UDC 614.7
DOI: 10.21668/health.risk/2019.4.01.eng

Read online

POPULATION HEALTH AS A TARGET FUNCTION AND CRITERION FOR ASSESSING EFFICIENCY OF ACTIVITIES PERFORMED WITHIN "PURE AIR" FEDERAL PROJECT

A.Yu. Popova[1, 3], N.V. Zaitseva[2], I.V. May[2]

[1]Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing, 18, bld. 5 and 7, Vadkovskiy pereulok, Moscow, 127994, Russian Federation
[2]Federal Scientific Center for Medical and Preventive Health Risk Management Technologies, 82 Monastyrskaya Str., Perm, 614045, Russian Federation
[3]Russian Medical Academy for Postgraduate Studies, 2/1 Barrikadnaya Str., Moscow, 123995, Russian Federation

We took several cities (Bratsk, Krasnoyarsk, Norilsk, and Chita) included as priority ones into the "Pure air" federal project as an example and showed that it was not sufficient to only aim at reducing gross emissions of pollutants and apply it as a criterion to assess efficiency of air-protecting activities performed in a city. Health risk calculations, and comparative analysis of risk assessment and medical statistical data on population applying for medical aid, combined with the results of profound targeted examinations, revealed that medical and demographic losses (additional population mortality and morbidity) occurred due to a significant number of chemical admixtures, including those, who were not included into a list of pollutants which had to be reduced. Consequently, air-protecting activities don't necessarily result in relevant improvement of a sanitary-hygienic and medical-demographic situation. Residual health risks still remain high.

We showed that there were several significant aspects related to developing and working out in detail complex regional action plans within the "Pure air" federal project. They were a necessity to constantly and profoundly inform a wide circle of people who make decisions on ambient air protection about adverse impacts exerted by specific components in emissions on population health and actual medical and demographic losses on a territory; to assess whether it was technically possible to achieve recommended emission levels and to discuss it with economic entities in order to work out optimal decisions as regards orientation and urgency of specific activities in the sphere; to integrate assessments of air-protecting activities efficiency with prospect city-planning in a region, and to include compensatory medical and prevention activities into regional action plans that should help achieving acceptable health risks levels.

Key words: *"Pure air" federal project, sanitary-hygienic situation, ambient air pollution, risk, population health.*

Strategic documents adopted in the RF, including The RF President Order dated May 07, 2018 No. 204[1, 2], set priority goals for the country development; medical and demographic

Anna Yu. Popova – Doctor of Medical Sciences, Professor, Supervisor, Head of the Department for Sanitary-Epidemiologic Service Organization (e-mail: rmapo@rmapo.ru; tel.: +7 (499) 458-95-63; ORCID: https://orcid.org/0000-0002-4315-5307).

Nina V. Zaitseva – Academician of the Russian Academy of Sciences, Doctor of Medical Sciences, Professor, Scientific Director (e-mail: znv@fcrisk.ru; tel.: +7 (342) 237-25-34; ORCID: https://orcid.org/0000-0003-2356-1145).

Irina V. May – Doctor of Biological Sciences, Professor, Deputy Director responsible for research work (e-mail: may@fcrisk.ru; tel.: +7 (342) 237-25-47; ORCID: https://orcid.org/0000-0003-0976-7016).

[1] On the Concept for the long-term social and economic development of the Russian Federation up to 2020 (together with The Concept for the long-term social and economic development of the Russian Federation up to 2020): The RF Government Order dated November 17, 2008 No. 1662-r (last edited on September 28, 2018). *KonsultantPlus*. Available at: http://www.consultant.ru/document/cons_doc_LAW_82134/ (date of visit September 13, 2019).

[2] On national goals and strategic tasks regarding The RF development up to 2024: The RF President Order dated May 07, 2018 No. 204. *Garant*. Available at: https://www.garant.ru/products/ipo/prime/doc/71837200/ (date of visit September 13, 2019).

issues are obviously among the most significant ones. They concern population life expectancy, an increase in population number, a decrease in mortality among employable population caused by cardiovascular system diseases, malignant neoplasms, etc. These priorities have been selected quite relevantly as unfavorable demographic trends unavoidably exert negative influence on the RF status in the world, make the country lag behind technological leaders and prevent any rise in life quality and living standards [1, 2].

