions are required.

Keywords: environmental pollution, urban area, pollution growth, Russian cities, ecological rating

Город как объект эколого-экономических исследований: пример российских городов

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РЕФЕРАТ
Рост загрязнения окружающей среды, особенно в больших городах, диктует необходимость поиска причин этой тенденции, большинство из которых относятся к экономической сфере. Целью этой работы является не только описание состояния окружающей среды в российских городах с населением в 100 тыс. жителей и более, но и выявление основных экономических факторов, влияющих на интенсивность загрязнения окружающей среды. Экологический и экономический анализ городов России, выполненный в этой работе, помог выявить наиболее неблагоприятные из них с точки зрения уровня воздействия на окружающую среду. Низкое качество окружающей среды в этих городах во многом обусловлено природными и климатическими факторами (плохие условия для дисперсии загрязняющих веществ) и особенностями их экономического развития: функционированием крупных промышленных предприятий черной и цветной металлургии, нефтехимии, строительной отрасли. Вывод заключается в том, что для улучшения качества окружающей среды в этих городах требуются комплексные социальные, экологические и экономические решения.

Ключевые слова: загрязнение окружающей среды, городская территория, рост загрязнения, города России, экологический рейтинг

1. Introduction

It is well-known that at the planetary scale the most important global economic problem of the modern society is the ecological one. Environmental safety is influenced by the number of factors, the most significant among which is the economic growth as the result of modern achievements in science and technology. On the other hand, in the system «society — production — nature» a key place is occupied by modern scientific and technological achievements and they should be regarded as the effective means of scientific and technical development of natural environment.

The organizational and economic mechanism of nature management should be directed not only to the use of science and technology achievements in the sphere of material production, but also to the ecologization of productive processes themselves. The ecologization of material production processes implies their compliance with the principle of their «inscribing» into natural processes. In the last quarter of the century this principle became especially actual not only for agriculture, forestry, livestock husbandry, but also for other sectors of economy, including urban economy (Khaikin M. M., Zhukova P. S., 2015).

The latest achievements of scientific and technological progress are realized mainly in urban areas, chiefly in large industrial centre. However, these achievements are often detrimental to quality of life and they have negative consequences. Therefore, the environmental conditions in many cities are evidently unfavourable (Bityukova V. R., 2012).

Taking into account that at the present time approximately 50% of the world's population lives in urban areas and the forecast value of this indicator will increase to 60% by 2030 and in industrialized countries will exceed 80% (United Nations, 2016), it is obvious that urban areas become the main ones in solving environmental problems.

Thus, within the framework of spatial ecological and economic analysis city is the main object of research.

Since the second half of the 19th century urban population growth was so intense in the world and the spheres of material and non-material production developed so rapidly that the state of the environment of a number of cities no longer satisfied the needs of a city dweller as a biocultural creature. The beginning of the processes of active urbanization in our country dates back to the last quarter of the 19th century, which especially intensified after the revolutions of 1917.

Megalopolises qualitatively transform almost all elements of nature: climate, atmosphere, soil, flora, fauna, relief, soils, groundwater and water. 80% of all air emissions and 75% of the total pollution are concentrated in cities. The harmful impact of cities on the state of the environment extends over a distance of about 70–100 km from their borders.

The concept of «pollution» has significantly expanded. Now it includes any biological species, chemical compound, anthropogenic and natural physical agent, which, entering the ecosystem, begins to influence the change of its parameters (Satterthwaite D., Dodman D., 2013).

In Table 1 the most significant ecological problems of cities, which especially exacerbate in connection with the active processes of formation and growth of urban agglomerations, are considered:

Table 1

Ecological Problems of Urban Areas

Problem	Directions of Impact
High loads on lithosphere	Changes in the relief, in the structure of catchment basins, in the properties of lithosphere, formation of caverns as results of construction works
High loads on landscape	Destruction of natural landscapes in cities and their suburbs as a result of high attendance of recreational areas; the alienation of land for landfills, residential development, motorways; lack of recreational areas; plant diseases as a consequence of changes in the composition of soils, atmosphere and hydrosphere pollution; the formation of «urban» species composition of vegetation

Cont. tabl. 1

Problem	Directions of Impact
Problems related to water supply	Significant changes in the water balance; active exploitation of water resources and changes in the hydrological and hydrogeological situation as consequences; influence of economic activities on the state of sources of drinking water; interaction of surface and ground waters
Problems associated with air pollution	Acid precipitation; excessive dust content in the atmosphere, «heat islands», etc.
Problems of solid waste management	Accumulation of solid wastes in urban areas, institutional contradictions accompanying the process of their utilization
Light pollution, vibration, noise, electromagnetic radiation	Light pollution, vibration, noise, electromagnetic radiation that have negative impact on the population of a city and its suburbs
Problems associated with the functioning of city's engineering and transport infrastructure (power supply, sewerage, transport, water, heat, gas, etc.)	Negative impact of engineering and transport infrastructure of a city and its suburbs on the state of urban environment

