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FROM THE CHIEF EDITOR

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National and regional security: a view from the region

This issue of the Journal is published in the run-up to the 9th Session of the Russia-Belarus InterAcademy Council on the Issues of Development of the Union State and the International Research-to-Practice Conference "Integration within the Union State as the main tool for the implementation of Russia and Belarus security strategy" held in Vologda (3 – 5 July). The Conference will bring together the leading scientists of the Russian Academy of Sciences and the National Academy of Sciences of Belarus, employees of scientific and educational institutions, heads and specialists of federal, regional and local authorities, representatives of social institutions and economic entities. The main idea of the Conference is the search for and substantiation of possibilities for enhancing the integration within the Union State, through further development of cooperation in trade, economic, scientific-innovation and socio-humanitarian spheres of Russia and Belarus.

On the eve of this important scientific and practical event, a number of articles touching upon these problems have been published in this issue. According to the results of the Conference, the Journal will present in detail the content of plenary and sectional meetings, the suggestions of scientists and practitioners concerning the development of integration processes of Belarus and Russia and the enhancement of security of the two states on this basis.

Officially, the concept *security* in modern Russia, was defined in the Federal Law "On security" dated March 5, 1992, as "the state of protection of the vital interests of a person, society and state from internal and external threats". This provision was substantially expanded in the Russian Federation National Security Strategy up to 2020, adopted in May 2009.

The Strategy identified the main threats to the country's economic security:

– preservation of export-oriented development model;

– high dependence of the most important sectors of Russia's economy on external economic conditions;

– low resistance and weak protection of the national financial system;

– lag in the development of advanced technological structures;

– loss of control over national resources;

– uneven development of regions;

– preservation of conditions for corruption and criminalization of economic and financial relations;

– aggravation of global information confrontation.

Other threats were also identified, the overcoming of which is dictated by the rapidly developing globalization of the world economy.

Since then a lot of interesting studies have been published on the assessment of the current state of Russia's national security, and the ways of its strengthening have been substantiated[1].

A major contribution of the national science ito this issue is found in the idea of using the method of extremely critical indicators for studying the Russian society. The extremely critical is the value of the indicator, going beyond the boundaries of which indicates the emergence of a threat to the functioning of economy and life of society due to the violation of the normal course of processes reflected by this indicator. Here it is necessary to distinguish between the indicators and corresponding critical (threshold) values that determine the simple reproduction ability of a system and its development ability.

Going beyond the boundaries of the former means that the system loses its self-preservation ability – there is a threat of its destruction or transition into a qualitatively new state. Going beyond the boundaries of the latter reflects the loss of competitiveness by the system, resulting in the threat of its subordination or absorption by another socio-economic system.

The recent works of RAS Academician S.Yu. Glazyev and Professor V.V. Lokosov show that the Russian society have been for a long time living in the conditions of extremely critical state according to many fundamental indicators of social and economic processes, balancing on the verge of collapse[2].

In this conditions, the Russian government realizes the need to enhance the country's security. Essentially, the Decrees adopted on May 7, 2012 by President V.V. Putin (immediately after his inauguration), which are aimed at the radical acceleration of the country's economic and social development, represent a working programme on ensuring its security.

But of greater importance is the fact that V.V. Putin intends to implement the transformation strategy that he has defined, and to achieve the goals set in the Decrees by 2018.

This was clearly shown at the meeting held May 7, 2013, which was devoted to the progress in the execution of the Decrees, the meeting was attended by the members of the Cabinet of Ministers, Presidential Administration, Plenipotentiary Representatives of the Head of State in the federal districts.

The President particularly pointed out the necessity of consistent solution of issues concerning long-term national economic and social policy, development of the Armed Forces, implementation of the foreign policy, demographic policy. V.V. Putin noted: "Nevertheless, I am confident that the objectives we have set are absolutely realistic despite all the current problems and challenges. We must not

[1] See, for example, the research carried out at the Market Economy Institute: Modernization and economic security of Russia. Vol. 1. Ed. by. Academician N.Ya. Petrakov. Moscow: Finance and Credit, 2010; Modernization and economic security of Russia. Vol. 2. Ed. by Academician N.Ya. Petrakov. Moscow, Saint Petersburg: Nestor-History, 2011.