Activities that should be implemented within national projects, including "Ecology" national project, are supposed to help achieving necessary positive dynamics of population life expectancy and decrease in population mortality and morbidity. "Ecology" national project doesn't have a direct priority as regards reducing population health risks, improving medical and demographic parameters, or providing citizens with more comfortable living environment[2]. The project is oriented at overall decrease in negative technogenic impacts on the environment. Thus, "Pure air" federal project[3], which is an integral part of "Ecology" national project, fixes a key task to *"…decrease ambient air contamination in large industrial centers, including not less than a 20 % decrease in total emissions of pollutants into ambient air in the most contaminated cities"*

The project fixes also priority territories where issues related to ambient air contamination are the most pressing. They include such cities as Bratsk, Krasnoyarsk, Norilsk, Lipetsk, Magnitogorsk, Nizhniy Tagil, Novokuznetsk, Omsk, Chelyabinsk, Cherepovets, and Chita. Approximately 6.4 million people live there. All these territories suffer from high or elevated ambient air contamination.

As planned, approaches to optimal planning and implementation of air protection activities are to be tested in 12 priority cities; they should allow achieving a fundamental improvement in the existing situation. Should these approaches be considered efficient, they can be also applied in other cities and on other territories in the country[4].

A decrease in overall emissions of pollutants into the atmosphere undoubtedly seems to be a most significant task as it is a relevant tool for preserving natural chemical structure of ambient air or atmospheric heat balance. However, it is only secondary next to reducing adverse impacts on population health, especially on densely populated territories such as large industrial cities.

Results obtained via large-scale and long-term research, including works recognized by the World Health Organization, prove that ambient air contamination produces adverse effects on population mortality and morbidity. Relevant scientific works confirm that additional death cases may occur among population due to respiratory organs diseases and cardiovascular system diseases caused by ambient air being contaminated with fine-dispersed dust [3–5], and sulfur dioxide [6]. Benzpyrene, benzene, compounds of chromium, lead, nickel, cadmium, and arsenic, and polycyclic hydrocarbons cause additional cancer cases when they are introduced with inhaled air [7–9]. Various diseases occur in the respiratory organs under exposure to elevated concentrations of nitrogen dioxide, hydrogen chloride, hydrogen sulfide, ammonia, toluene, xylol, phenol, and some other admixtures [10–16].

As per results of macroanalysis, in the RF only in 2018 there were approximately 2.4 thousand additional death cases caused by ambient air contamination (respiratory organs diseases and malignant neoplasms). Effects produced by ambient air contamination are likely to result in about 863.55 thousand disease cases among children and adults; these diseases occur in the respiratory organs, circulatory system, musculoskeletal system, connectivity tissue, and blood and blood-making organs; there are also certain disorders in the immune mechanism, nervous sys-

[3] The Profile of "Ecology" national project. Approved on December 24, 2018. Available at: https://rg.ru/2018/05/08/president-ukaz204-site-dok.html (date of visit October 02, 2019).

[4] The Profile of "Pure air" federal project. Available at: https://rg.ru/2018/05/08/president-ukaz204-site-dok.html (date of visit October 02, 2019).

ISSN (Print) 2308-1155 ISSN (Online) 2308-1163 ISSN (Eng-online) 2542-2308

tem, endocrine system, digestive organs, and neoplasms[5].

When population health becomes a criterion for assessing efficiency of measures taken within "Pure air" federal project, lists and parameters of air-protecting activities should be well-defined and well-substantiated. A simple reduction in overall emissions by a fixed volume is not always efficient without taking into account actual hazards caused by this or that component for people's lives and health; so, it can't always lead to a substantial increase in population life quality and make a sanitary-hygienic situation conform to fixed standards [17].

Plans which are designed within a project are not fixed once and for all; they can be adjusted, specified, and supplemented. Thus, it seems truly vital to get a better insight into algorithms and procedures for assessing efficiency of suggested activities according to medical and demographic criteria. However, it doesn't mean that ecological, technical and/or technological criteria applied in such assessments should be neglected.

Our research goal was to test a mechanism for assessing sufficiency and efficiency of activities implemented within "Pure air" federal project as per health-related criteria[6].

Data and methods. We achieved our research goal via step-by-step finding solutions to the following tasks thus making an overall algorithm:

– assessing ambient air quality in areas where people permanently lived in priority cities;

– assessing population health risks;

– splitting up unacceptable risks into components and assessing contributions made by specific pollutants into overall existing risks;

– comparing risk levels with population morbidity in order to determine whether risk assessments are consistent with the existing medical and demographic situation on a particular territory;

– analyzing regional sets of air-protecting activities regarding effects expected to be produced by them being relevant to risk factors structure;

– working out recommendations on improvements that are to be made in activities implemented within "Pure air" federal project.