Source: compiled by the authors

2. Literature review

In this study our attention is concentrated on Russian cities. The ecological problems of Russian cities are very acute. There are various approaches to assessing the quality of urban environment. For example, an ecological rating of Russian cities is drawn up annually by the specialists of the Ministry of Natural Resources and Ecology of the Russian Federation (The Ministry of Natural Resources..., 2016). The rating methodology was developed by the company EY (Ernst & Young) under the order of the Ministry of Natural Resources of Russia, taking into account the recommendations of the Organisation for Economic Co-operation and Development (OECD) and world analogues. This methodology provides for an assessment on basis of 26 indicators, which are grouped according to the following sections: air quality (4 indicators), water consumption and its quality (4 indicators), use of territories (2 indicators), waste management (3 indicators), transport (4 indicators), energy consumption (4 indicators) and environmental impact management (5 indicators). In order to obtain the initial data official requests are sent to all regions of the Russian Federation.

94 cities took part in the last rating of 2015 (as well as in the rating of 2014). Besides the capitals of all regions of Russia and federal cities, 9 other cities participated in the rating: Vyborg, Glazov, Evpatoria, Yelets, Mozhga, Nefteyugansk, Ramenskoye, Sarapul, Surgut. At the same time, 39 cities could not collect enough data for one or several categories and they did not enter the general rating.

In the rating of 2015 leading positions were occupied by Gorno-Altaisk, Moscow, Vologda, Magas and Kursk. Simultaneously Simferopol was the first in air quality, Syktyvkar — in the level of waste management, and Kyzyl — in water quality. Lipetsk, Yuzhno-Sakhalinsk, Salekhard, Vladivostok and Tyumen were in the end of the general rating.

Despite the fact that the ecological rating of Russian cities (described above) is considered to be the most comprehensive, objective and compiled annually (from 2013), its methodology implies the collection of hard-to-access information (for example, the indicator «the share of more ecological transport» from the section «transport»), which is not always reflected in official statistical publications. Moreover, the lack of actual data on indicators reduces the position of a city in the rating, which significantly distorts the results of the assessment.

The rating of sustainable development of Russian cities, which is compiled annually (since 2012) by the rating agency «SGM» (The «SGM» Agency, 2016), is another example of an integrated assessment of environmental quality of cities in Russia.

The methodological basis of the rating is founded on the concept of a triune outcome, which takes into account both economic performance of activities, and social, environmental impact of economic entities or a city/ a region. All three components are included in the final index of sustainable development of a city on the basis of the principle of equivalence.

The assessment of sustainable urban development is based on the analysis of 31 statistical indicators, describing a city by four main categories: social infrastructure (9 indicators), urban infrastructure (7 indicators), economic development (9 indicators), ecology (3 indicators). The three remaining indicators characterize demographic situation in a city. The converted private indicators are included in the final index of a category according to their weight, determined expertly. Only those indicators are used in the assessment that is available for the largest number of cities (at least 95% of the total number). It is worth mentioning that the division of indicators into categories and their number differ depending on the year of rating, which makes it difficult to analyze the dynamics of sustainable development of Russian cities.

Open statistical data on municipalities, the websites of regional divisions of Rosstat and the chargeable statistical portal «Multistat» are the main sources of information for drawing up the rating.

The rating embraces the cities of the Russian Federation with a population of 100 thousand people and more (in 2015 179 Russia's cities met this criterion).

In 2015 the absolute leaders of the sustainable development rating were Tyumen, Surgut and Moscow. The top ten leaders also included Krasnodar, Perm, St. Petersburg, Ekaterinburg, Kazan, Nizhnevartovsk and Nefteugansk. The cities-outsiders of the rating were Kamyshin, Novocherkassk, Taganrog, Grozny, Murom, Biysk, Miass, Nizhny Tagil, Artem, Belovo.

This rating mainly assesses the level of socio-economic development of cities rather than their sustainability. The ecological component is represented by only three indicators, one of which describes the degree of air pollution (specific emissions of pollutants per 1 sq. km of urban area), the other — the level of water consumption (water consumption per unit of industrial output), the third — the density of urban population. The use of expert assessments when calculating summary indices by categories imparts subjective character to the rating.

3. Methodology

In this study our attention is concentrated on Russian cities with the population of 100 thousand inhabitants and more. In 2015 74% of Russia's population lived in cities; 29% of the urban population — in big cities with a population of 1 million people and more (United Nations, 2016).

The analysis of open, officially published statistics of the Federal State Statistics Service for Russian cities with the population of 100 thousand people and more over a period of 2004–2016 (Federal Service of State Statistics (Rosstat), 2005, 2006, 2007, 2009, 2011, 2013, 2015, 2017) allowed us to identify cities with unfavourable ecological situation and to determine the trends of pollution of atmospheric air, surface water bodies and land resources. It is worth noting that, unlike regional statistics, municipal one has a very narrow set of indicators and different time series.