[2] See: Glazyev S.Yu., Lokosov V.V. Assessment of the critical threshold values of the indicators of the state of Russian society and their use in the socio-economic development management. RAS bulletin. 2012. Vol. 87. No. 7. (By the way, this article was reprinted in our Journal No. 4 (2012).

use the complex, objective circumstances as an excuse. We must carry out all the measures we have planned."[3]

Modern Russia has developed comprador capitalism, when a large part of the national bourgeoisie and bureaucracy use the revenues obtained in the country for the development and accumulation of capital abroad. The attempts of the government to change it by means of motivation of business have failed.

Evaluating the situation, S.Yu. Glazyev points out: "All together, this is largely the result of uniting the corrupt part of officials and monopolists... the Government should define targets and conditions for economic development, and business – to participate in their formulation and take responsibility for their implementation. We, on the contrary, have the following situation: business often sets tasks, and government officials perform them" [4].

The federal level of power can and should provide protection mainly from the most important and biggest threats. The population in their daily life faces a much greater range of threats, many of which are local in their character. The solution of such problems is carried out by local authorities. At the same time, the state authorities of the RF subjects can prevent and eliminate the consequences of local threats most efficiently.

In our opinion, for considering the specific features of ensuring security in the regions, it is necessary to develop a special system of parameters related to the specifics of a particular territory. This requires a special study of the security performance of the regions, which should be linked with the overall scheme of analysis of indicators that are used at the federal and sectoral levels. This system should also be combined with the existing system of statistics and forecasting, accompanied by the regular monitoring and forecast of factors influencing the level of threats to regional security.

A major threat to the regional security in recent years consists in the crisis of the regional budgets. By the end of 2012, only 16 regions have been left that are donors to the federal budget. In other regions there is a continuous growth of public debt.

The size of public debt of the RF subjects increased to 30% in relation to the own revenues (against 24% at the beginning of the year). The number of regions that have debt load over 50%, has increased during the year from 15 to 25.

Why is the crisis of the regional finances aggravating significantly? One of the serious factors, in our opinion, is a very liberal financial and economic policy conducted by the Government of the Russian Federation, which is aimed at regarding the private interests of the biggest oligarchic structures, power elites and service bureaucracies. The report of the RF Ministry of Economic Development "Results of activity of the Ministry of Economic Development of the Russian Federation in 2012 and objectives for the year 2013", in our opinion, largely confirms this fact, as it dwells on imaginary successes and declares positive expectations.

How does the leading Ministry of the Government of the Russian Federation assess the results of its work? There is no clear answer to this question in the report, there is no analysis of the current socio-economic reality, there is no fair assessment of what has been done, on the basis of which we could speak about the professional level of the Ministry's leadership and the effectiveness of its economic policy. Instead, the content of the report was reduced to the description of individual actions of the office, and, judging by them, it turns out that the Russian economy and social sphere are on the right way, and the Ministry has even more ambitious plans for the future that are in no way linked with the real situation in the economy.

[3] Putin V.V. Speech at meeting on implementation of Presidential Decrees of May 7, 2012. Official website of the President of Russia. Available at: http://eng.kremlin.ru/transcripts/5373

[4] Glazyev S. The die is cast. Expert. 2013. No. 17 – 18.

The 2012 results indicate the absence of obvious success, breakthrough actions that would have led the country to economic growth. A decrease is evident in the dynamics of the key indicators: gross domestic product – from 4.3% in 2011 to 3.4% in 2012; industrial production – from 4.7% to 2.6%, respectively; investments in fixed capital – from 10.8% to 6.6%.

Sustainable crisis trends are continuing in 2013 as well. The stagnation of the economy became the reason for the decrease in the forecast GDP growth in 2013 from 3.6% to 2.4%. According to the Ministry of Economic Development, the country received 400 billion rubles less in the first three months of the current year as a result of a zero GDP growth.

Consolidated groups: advantages for big business, drawbacks for the budget

According to experts, preservation of the adverse institutional business climate is the main internal deterrent to the improvement of economic indicators[5].

The Presidential Decree "On the long-term national economic policy" No. 596 dated May 7, 2012 envisages that Russia will have achieved by 2018 the 20th place in the World Bank's Doing Business (in 2012 the Russian Federation ranked 112).

It's not a coincidence, that a significant part of the report by the Ministry of Economic Development is devoted to this issue. In this case, speaking about support to business, the officials focus on targeted improvement of special taxation schemes, on the provision of certain tax benefits, investment loans; and they overlook the general negative trends of the state of business climate in the country.

Can we consider the situation in this field to be improved, if the business community negatively evaluates the existing business climate of the country? Here are just some of the examples in this respect, contained in the report of the Leningrad Chamber of Commerce and Industry[6] .