We tested the algorithm in Krasnoyarsk, Norilsk, Bratsk, and Chita; we applied health risk assessment methodology as our basic methodical instrument for assessing whether implemented activities were sufficient and yielded expected results. The methodology was supplemented with comparative analysis of the results obtained via the assessment and medical statistical data as well as data obtained via specific research.

To assess population exposure, we took air quality monitoring data collected over a long-term period at stationary monitoring posts belonging to Rosgidromet state ecological monitoring network and posts included into Rospotrebnadzor's social and hygienic monitoring system.

We calculated lifetime carcinogenic risk taking an upper 95 % -limit of average annual long-term (2014–2018) concentration of a specific admixture as contamination level; all analyzed admixtures were measured at monitoring posts located in examined cities. Non-carcinogenic risk was calculated basing on the same initial data but it was given with hazard quotients and indexes (Hazard Index, HI)[7].

When calculated health risks were considered to be "unacceptable", we split them up into specific components and assessed contributions made by each substance into an overall health risk level. It was done in order to determine substances that made the most significant contribution into health risks; so, should their ground concentrations be reduced, it would produce the most considerable effects regarding population health improvement.

We compared calculated risk levels with

---

[5] On sanitary-epidemiologic welfare of the population in the Russian Federation in 2018: the State Report. Moscow The Federal Center for Hygiene and Epidemiology, 2018, 246 p.

[6] Economic aspects related to such activities were excluded from the present work; we also didn't perform any conformity assessment to check whether examined activities could be considered the best available ones as per technological parameters.

[7] P 2.1.10.1920-04. The Guide on assessing population health risks under exposure to chemicals that pollute the environment. Moscow, The Federal Center for State Sanitary and Epidemiologic Surveillance of the RF Public Healthcare Ministry, 143 p.

data on population mortality and morbidity taken from the official medical statistics[8], and with results obtained via in-depth research performed on selected territories.

We assessed contents and structure of regional air-protecting activities as per "Complex plans of activities aimed at reducing pollutants emissions…" in regions approved by the Deputy Head of the Russian Federation Government on December 28, 2018.

Basic results. We analyzed results obtained via long-term instrumental measuring within Rosgidromet ecological monitoring and Rospotrebnadzor's social and hygienic monitoring system; the analysis revealed that there was a wide range of chemical admixtures registered in ambient air on territories where people permanently lived in the examined cities. Thus, in Bratsk, 29 chemicals were registered in significant concentrations, and some of them were even higher than hygienic standards. Seven chemicals were carcinogens (benzpyrene; benzene; compounds of nickel, lead and chromium; formaldehyde; ethyl benzene).

Even more pollutants were registered with instrumental methods in Krasnoyarsk; there were totally 37, 5 out of them being carcinogenic. 15 admixtures were registered and measured by Rosgidromet and Rospotrebnadzor in Norilsk; in Chita, 21 admixtures.

Practically all the measured admixtures produce well-proven adverse effects on health under short-term and/or long-term exposure.

Table 1 gives some average annual concentrations of chemicals registered in 2014–2018 in Bratsk. It also contains exposure criteria (reference concentrations); should they be exceeded, adverse effects on population health and target organs and systems are likely to occur. If population is exposed to concentrations that exceed reference ones, functional disorders in these target organs or systems are to be expected.

Population health risks calculated on the basis of field observation results were assessed as unacceptable ones as per various violations of hygienic standards practically on all the examined territories. Table 2 contains health risks parameters and characteristics[9] in Bratsk.

Table 1

Concentrations of chemicals with proven adverse effects on health under long-term exposure fixed at monitoring posts included into ecological and social and hygienic monitoring systems in Bratsk in 2014–2018

Chemical	Concentration, mg/m^3			Target organs and systems
	Average annual long-term	95-% provision	RfC	
Nitrogen dioxide	0.0408	0.0512	0.040	Respiratory organs, blood
Nitrogen oxide	0.060	0.078	0.060	Respiratory organs
Benzpyrene	2.0E-06	4.1E-06	1.0E-06	Respiratory organs, immune system, development, carcinogen
Benzene	0.036	0.053	0.030	Respiratory organs, development, blood, immune system, central nervous system, reproductive system, cardiovascular system
Particulate matter	0.086	0.148	0.075	Respiratory organs, mortality
Phenol	0.064	0.095	0.006	Cardiovascular system, kidneys, central nervous system, respiratory organs
Hydrogen sulfide	0.002	0.004	0.002	Respiratory organs

[8] Datasets issued by the Department for Monitoring, Analysis, And Strategic Development of Public Healthcare of the RF Public Healthcare, and the Central Scientific Research Institute for Public Healthcare Organization and Informatization of the RF Public Healthcare Ministry.