In 2013 the Federal State Statistics Service (Rosstat) published the bulletin «Key Environmental Indicators», where, among other things, the data on emissions of air pollutants from stationary sources and road transport were presented for 181 Russian cities for 2012.

In the bulletin of 2015 the data for 2014 were published on the Rosstat website, but these data were focused on regions in general, and not on certain cities. In the survey of 2015 the list of cities is much smaller (37 cities) than in the bulletin of 2013 and the surveys of 2015 and of 2017 do not have data on automobile emissions. Therefore, in our study of the most environmentally polluted cities in Russia the data from the bulletin of 2013 (rather than from the one of 2015 and of 2017) were used.

It is also worth mentioning that the distribution of places in the rating by total volume of emissions does not always reflect the real difference in environmental pollution of cities. For example, by total emissions Moscow is in the second place, and Krasnoyarsk is in the 11th place. But in Krasnoyarsk sulfur dioxide prevails in emissions of pollutants (more than 80%), which is 2 times more toxic than nitrogen dioxide, whose content is about 50% in pollutant emissions in Moscow.

4. Key Results

Figure 1 shows the emission of pollutants into atmosphere (per square kilometer of urban area) in twenty cities of Russia with the highest values of this indicator as of 2012.

In 2012 the leader in the emissions of pollutants from all sources was Norilsk. The basic mass of pollution came from stationary sources, mainly from the world's largest mining and metallurgical plant (Polar Division of Public Joint Stock Company "Mining and Metallurgical Company "Norilsk Nickel"). Cherepovets and Angarsk are also among the top three leaders in this indicator. In other cities the values of this indicator did not exceed the value of 1000 tons per square kilometre of urban area. In 2012 in Moscow the contribution of road transport to air pollution was 93%, in Yaroslavl — 48%, in Ryazan — 38%, in Krasnoyarsk and Chelyabinsk — 37%, in Tula — 33%, in Omsk — 28%. In the other cities, shown in Fig. 1, the main contribution to air pollution was made by stationary sources (enterprises, organizations).

The dynamics of pollutant emissions into atmosphere from stationary sources in twenty cities of the Russian Federation under consideration for the period from 2004 to 2012 testifies to the lack of a common trend for all cities (see Figure 2).

In Angarsk, Novocherkassk and Omsk there is a tendency to the increase in emissions of pollutants into atmosphere from stationary sources (per square kilometre of urban area), in Cherepovets, Sterlitamak, Tula, Achinsk, Severodvinsk, Chelyabinsk, Volzhsky, Salavat and Ryazan — a tendency to the decrease, and in Norilsk, Lipetsk, Moscow, Novokuznetsk, Magnitogorsk, Krasnoyarsk, Nizhny Tagil and Yaroslavl — stabilization at approximately the same level.

Figure 3 presents the dynamics of pollutants' emissions from road transport in twenty cities of the Russian Federation — leaders in total emissions into atmosphere in 2012, calculated per square kilometre of urban area. This dynamics was formed, using available statistics for three years: 2010, 2012 and 2014. As above no common tendency for the cities under consideration was observed. The clear tendency of growth of pollutants' emissions into atmosphere from road transport was traced in Moscow, Sterlitamak, Chelyabinsk and Salavat, and the reduction of emissions was in Norilsk, Novokuznetsk, Volzhsky and Yaroslavl.

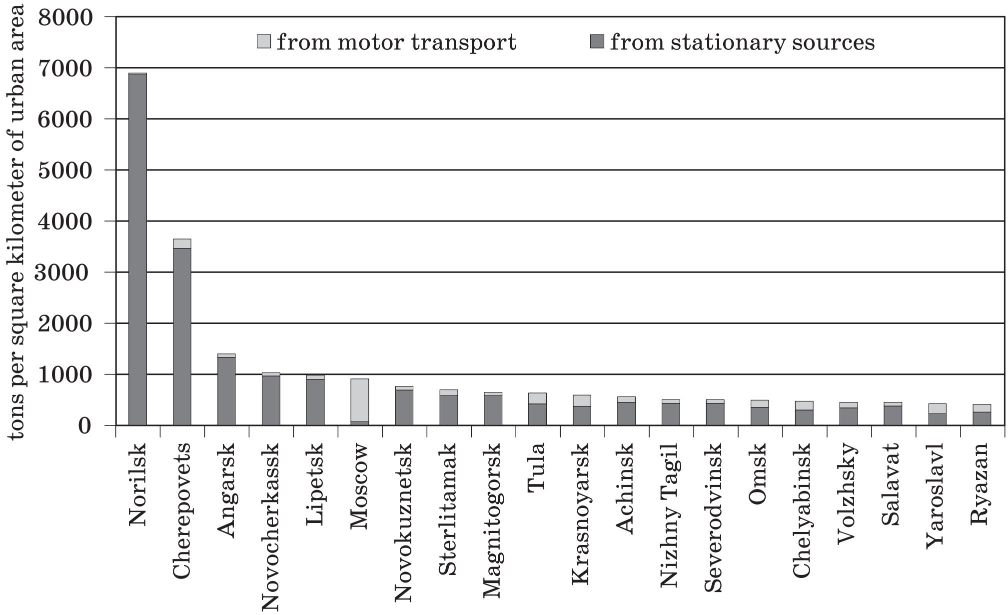

Figure 1. Emission of Pollutants into Atmosphere in Twenty Russian Cities
with the Highest Values of This Indicator (as of 2012)

S o u r c e: compiled by the authors.