According to the survey of the Russian Union of Industrialists and Entrepreneurs, 41% of the companies' managers in 2012 didn't notice any changes in the business climate, and those, who think that it has deteriorated, are three times more than those who think the opposite.

The "economic sentiment index", made by the National Research University Higher School of Economics according to the survey of 20.5 thousand representatives of medium-sized business, by the end of 2012 dropped to the lowest level for the last half-year. Almost half of domestic businessmen expect to transfer their business abroad. By the level of self-esteem of their readiness to entrepreneurship (only 2% of the population express entrepreneurial intentions) Russia, with a significant margin, occupies the last place among all the European countries.

The state's attempts to change the institutional environment for entrepreneurship, small and medium-sized first of all, have failed. It can't be said about the representatives of big business. Contrary to the principles of parity and competitive development in the economy, most of the legislative initiatives are directed on promoting the interests of a limited number of the largest companies, many of which are under foreign jurisdiction.

A convincing example of this is found in the introduction from January 1, 2012 of the institute of consolidated groups of taxpayers (CGT)[7] that has a narrow focus due to the establishment of strict criteria of formation.

[5] Starodubovskiy V. Dynamics of stagnation. Russian economy in 2012. Ekonomicheskaya politika. 2013. No. 2. P. 141.

[6] The state of business environment in Russia in 2012–2013: report of the Leningrad Chamber of Commerce and Industry. Available at the official website of the LCCI: http://lotpp.ru/news/palaty/3933/

[7] On the introduction of amendments to parts one and two of the Tax Code of the Russian Federation in connection with the creation of the consolidated group of taxpayers: Federal Law No. 321 dated November 16, 2011.

Table 1. Profit tax revenues, billion rubles

Subject	January – March 2012	January – March 2013	Changes	
			Billion rubles	%
Khanty-Mansi Autonomous Okrug	16.8	8.8	-8.0	-47.6
Tyumen Oblast	29.1	16.6	-12.5	-43.0
Belgorod Oblast	5.6	3.4	-2.2	-39.3
Kemerovo Oblast	6.3	4.2	-2.1	-33.3
Vologda Oblast	2.6	1.8	-0.6	-30.8
Russian Federation	502.4	474.7	-27.7	-5.5
Sources: Federal Treasury; ISEDT RAS calculations.				

Access to consolidation will be granted only to those organizations, which have the annual amount of federal taxes of more than 10 billion rubles, the annual revenue of not less than 100 billion rubles and the amount of assets according to the balance exceeding 300 billion rubles.

In accordance with these criteria, small and medium enterprises will not be able to take advantage of the new taxation scheme, this fact places them in unfavourable conditions in comparison to major taxpayers (according to the Expert RA, in 2011, only 71 out of the 400 largest Russian companies had their annual revenues exceeding 100 billion rubles[8]).

CGT introduces a new taxation scheme, which excludes control over transfer pricing and allows the offsetting of losses of companies within the group. Since the legislation does not stipulate any restrictions on the size of the losses taken into account when calculating the tax base, it can be assumed that the creation of CGT creation will lead only to the reduction in taxable income and aggregate profit tax paid by all group members. At the same time, the CGT shall comply with the right, set by the tax legislation, to reduce the tax base by the amount of losses for the previous accounting periods[9].

Benefits for the subjects of CGT are obvious. As for the budget, its interest is not so clear. The first results of CGT functioning prove this conclusion.

According to the Federal Tax Service, as a result of creating CGT, regional budgets didn't receive 8 billion rubles of profit tax in 2012[10]. The reduction in tax revenues affected primarily the regions, where the budget is formed at the expense of oil and gas industry and metallurgy, which are the main sources of CGT as well[11] *(tab. 1)*.

The introduction of consolidated taxation will lead to the fact that the country's budget system will have shortfall in income, this is indicated by the decreasing dynamics of financial performance of the budget-forming companies that created CGT *(tab. 2)*. It should be noted that all of these companies are the key stimulators of tax revenues in the budget of the country.

Thus, the current tax policy, primarily with regard to large businesses, doesn't promote the growth of budget revenues. The results of ISEDT RAS research on evaluating the situation at basic iron and steel works show a decrease in their participation in the formation

[8] Official website of the rating agency Expert RA. Available at: http://www.raexpert.ru/releases/2012/

[9] It should be mentioned that, in accordance with Item 6, Article 278.1 of the RF Tax Code, the participants of the CGT have no right to reduce the consolidated tax base by the losses incurred in the tax periods prior to their joining the group.