[9] Criteria for health risk assessment given with HI and accepted in conformity with MG 2.1.10.0156-19 "Assessment of ambient air quality and health risk analysis in order to substantiate managerial decisions taken in the sphere of providing ambient air quality and sanitary-epidemiologic welfare of the population", approved by the RF Chief Sanitary Inspector on December 02, 2019.

Xylol	0.06	0.08	0.1	Central nervous system, respiratory organs, kidneys, liver
Toluene	0.03	0.05	0.4	Central nervous system, respiratory organs, development
Sulfur dioxide	0.03	0.081	0.05	Respiratory organs, mortality
Carbon disulfide	0.15	0.7	0.7	Central nervous system, development
Carbon oxide	1,8	2,5	3,0	Blood, cardiovascular system, development, central nervous system
Formaldehyde	0.0032	0.005	0.003	Respiratory organs, eyes, immune system
Non-organic poorly soluble fluorides	0.018	0.038	0.013	Skeletal system, respiratory organs
Fluoric gaseous compounds	0.021	0.048	0.03	Skeletal system, respiratory organs
Aluminum compounds		0.005	0.005	Respiratory organs, body weight
Methyl mercaptan	0.0006	0.00012	0.001	Respiratory organs, central nervous system
Lead	3.2E-06	4.2E-06	5.0E-05	Central nervous system, blood, development, reproductive system, hormonal system, kidneys
Manganese	2.1E-05	3.4E-05	5.0E-05	Central nervous system, blood, development, reproductive system, hormonal system, kidneys
Nickel	2.8E-05	3.3E-05	5.0E-05	Respiratory organs, blood, immune system, central nervous system
Chromium	0.00004	0.00008	0.0001	Respiratory organs

Table 2

Population health risks (hazard indexes or HI) under chronic inhalation exposure to chemicals contained in ambient air in Bratsk

Target organs or system	Average HI in the city	HI range	Risk characteristic	Priority risk factors
				chemical
Respiratory organs	12.46	0.85–23.62	High	Particulate matter
				Formaldehyde
				Chlorine
				Nitrogen dioxide
				Sulfur dioxide
Immune system	9.95	5.08–25.43–	High	Formaldehyde
				Benzene
				Nickel compounds
Central nervous system	3.57	0.47–8.21	Alerting, and in some city zones, high	Aluminum compounds
				Phenol
Development	5.16	0.22–20.81	Alerting, and in some city zones, high	Benzene
				Carbon oxide
				Ethyl benzene
Blood system	2.74	0.87–6.22	In some city zones, high	Benzene
Liver	1.50	1.76–2.28	Acceptable	Phenol
Kidneys	1.59	1.00–2.65	Acceptable	Phenol
Cardiovascular system	1.89	1.02–2.56–	Acceptable	Lead compounds
				Phenol

Calculated individual lifetime carcinogenic risk was expected to be up to 3.44E-0.4 in Bratsk; such a risk is considered to be unacceptable and can result in 1.2 additional cancer cases caused by ambient air pollution alone. Chromium and nickel compounds in ambient air make the greatest contribution into carcinogenic risks.

Therefore, a lot of various chemical admixtures make certain contributions (major ones on certain territories in the city) into population health risks occurrence in Bratsk; such admixtures are both commonly spread (dusts, carbon oxide, nitrogen oxide, and sulfur oxide) and specific ones (heavy metals compounds, phenol, aromatic hydrocarbons, and formaldehyde).

In Krasnoyarsk, "high" health risks (HI>6.0) were determined to cause untimely deaths, diseases in the respiratory organs, central nervous system, immune system, neuroendocrine system, blood and blood-making system, development disorders, etc.

In Norilsk and Chita, high health risks existed as regards respiratory organs diseases, development processes, blood system, etc.

Given that risks are somewhat probabilistic and calculated, we performed reconnaissance assessment of population morbidity in the examined cities exactly as per the same nosologies with predicted risks causing them being assessed as unacceptable.

We determined that it was well-grounded to expect health risks turning into actual registered diseases cases.