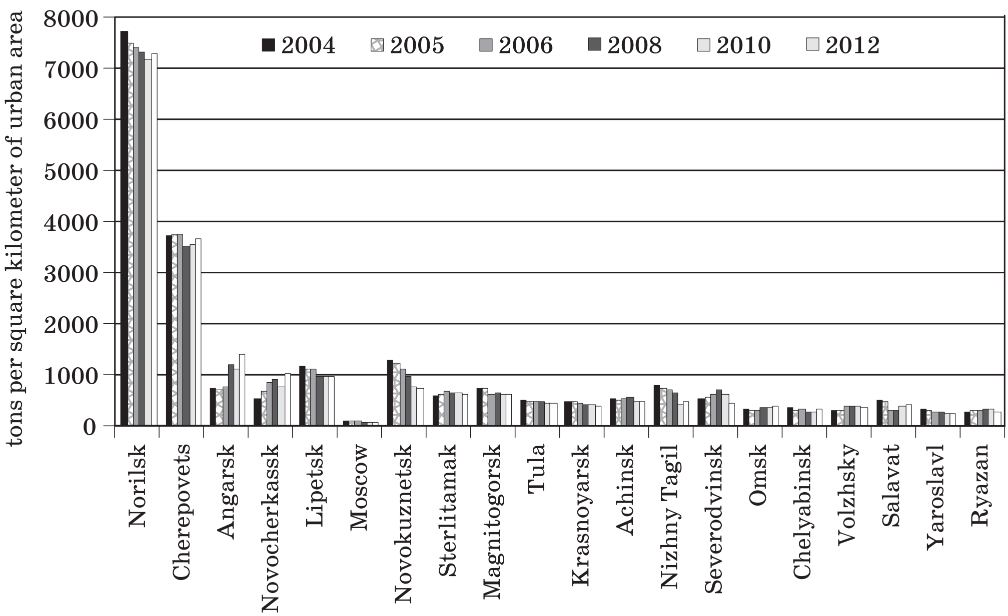

Figure 2. Dynamics of Pollutant Emissions into Atmosphere from Stationary Sources
in Twenty Cities of the Russian Federation — Leaders in Total Pollutant Emissions in 2012

S o u r c e: compiled by the authors.

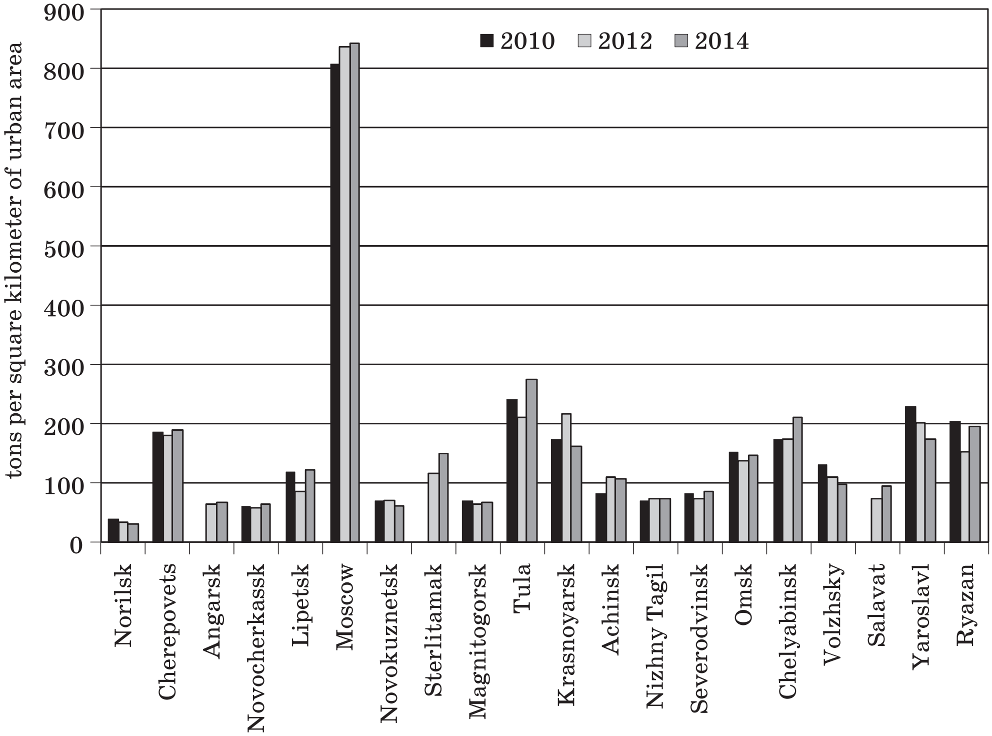

Figure 3. Dynamics of Pollutant Emissions into Atmosphere from Motor Transport in Twenty Russian Cities — Leaders in Total Pollutant Emissions in 2012

S o u r c e: compiled by the authors.