[10] The project "The main areas of tax policy for 2014 and planned period of 2015 and 2016". Official website of the newspaper Ekonomika i zhizn. Available at: http://www.eg-online.ru/information/210304/

[11] According to the newspaper RBC daily, at present there are 15 CGT. They include such large companies as Gazprom, Rosneft, LUKOIL, MegaFon, NLMK, Severstal. Official website of RBC daily. Available at: http://rbcdaily.ru/indHStry/562949986221257

Table 2. Financial indicators and tax on profits of companies that switched to consolidated taxation, million rubles

Indicators	1 quarter of 2012	1 quarter of 2013	Dynamics, %
OAO Severstal			
Profit on sales	3551.7	2391.5	-32.7
Pre-tax profit	5474.9	-735.1	X
Current profit tax	1131.6	0.053	-100.0
OJSC Gazprom			
Profit on sales	322587.3	305169.1	-5.4
Pre-tax profit	377563.4	258292.9	-31.6
Current profit tax	84148.6	16147.2	-80.8
OJSC NLMK			
Profit on sales	2293.5	319.5	-86.1
Pre-tax profit	4597.6	-185.9	X
Current profit tax	1150.6	266.4	-76.8
OJSC Rosneft			
Profit on sales	90811.9	44981.4	-50.5
Pre-tax profit	103665.7	28936.3	-72.1
Current profit tax	23878.4	7301.1	-69.4
Sources: Companies' income statements for the first quarter of 2013; ISEDT RAS calculations.			

of revenues of the budgets of all levels, mainly through the use of numerous offshore schemes to export the significant volumes of profit. So, for 2000 – 2012 tax incomes in the RF budget system from Cherepovets Steel Mill reduced from 14% to 3.4%, NLMK – from 20% to 5.7%, Magnitogorsk Iron and Steel Works – from 12% to 3% *(tab. 3)*.

It seems that the new scheme of taxation consolidation, which the authors of the report consider to be a tool for creating "favourable conditions for taxpayers to fulfil their obligations"[12], provides additional opportunities for optimization of tax base through the balancing of profits and losses.

On the contrary, the results of regional budgets execution for 2012 and for January – March 2013 indicate that the situation concerning the receipt of tax payments have aggravated, which will require compensatory transfers from the federal budget, and from regional authorities – the search for new revenue sources for financing social obligations. Herewith, the recognition of the institute of CGT as one of the main measures "aimed at creating an efficient and stable tax system, which provides fiscal stability"[13] raises obvious doubts.

Tax incentives for the rich

Another area improving the business environment, according to the authors of the report, is granting exemptions from VAT payment with regard to the services rendered on the securities market. The list of services not subject to taxation is rather extensive (services provided by brokers, dealers, management companies of investment, unit investment funds, etc). But do financial intermediaries really need fiscal loosening?

In 2010 – 2012 the share of subjects of financial activity in the total revenues of organizations was 16%, and their share in the total volume of tax receipts was 4%. Ranking third in terms of revenue, financial intermediaries have minimum tax burden compared with manufacturing enterprises *(tab. 4)*.

[12] Section 1.1 of the report of the Ministry of Economic Development "On the performance results and objectives for 2013 – 2015".

[13] Chapter 1 of the report of the Ministry of Economic Development "On the performance results and objectives for 2013 – 2015".

Table 3. Tax payments of metallurgical complexes to the RF budgetary system in 2000 – 2012, million rubles

Indicators	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
ChMK													
Taxes, total	8219	5582	4860	9081	17498	16747	14450	23633	26999	3990	9186	11792	7659
In % to profit	13.9	10.7	8.0	11.1	13.4	11.7	9.0	12.2	11.1	2.8	4.4	4.6	3.4
NLMK													
Taxes, total	7694	4237	5827	9117	16451	13987	19295	15557	20703	6809	11529	14888	13642
In % to profit	19.9	11.4	10.9	12.2	13.0	11.7	13.8	10.0	10.2	5.3	6.4	6.7	5.7
MMK													
Taxes, total	7272	3897	4487	9565	12071	14367	16043	15315	17400	5082	10243	15988	7283
In % to profit	12.1	7.4	7.4	10.8	9.0	9.8	9.9	8.0	7.7	3.7	5.1	6.5	3.0
Sources: Annual statements of Severstal, NLMK, MMK, ISEDT RAS calculations.													