Thus, for example, in Bratsk where risks causing respiratory organs diseases were considered to be unacceptable and were assessed as high, morbidity with respiratory organs diseases among children has recently been equal to approximately 1.700 cases per 1,000 children. It is 1.21.3 times higher than on average in the region and 1.4–1.5 times higher than on average in the country. Chronic bronchitis among children in Bratsk is registered 2.6 times more frequently among children and 1.9 times more frequently among adults than in the region on average. Bronchial asthma (asthmatic state) is 1.6 times more frequently first diagnosed among teenagers in Bratsk than in the region on average. Nervous system diseases and congenital malformations are 1.2–1.4 times more frequently registered in Bratsk than in the region on average, etc.

In-depth medical and biological examinations of population also confirm that risks related to ambient air contamination turn into additional morbidity cases [18, 19]. Thus, urine and blood taken from children in Bratsk contain those chemical admixtures that were considered priority risk factors on the territory such as benzpyrene, chromium, aluminum, nickel, fluorides, etc; such admixtures were either absent or their concentrations were authentically lower in biological media of children from a reference group. We detected authentic dependences between these chemicals in children's bodies and a number of health disorders that were similar to expected ones. Examined children more frequently suffered from respiratory organs diseases, predominantly chronic inflammations in the upper respiratory tracts (2.9 times more frequently than in a reference group); functional disorders in the vegetative and central nervous system were 5.5 times more frequent than in a reference group. We also detected development disorders as congenital malformations of the heart and kidneys which were 1.5 times more frequent than in a reference group; small anomalies in kidneys development were 1.6 times more frequent than in a reference group.

Statistical, epidemiologic, and targeted medical and biological research that are now being accomplished in Krasnoyarsk and Norilsk, allow obtaining results, though fragmented, that are similar in their essence to above-mentioned ones. Besides, data are well consistent with sanitary-hygienic and medical-biological research that has been previously accomplished on these territories [20–25].

Therefore, risks calculation, and comparative analysis of risk assessment results that were compared with medical statistic data on population applying for medical health and results of in-depth targeted medical examinations on certain territories confirm that it is vital and relevant to work out air-protecting activities taking into account health-related criteria.

Such an approach will allow not only reducing gross emissions but also providing improvement in medical and demographic situation on a territory and preserving population health as a most significant resource for the development of the state. Reduced emissions of carcinogens and chemicals that cause additional morbidity with cardiovascular system diseases should lead to a decrease in number of disease cases with high fatality rate; it fully corresponds to goals fixed within "Demography" national project. A decrease in environmental pollution with substances that are hazardous for the endocrine system can make its contribution into a reduction in overall number of health disorders related to human hormonal state etc.

But still, analysis of activities that are to be implemented in their initial form doesn't allow assessing their sufficiency and consistency with population health criteria.

Most activities planned within "Pure air" federal project are not strictly bound to specific emission sources. Documents do not fix actual decrease in emission power (g/sec), and there are no other parameters to measure changes in emission volumes.

Thus, in Bratsk there is a range of planned activities that are aimed at reducing emissions by more than 126.5 thousand tons per year; but less than 2 % of this planned potential reduction is technologically substantiated. "Irkutsenergo" PLC plans to reduce emissions from smoke chimneys 0001/0002 at the Heat and Power Plant No.7 due to switching this object from solid fuel (coal) to gas and installing more efficient electrical filters (solid particles emissions reduced by 156.4 tons per years; sulfur dioxide, by 1,202.2 tons per year); the company also plans to reduce emissions from smoke chimneys No. 1 and 2 at the Heat and Power Plant No.6 due to modernized electrical filters and multicyclone devices in the central section (emissions of solid ash particles are to be reduced by 709 tons)[10].

Action plans don't contain any substantiation for potential decrease in emissions of chemicals that are fundamentally significant for minimizing adverse effects produced on population health; such chemicals are metal compounds (aluminum, lead, and nickel), aromatic hydrocarbons (benzene, xylol, and toluene), phenol, hydrogen sulfide, etc. The largest emissions sources in Bratsk including "RUSAL. Bratsk Aluminum Plant" PLC, "Ilim Group in Bratsk" PLC, and "Mechel" Bratsk Ferroalloy Plant plan to adjust their environmental activities within complex ecological expertise aimed at granting these enterprises ecological licenses in 2021–2022[11].