Nine of the considered cities — leaders in total emissions into atmosphere in 2012, calculated per square kilometre of urban area, (Norilsk, Novocherkassk, Moscow, Sterlitamak, Magnitogorsk, Krasnoyarsk, Achinsk, Nizhny Tagil and Chelyabinsk) were included in the Priority List of cities with very high levels of atmospheric air pollution. The Priority List was drawn up by specialists of Roshydromet based on the comprehensive analysis of observations in 2012 (Roshydromet, 2013). It includes 28 cities with different population size (including less than 100 thousand people), in which Roshydromet conducts regular observations of atmospheric condition. 20 out of 28 cities are located in the Asian part of Russia, which is characterized by particularly unfavourable climatic conditions for dispersion of impurities.

Further, on the basis of available data for 2008 twenty cities of the Russian Federation with population of 100 thousand people and more — the leaders in the volume of polluted sewage, discharged into surface water bodies, (per capita) were sorted out (see Figure 4). This list of cities differs from the previous one. However, there are cities that are included in both lists. These are Norilsk, Angarsk, Novokuznetsk, Magnitogorsk, Achinsk and Nizhny Tagil.

Data on the volume of wastewater, discharged into surface water bodies, for Russian cities are given for 2009, since no information for later periods has been published (Federal Service of State Statistics (Rosstat), 2011, 2013, 2015, 2017).

In 2009 Vladivostok, Angarsk and Magnitogorsk were among the top three leaders in discharging contaminated sewage into surface water bodies. Despite the fact that Mag-

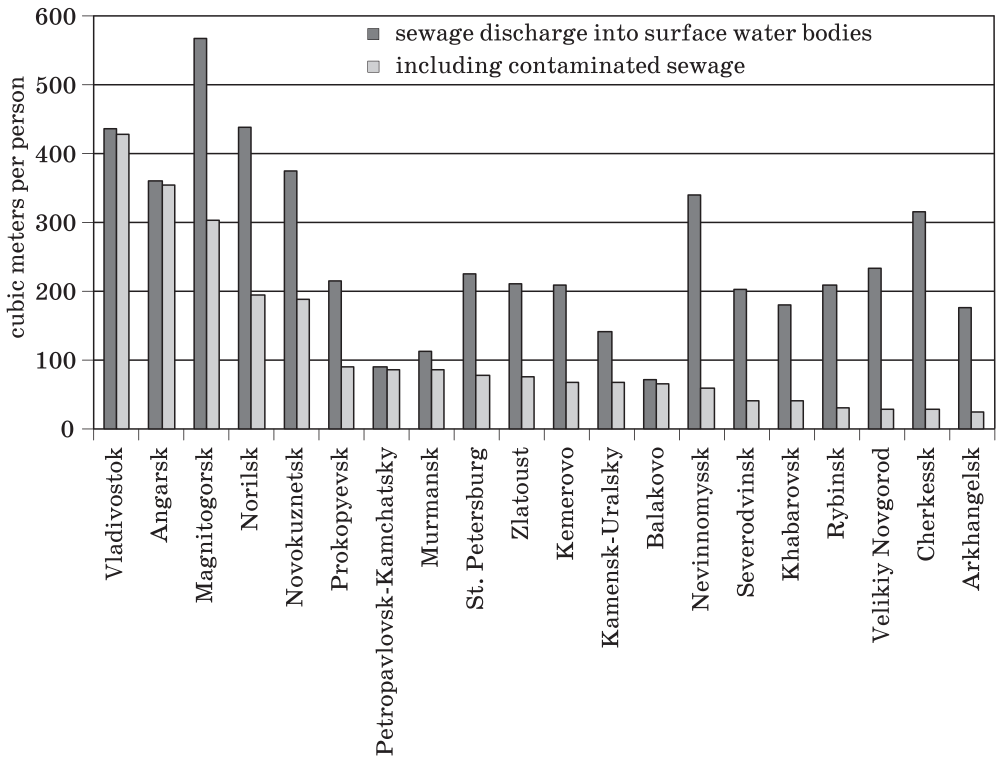

Figure 4. Volume of Wastewater, Discharged into Surface Water Bodies, in Twenty Russian Cities — Leaders in Volume of Discharged Polluted Sewage (as of 2009, volume per capita)

Source: compiled by the authors.

nitogorsk is in this list, the volume of discharged contaminated sewage was 53,5% of total discharge of sewage. Only in Vladivostok, Angarsk, Petropavlovsk-Kamchatsky and Balakovo discharged sewage was not partially cleaned at treatment facilities. In other cities under consideration all wastewater was discharged into surface water bodies with treatment, preventing environmental damage.