Table 4. Revenues and tax receipts from financial intermediaries and manufacturing productions in 2010 – 2011

Indicators	Financial intermediaries				Manufacturing enterprises			
	2010		2011		2010		2011	
	billion rubles	share, %	billion rubles	share, %	billion rubles	share, %	billion rubles	share, %
Revenues	12702.9	16.3	14706.1	15.5	17553.8	22.6	22236.2	23.4
Tax receipts	316.9	4.1	382.2	3.9	1342.0	17.5	1695.7	17.4
Including VAT	32.2	2.3	30.1	1.6	239.6	17.3	320.6	17.4
Tax burden, %	2.5		2.6		7.6		7.6	
Sources: Rosstat; Federal Tax Service; ISEDT RAS calculations.								

After financial intermediaries have been granted VAT exemption, the losses of the federal budget exceed 30 billion roubles, which is more than the expenditures on water, forestry, environmental protection, landscaping, many types of educational activities, etc.

Certainly, tax stimulation of higher-yielding subjects generates not only enormous lost profits in the fiscal crisis conditions, but also the structural disproportions of the Russian economy, limiting inflow of investments in the manufacturing production sphere.

Half-hearted optimization[14]

Some of the actions of the Ministry of Economic Development certainly deserve approval: in particular, it is the abolition of privileges on property tax for subjects of natural monopolies: public railways, main pipelines and power lines[15]. However, here the legislation envisages some limitations in the form of the transitional period during which the reduced tax rates will be in effect; therefore, regional budgets will experience a noticeable increase only in 2017.

According to our calculations, as a result of complete cancellation of privileges, additional revenues from corporate property tax into the regions' budgets could increase by 33.4% and amount to 156.3 billion rubles *(tab. 5)*.

The issue concerning the complete abolition of property tax privileges and land tax privileges remains unsettled. The total amount of remaining preferences is about 60 billion rubles.

[14] The necessity of carrying out the revision of benefits for regional and local taxes and considering the abolition of privileges on property tax and land tax was announced in the Budget Address of the President dated June 29, 2011.

[15] On amending Part 2 of the Tax Code of the Russian Federation: Federal Law No. 202 dated November 29, 2012.

Table 5. Calculation of additional revenues from corporate property tax in the consolidated budgets of the RF subjects as a result of cancellation of tax privileges, billion rubles

Indicators	2011
Privileges provided*	156.3
Tax base (provisionally, proceeding from the sum of privileges)	7104.5
Possible receipts taking into account partial cancellation of privileges:	
2013 – rate 0.4%	28.4
2014 – rate 0.7%	49.7
2015 – rate 1.0%	71.0
2016 – rate 1.3%	92.4
2017 – rate 1.6%	113.7
2018 – rate 1.9%	135.0
2019 – 2.2% (complete cancellation of privileges)	156.3
Actual revenues from corporate property tax from all payers	467.6

* to the following organizations: public railways, main pipelines and power lines.
Source: ISEDT RAS calculations according to the report f No. 5-NIO FTS RF and the Federal Treasury.

There is no deoffshorization of the economy

Unfortunately, the report didn't touch upon the deoffshorization of Russia's economy. The calls of the country's political leadership to stop withdrawing money abroad and return them to Russia are not followed by concrete actions and remain empty words.

The results of ISEDT RAS research devoted to analysing production and financial activities of leading transnational metallurgical corporations owned by offshore companies showed that the lion's share of the profit received by Russian iron and steel works is not directed toward the development, but is reserved for paying large dividends to the owners of these enterprises *(tab. 6)* and transferring to offshores through the mechanisms of transfer pricing and through affiliated companies[16].

According to the Central Bank, the annual export of money from the country is 2 trillion rubles more than its import. For the first quarter of 2013 over 800 billion roubles have been already taken abroad. If we add these resources to the amount of those lost due to the decline in economic growth rate, then the total amount of financial losses will be 1.2 trillion rubles.

Academician S.Yu. Glazyev concludes: "This cannot continue any longer. Any export of capital will change to its accumulation in the country that will provide a foundation for modernization and development of the economy, otherwise Russia will face irreversible colonization and remain at the raw material periphery of the world economy. The second scenario will result in the significant deterioration of Russia's ruling elite, both due to the escalation of social tension, caused by the decline in the population's standard of living, and due to the expropriation of a significant part of capital accumulated in offshores"[17].