By October 1st, 2019 in Krasnoyarsk only 2.7 % reduced emissions (6,704.343 tons per year) have specific technological substantiation. Emission sources with their aerodynamic and ecological properties to be changed have been determined. Activities that are to be implemented in Krasnoyarsk are aimed at reducing emissions of nitrogen dioxide, nitrogen oxide, benzpyrene, sulfur dioxide, tarry substances, carbon oxide, solid fluorides, hydrogen fluoride, and several dusts. Having assessed efficiency of these activities, experts revealed that their implementation would result in a decrease in health risks under chronic exposure for almost 4.8 thousand people. The greatest risks reduction will be achieved regarding damage to the skeletal system with fluorides being a risk factor for it, as hazard index HI will fall from 2.4 to 1.3. However, a decrease as per priority risk groups (respiratory organs, central nervous system, and blood system) amounts to not more than 0.5 % off the initial level. Health risks remain "high| for all the exposed city population even after implementation of planned activities.

Obtained results don't allow making certain conclusions on achieving acceptable health

[10] The Letter by "Irkutsenergo" PLC dated September 27, 2019 No. 116-35/2680-2598.

[11] The Letter by "RUSAL Bratsk Aluminum Plant" PLC No. RB-out-19-45-0199 dated September 27, 2019, the Letter by "Ilim Group in Bratsk" PLC No. FB-25300-329 dated September 27, 2019. The Letter by "Mechel" Bratsk Ferroalloy Plant No. 2679 dated October 01, 2019.

risks if other activities included into complex plans have similar efficiency.

Special attention should be paid to issues related to a necessity to regulate emissions of fine-dispersed particles which are solid fractions in dust and gas mixtures with particles sizes being less than 10 µm (PM10) and 2.5 µm (PM2.5). Fine-dispersed particles are registered in ambient air in many cities, including their concentrations that are much higher than reference ones which are safe for health. Thus, for example, in Krasnoyarsk 12 out of 44 day samples (27.3 %) taken from April to October 2019 within social and hygienic monitoring activities contained particulate matter in concentrations exceeding hygienic standards with their level sometimes being up to 4.7 average daily MPC. Occurrence of fine-dispersed particles in emissions from both stationary and mobile pollution sources has also been proved by specific research [26–29]. At the same time, fine-dispersed particles nowadays are practically never identified or estimated when emissions from ambient air pollution sources are inventoried. Consequently, PM10 and PM2.5 are not included into ecological standardizing and are not considered a specific risk factor that should be reduced via implementing air-protecting activities. Accordingly, it is impossible to assess sanitary-hygienic and medical-demographic consequences caused by pollution with PM or efficiency of activities aimed at environmental protection.

Conclusion. Undoubtedly, it is not enough to simply list priority chemical admixtures and determine what decrease in their levels should be achieved. There are other important aspects related to developing and detailing complex regional action plans within "Pure air" federal projects. They are:

– a necessity to constantly and fully inform a wide circle of people who are to make decision on air protection in priority cities included into the federal project; such people should be provided with relevant data on adverse effects produced by specific components in emissions on population health;

– population health parameters being a target function and a key criterion in assessing efficiency of planned air-protecting activities;

– assessment and discussion with economic entities whether recommended emission levels are technically achievable; working out optimal solutions on targets and urgency of specific activities;

– supplementing complex activity plans with documents that contain specific technical description of air-protecting activities (giving exact information on emission sources and on pollutants emissions of which should be reduced, masses of pollutants emissions from each source before and after planned activities have been implemented (g/sec, tons/year) etc.;

– assessment of possibility (or, on the contrary, impossibility) to achieve combined reduction in a set of admixtures that are technologically interconnected;

– integration of efficiency assessments for air-protecting activities with prospect town planning on territories;

– in case acceptable health risk levels can't be achieved due to technical and/or technological limitations medical and prevention activities are to be included into compensatory action plans; such activities are fixed by the Federal Law issued on July 26, 2019 No. 195-FZ "On accomplishing an experiment on fixing quotas for pollutants emissions…"[12].

Funding. The research was not granted any financial support.

Conflict of interests. The authors declare there is no any conflict of interests.

References

1. Medvedev D.A. Russia-2024: the strategy of social and economic development. *Voprosy ekonomiki*, 2018, no. 10, pp. 5–28 (in Russian).

2. Popova A.Yu. Strategic priorities of the Russian Federation in the field of ecology from the position of preservation of health of the nation. *Zdorov'e naseleniya i sreda obitaniya*, 2014, vol. 251, no. 2, pp. 4–7 (in Russian).