The dynamic analysis of per capita polluted sewage, discharged into surface water bodies, also shows the absence of a common trend for all cities, but almost in all twenty cities the value of this indicator in 2009 was the lowest in comparison with its value in other years (see Figure 5).

Thousands, millions cubic meters of solid domestic wastes are generated in cities annually. They can be transported to landfills after or without industrial reprocessing. Waste disposal without recycling causes the greatest damage to environment than waste burial of industrial reprocessing leavings. Table 2 shows twenty Russian cities with the largest per capita volume of solid domestic wastes, buried without their industrial reprocessing, as of 2012.

As it can be seen from Table 1, in all cities under consideration (except Arkhangelsk and Vladimir) almost all domestic wastes were delivered to landfills without industrial reprocessing. In Arkhangelsk 16% of removed solid domestic wastes were reprocessed, in Vladimir — 5%.

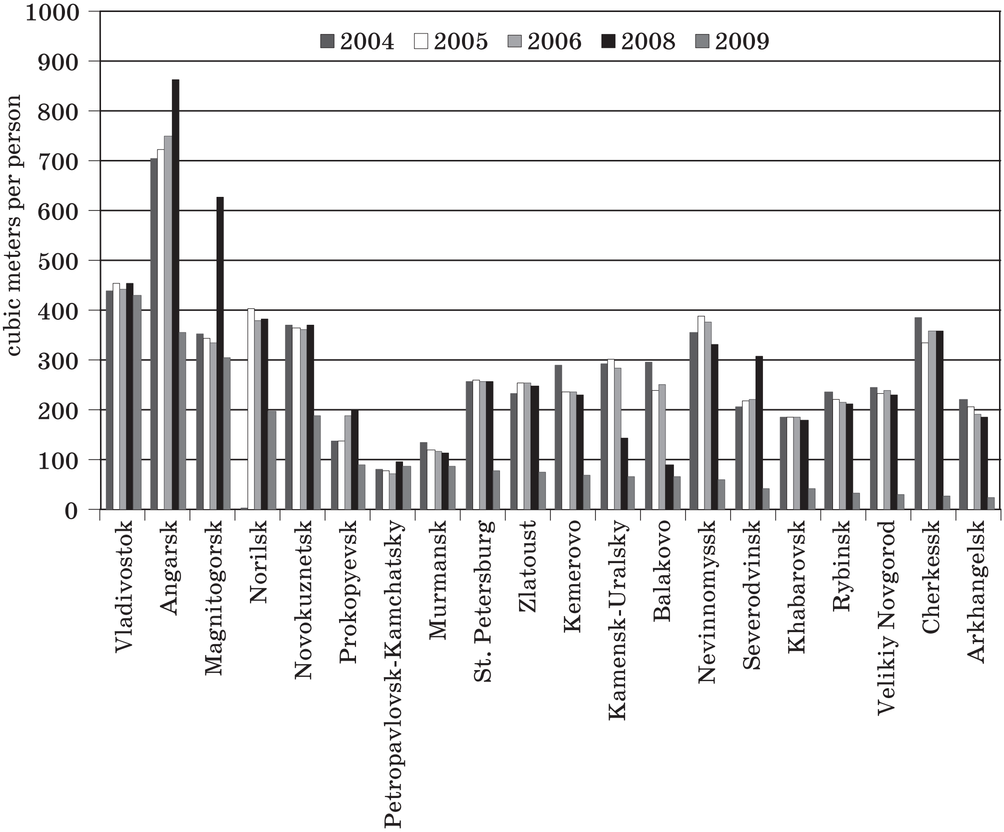

Figure 5. Dynamics of Per Capita Volume of Polluted Sewage, Discharged into Surface Water Bodies, in Twenty Cities with the Largest Values of This Indicator in 2009

Source: compiled by the authors.

Table 2

Russian Cities with the Largest Volumes of Solid Domestic Wastes Transported to Landfills without Industrial Reprocessing in 2012

City	Removed Solid Domestic Wastes per Year, thousand cubic meters	Solid Domestic Wastes, Buried without Industrial Reprocessing	
		Thousand Cubic Meters	Cubic Meters per Capita
1	2	3	4
Elista	996,4	996,4	9,6
Samara	9202,1	9202,1	7,9
Irkutsk	4678,5	4678,5	7,8
Krasnodar	4334,3	4334,3	5,7
Saratov	4702,6	4699,6	5,6
Penza	2341,6	2341,6	4,5

Cont. tabl. 2

1	2	3	4
Veliky Novgorod	962,7	962,7	4,4
Petropavlovsk-Kamchatsky	760,0	760,0	4,2
Blagoveshchensk (Amur Region)	895,6	895,6	4,1
Kaluga	1328,5	1328,5	4,1
Arkhangelsk	1687,6	1420,5	4,1
Vladimir	1352,4	1281,1	3,7
Tyumen	2231,1	2231,1	3,7
Kaliningrad	1485,0	1485,0	3,4
Tomsk	1831,0	1831,0	3,4
Nizhny Novgorod	4219,7	4219,7	3,4
Tver	1355,1	1355,1	3,3
Yuzhno-Sakhalinsk	613,0	613,0	3,3
Syktyvkar	783,0	783,0	3,3
Volgograd	3163,7	3163,7	3,1

Source: compiled by the authors.