[12] On accomplishing an experiment on fixing quotas for pollutants emissions and making alterations into certain legislative acts of the Russian Federation as regards reducing ambient air pollution: The Federal Law issued on July 26, 2019 No. 195-FZ. *KonsultantPlus*. Available at: http://www.consultant.ru/law/hotdocs/58662.html/ (date of visit September 13, 2019).

3. Polichetti G., Cocco S., Spinali A., Trimarco V., Nunziata A. Effects of particulate matter (PM10, PM2.5 and PM1) on the cardiovascular system. *Toxicology*, 2009, vol. 261, no. 1–2, pp. 1–8. DOI: 10.1016/j.tox.2009.04.035

4. Dockery D.W., Pope C.A., Xu X., Spengler J.D., Ware K.H., Fay M.E., Ferris B.G., Speizer F.E. An association between air pollution and mortality in six U.S. cities. *New. England. J. Med.*, 1993, vol. 329, pp. 1753–1759. DOI: 10.1056/NEJM199312093292401

5. Pope C.A., Shwartz J., Ransom M.R. Daily mortality and PM10 pollution in Utah Valley. *Arh. Environ. Health*, 1992, vol. 47, pp. 211–217. DOI: 10.1080/00039896.1992.9938351

6. Burnett R.T., Smith-Doiron M., Stieb D., Cakmak S., Brook J.R. Effects of particulate and gaseous air pollution on cardiorespiratory hospitalizations. *Archives Environmental Health*, 1999, vol. 54, no. 2, pp. 130–139. DOI: 10.1080/00039899909602248

7. Burger M., Catto J.W., Dalbagni G., Grossman H.B., Herr H., Karakiewicz P., Kassouf W., Kiemeney L.A. [et al.]. Epidemiology and risk factors of urothelial bladder cancer. *Eur. Urol.*, 2013, vol. 63, no. 2, pp. 234–241. DOI: 10.1016/j.eururo.2012.07.033

8. Carpenter, D.O., Bushkin-Bedient S. Exposure to chemicals and radiation during childhood and risk for cancer later in life. *J. Adolesc. Health*, 2013, vol. 52, no. 5, pp. 21–29. DOI: 10.1016/j.jadohealth.2013.01.027

9. World Cancer Report. *IARC*, 2014. Available at: https://www.iarc.fr/cards_page/world-cancer-report/ (01.10.2019).

10. Wolf J., Corvalan C., Neville T., Bos R., Neira M. Diseases due to unhealthy environmental: as updated estimate of the global burden of diseases attributable to environmental determinants of health. *Journal of Public Health*, 2017, vol. 39, no. 3, pp. 464–475. DOI: 10.1093/pubmed/fdw085

11. Air Pollution Science for 21-st Century. In: J. Austin, P. Brimblecombe, W. Sturgeseds. *Elsevier Science Ltd*, 2002, 676 p.

12. Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. *World Health Organization*, 2016. Available at: https://www.who.int/airpollution/ambient/health-impacts/en/ (01.10.2019).

13. Nieuwenhuijsen M.J., Dadvand P., Grellier J., Martinez D., Vrijheid M. Environmental risk factors of pregnancy outcomes: a summaryof recent meta-analyses of epidemiological studies. *Environ Health*, 2013, vol. 15, no. 12, p. 6. DOI: 10.1186/1476-069X-12-6

14. State of the science of endocrine disrupting chemicals. In: A. Bergman, H.J. Heindel, S. Jobling, K.A. Kidd, R.T. Zoeller eds. Geneva, WHO and UNEP Publ., 2012, 38 p.

15. Ekong E.B., Jaar B.G., Weaver V.M. Lead-related nephrotoxicity: a review of the epidemiologic evidence. *Kidney Int*, 2006, vol. 70, no. 12, pp. 2074–2084. DOI: 10.1038/sj.ki.5001809

16. Kazimov M.A., Aliyeva R.H., Aliyeva N.V. City air pollution with heavy metals and evaluating their jeopardy for public health. *Meditsina truda i promyshlennaya ekologiya*, 2014, no. 5, pp. 37–41 (in Russian).

17. Revich B.A. Natsional'nyi proekt «Chistyi vozdukh» v kontekste okhrany zdorov'ya naseleniya [“Pure air” national project within the context of population health protection]. *Ekologicheskii vestnik Rossii.* Available at: http://ecovestnik.ru/index.php/2013-07-07-02-13-50/nashi-publikacii/3132-natsionalnyj-proekt-chistyj-vozdukh-v-kontekste-okhrany-zdorovya-naseleniya (01.10.2019) (in Russian).

18. Zaitseva N.V., Zemlyanova M.A., Kol'dibekova Yu.V., Zhdanova-Zaplesvichko I.G., Perezhogin A.N., Kleyn S.V. Evaluation of the aerogenic impact of priority chemical factors on the health of the child population in the zone of the exposure of aluminum enterprises. *Gigiena i sanitariya*, 2019, vol. 98, no. 1, pp. 68–75 (in Russian).

19. Zaitseva N.V., Zemlyanova M.A., Bulatova N.I., Kol'dibekova Yu.V. Analysis and evaluation of blood plasma proteomic profile violations due to the increased concentration of fluoride ion in children’s urine. *Zdorov'e naseleniya i sreda obitaniya*, 2019, vol. 316, no. 7, pp. 23–27 (in Russian).

20. Ananina O.A., Pisareva L.F., Odintsova I.N., Khristenko E.L., Popkova G.A., Khristenko I.D. Cancer incidence among population of Norilsk. Formation of high risk groups for cancer. *Sibirskii onkologicheskii zhurnal*, 2013, vol. 58, no. 4, pp. 58–61 (in Russian).

21. Kurkatov S.V., Tikhonova I.V., Ivanova O.Yu. Assessment of the risk of environmental atmospheric pollutants for the health of the population of the city of Norilsk. *Gigiena i sanitariya*, 2015, vol. 94, no. 2, pp. 28–31 (in Russian).

22. Kashleva E.A., Ignateva L.P., Potapova M.O. Hygenic estimation of the influence factor ambiences on physical development of the children contingent. *Profilakticheskaya i klinicheskaya meditsina*, 2012, vol. 42, no. 1, pp. 15–18 (in Russian).

23. Meshkov N.A., Val'tseva E.A., Yudin S.M. Environmental situation and health in large industrial cities. *Mezhdunarodnyi zhurnal prikladnykh i fundamental'nykh issledovanii,* 2018, no. 9, pp. 50–57 (in Russian).

24. Nikiforova V.A., Pertseva T.G., Khoroshikh N.T., Nikiforova A.A. Ecological aspects of children's health in the northern territories of Eastern Siberia. *Sistemy. Metody. Tekhnologii*, 2014, vol. 21, no. 1, pp. 140–147 (in Russian).

25. Revich B.A. Kachestvo atmosfernogo vozdukha v megapolisakh i riski zdorov'yu naseleniya [Ambient air quality in megalopolises and population health risks]. *Chelovek v megapolise: opyt mezhdistsiplinarnogo issledovaniya*. In: B.A. Revich, O.V. Kuznetsova. Moscow, LENAND Publ., 2018, 640 p. (in Russian).

26. Chistyakov Ya.V., Eparkhin O.M., Volodin N.I. Melkodispersnaya pyl' – tekhnogennaya ugroza biosfere [Fine-disperse dust as a technogenic threat to the biosphere]. *Istoriya i perspektivy razvitiya transporta na severe Rossii,* 2014, no. 1, pp. 155–158 (in Russian).

27. Zagorodnov S.Yu., Kokoulina A.A., Popova E.V. Studying of component and disperse structure of dust emissions of metallurgical complex enterprises for problems of estimation *Izvestiya Samarskogo nauchnogo tsentra Rossiiskoi akademii nauk,* 2015, no. 17, pp. 451–456 (in Russian).

28. Ivanova A.A., Kumpan N.V., Bragina O.N., Kiseleva O.A., Myachina T.N. The need to develop guidelines on accounting for emissions of fine dust Thermal power plants. *Elektricheskie stantsii*, 2014, vol. 991, no. 2, pp. 57–63 (in Russian).

29. Zagorodnov S.Yu. Dust contamination of the atmospheric air of the city as an undervalued risk factor to human health. *Vestnik Permskogo natsional'nogo issledovatel'skogo politekhnicheskogo universiteta. Prikladnaya ekologiya. Urbanistika*, 2018, vol. 30, no. 2, pp. 124–133 (in Russian).

Popova A.Yu., Zaitseva N.V., May I.V. Population health as a target function and criterion for assessing efficiency of activities performed within "pure air" federal project. Health Risk Analysis, 2019, no. 4, pp. 4–13. DOI: 10.21668/health.risk/2019.4.01.eng

Received: 28.11.2019
Accepted: 20.12.2019
Published: 30.12.2019