It is worth noting that in 2002 in the Russian cities under consideration per capita volumes of solid domestic wastes were high enough. The specific value of the analyzed indicator ranged from 3 to 10 cubic meters per person. It is well known that the volume of solid domestic wastes formation is chiefly determined by standard of living of population. In 2012 in Moscow the volume of removed solid domestic wastes per capita amounted to 1.1 cubic meters, in St. Petersburg — to 1.5 cubic meters. The issue of dependence of the volumes of solid domestic wastes formation on standard of living of Russian urban population requires special consideration and analysis.

From 2005 to 2012 in all twenty cities under consideration there was an increase in the volume of removed solid domestic wastes (see Figure 6). The greatest growth for this period was observed in the top three leading cities in terms of the volume of solid domestic wastes, transported to landfills without industrial reprocessing: in Elista (six times), in Samara (four times) and in Irkutsk (three times). The increase in the volume of removed solid domestic wastes may indicate either a growth of city-dwellers' well-being, or an efficiency increase of public utilities supply, or an improvement in the quality of functioning of accounting and controlling wastes system. There may be other factors that require a special study in each particular city.

Russian cities, presented in Table 2 and in Figure 6, are neither among twenty cities with the highest total air pollutant emissions in 2012 nor among the number of cities with the maximum volume of discharged untreated sewage in 2009 (see Table 3).

Russian cities with unfavourable ecological situation by three indicators (criteria) are presented in Table 3. There are some cities with unfavourable ecological situation according to the first two above-mentioned criteria simultaneously. These are Norilsk, Angarsk, Novokuznetsk, and Magnitogorsk. In these cities negative impact on atmospheric air and surface water bodies is one of the strongest in comparison with other cities in Russia not included in the corresponding lists. This negative impact is chiefly induced by large industrial enterprises, located in these cities (see Table 4).

Arkhangelsk and Petropavlovsk-Kamchatsky are among the cities with the highest negative impact on water and soil resourses in Russia.

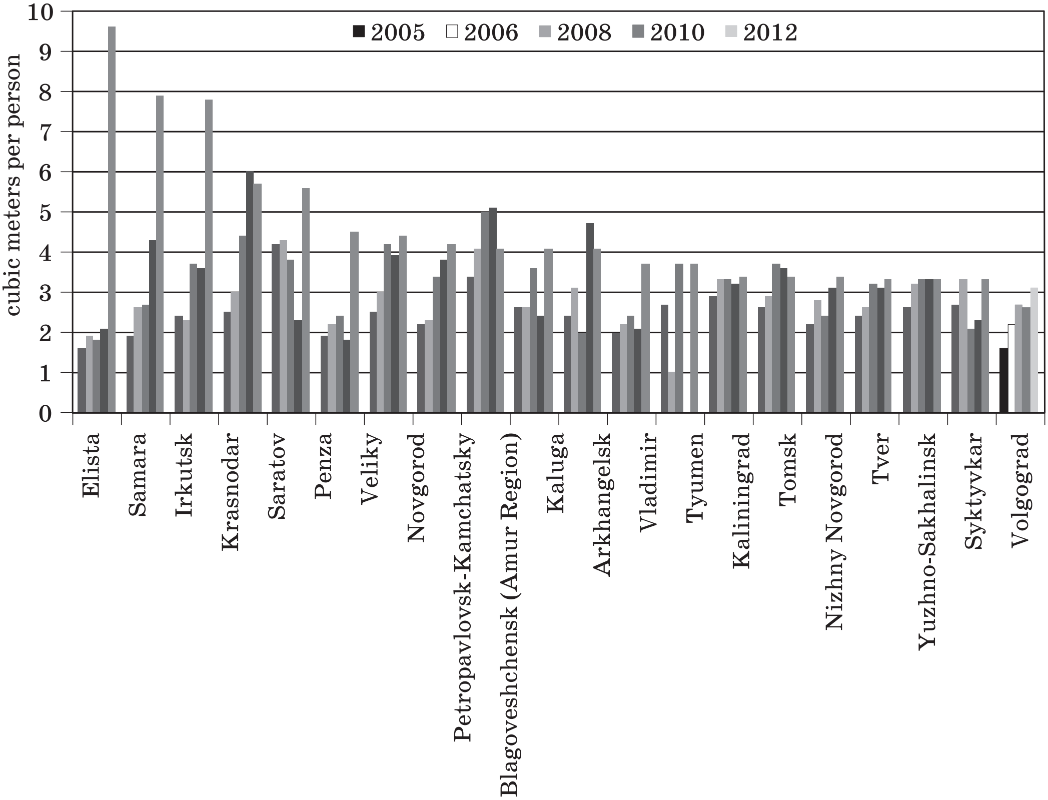

Figure 6. Dynamics of Volume of Solid Domestic Wastes, Transported to Landfills Without Industrial Reprocessing, in Russian Cities with the Largest Values of This Indicator in 2012

Source: compiled by the authors.

Table 3

Twenty Russian Cities with the Most Unfavourable Ecological Situation According to Three Considered Criteria

(*The Most Polluted Cities of the Russian Federation, According to the Indicator (Criterion)*)

Total Emissions of Air Pollutants, tons per square kilometer of urban territory (as of 2012)	Volume of Contaminated Sewage Discharge, cubic meters per person (as of 2009)	Volume of Solid Domestic Wastes, Buried without Industrial Reprocessing, cubic meters per person (as of 2012)
1	2	3
Norilsk	Vladivostok	Elista
Cherepovets	Angarsk	Samara
Angarsk	Magnitogorsk	Irkutsk
Novocherkassk	Norilsk	Krasnodar
Lipetsk	Novokuznetsk	Saratov
Moscow	Prokopyevsk	Penza
Novokuznetsk	Petropavlovsk-Kamchatsky	Veliky Novgorod

Cont. tabl. 3

1	2	3
Sterlitamak	Murmansk	Petropavlovsk-Kamchatsky
Magnitogorsk	St. Petersburg	Blagoveshchensk (Amur Region)
Tula	Zlatoust	Kaluga
Krasnoyarsk	Kemerovo	Arkhangelsk
Achinsk	Kamensk-Uralsky	Vladimir
Nizhny Tagil	Balakovo	Tyumen
Severodvinsk	Nevinnomyssk	Kaliningrad
Omsk	Severodvinsk	Tomsk
Chelyabinsk	Khabarovsk	Nizhny Novgorod
Volzhsky	Rybinsk	Tver
Salavat	Velikiy Novgorod	Yuzhno-Sakhalinsk
Yaroslavl	Cherkessk	Syktyvkar
Ryazan	Arkhangelsk	Volgograd

Source: compiled by the authors.

Table 4

Main Polluters in Russian Cities with the Most Unfavourable Ecological Situation According to Two of Three Considered Criteria

City	Main Sources of Pollution
Norilsk	Polar Division of PJSC Mining and Metallurgical Company «Norilsk Nickel»
Angarsk	Number of factories of JSC «Angarsk petrochemical company», heat power plants, construction plants, PJSC «Sibreactiv», JSC «Angarsk Electrolysis Chemical Combine»
Novokuznetsk	Plants of ferrous and non-ferrous metallurgy (first of all PJSC West-Siberian Metallurgical Combine, including West Siberian heat and power plant)
Magnitogorsk	Plants of ferrous metallurgy (primarily PJSC «Magnitogorsk Iron and Steel Works»)

Source: compiled by the authors.

5. Discussion and Conclusion

The analysis of the approaches to the integrated assessment of environmental quality in Russian cities (the rating of sustainable development of Russian cities, the ecological rating of Russian cities), fulfilled in this research, showed that such assessments entail great difficulties with the collection of hard-to-access information, which is not always reflected in official statistical publications, and as a result they are often unrepresentative. Taking into account that, unlike regional statistics, municipal (urban) one has a very narrow set of indicators and different time series, the integrated assessments of environmental quality in Russian cities is not recommended for practice.

So within the bounds of this work ecological and economic analysis of Russian cities with the population of 100 thousand people or more was performed separately for different components of the urban environment: air, water and ground. This analysis made it possible to identify the cities with the most unfavourable environmental conditions. Norilsk, Angarsk, Novokuznetsk, and Magnitogorsk were in the top 20 cities of Russia, which have the strongest negative impact on the state of atmospheric air (per square kilometer of urban area, as of 2012), and simultaneously in the top twenty Russian Cities, most intensively polluting surface water bodies (per inhabitant, as of 2009).

Two cities — Arkhangelsk and Petropavlovsk-Kamchatsky — were the worst according to the second and the third criteria: per capita volume of contaminated sewage discharge and per capita volume of solid domestic wastes, buried without industrial reprocessing, respectively.

From 2005 to 2012 in most Russian cities there was a total increase in the volume of the solid domestic wastes transported to landfills without industrial reprocessing.

The low quality of environment in these cities is largely due to natural and climatic conditions (bad conditions for contaminants dispersion) and specifics of their economic development: functioning of large industrial enterprises of ferrous and non-ferrous metallurgy, petrochemistry, construction industry. To improve the environmental quality in these cities comprehensive social, environmental and economic solutions are required.

The basis of environmental issues is socio-economic processes and phenomena. In the development strategies of these cities it should be recognized that the creation of favourable environmental conditions for cities' dwellers is impossible without solving the problems of functioning of industrial enterprises located in these cities. Either a lot of financial resources should be spent to create an expensive system of treatment facilities at enterprises, or these enterprises should be relocated from the cities at a safe for urban environment distance and the problem of transport availability of these enterprises to their workers should be solved.

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