However, the outflow of almost all the assets overseas, which ended in the last decade, shows the failure of the authorities to resist this negative process. The report by the Ministry of Economic Development is another proof in this respect. Introduction of the institute of CGT, which reveals additional ways of taxation minimization, as well as the provision of tax preferences for the subjects of the financial

[16] Ilyin V.A., Povarova A.I., Sychev M.F. The influence of the metallurgical corporation owners' interests on the socio-economic development: preprint. Vologda: ISEDT RAS, 2012.

[17] Glazyev S.Yu. The die is cast. Expert. 2013. No. 17 – 18. April 29. Available at: http://expert.ru/expert/2013/18/zhrebijbroshen/

Table 6. Received dividends and the fortune of the owners of metallurgical corporations in 2006 – 2011, billion rubles

Indicators	2006	2007	2008	2009	2010	2011
OAO Severstal						
Retained profits	122.9	144.7	148.8	150.2	106.2	90.1
Accrued dividends	8.4	15.9	25.5	0	5.6	12.7
Fortune of the owner	318.6	601.5	126.3	299.4	563.9	492.7
OJSC MMK						
Retained profits	62.6	105.7	105.7	129.5	149.5	144.3
Accrued dividends	29.2	9.2	3.7	3.6	3.2	0
Fortune of the owner	239.6	390.8	73.5	296.4	341.4	180.3
OJSC NLMK						
Retained profits	148.6	117.2	221.9	246.6	274.0	293.1
Accrued dividends	15.0	15.2	10.1	1.1	9.3	10.3
Fortune of the owner	397.6	586.7	152.8	477.8	731.5	512.0
Sources: reports of metallurgical corporations; *Forbes* magazine.						

sector, transferring their money into low-tax jurisdictions[18], indicates the lack of logic in the declared anti-offshore policy.

Summing up the assessment of the report by the Ministry of Economic Development, it is necessary to note that no significant measures aimed at the development of the economy and revenue potential of the budget were adopted at the federal level in 2012. Traditional methods of fiscal system management through the continuous introduction of amendments into the existing legislation are unable to solve the systemic problems anymore. In this regard, it is necessary to take measures for the significant adjustment of economic policy; the key and priority measures should be aimed at overcoming the offshore nature of the Russian economy.

And that will be a serious step in the enhancement of national and regional security.

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As in the previous issues, we publish the results of the recent public opinion monitoring of the state of the Russian society*.

The following tables show the dynamics of some parameters of social well-being and socio-political sentiments in the Vologda Oblast for the last 6 surveys (the period from August 2012 to June 2013) in comparison with the data for 2012.

[18] Out of 25.8 billion US dollars exported from the Russian Federation in the first quarter of 2013, banks account for 24 billion.

* The polls are held six times a year in Vologda, Cherepovets, and in eight districts of the oblast (Babayevsky District, Velikoustyugsky District, Vozhegodsky District, Gryazovetsky District, Kirillovsky District, Nikolsky District, Tarnogsky District, Sheksninsky District). The method of the survey is a questionnaire poll by place of residence of respondents. The volume of a sample population is 1500 people aged from 18 and older. The sample is purposeful and quoted. Representativeness of the sample is ensured by the observance of the proportions between the urban and rural populations, the proportions between the inhabitants of settlements of various types (rural communities, small and medium-sized city), age and sex structure of the adult population of the region. Sampling error does not exceed 3%.

The results of the ISEDT RAS polls are available at www.vscc.ac.ru

Estimation of power activity (How do you assess the current activity of..?)

Indicator	2007	2011	2012	June 2012	Aug. 2012	Oct. 2012	Dec. 2012	Feb. 2013	Apr. 2013	June 2013	Average for the last 6 surveys	Dynamics (+/-), last 6 surveys in comparison to 2012
RF President												
Approve	75.3	58.7	51.7	54.5	53.7	50.9	53.3	55.5	55.5	54.3	53.9	+2
Do not approve	11.5	25.6	32.6	28.9	31.1	32.1	34.6	29.2	31.5	29.3	31.3	-1
Chairman of the RF Government												
Approve	-	59.3	49.6	49.5	48.5	47.1	48.3	47.9	48.5	46.2	47.8	-2
Do not approve	-	24.7	33.3	31.5	34.5	32.8	35.9	34.4	35.7	33.2	34.4	+1
Governor												
Approve	55.8	45.7	41.9	44.7	45.3	43.6	42.5	43.0	44.4	44.3	43.9	+2
Do not approve	22.2	30.5	33.3	31.8	32.7	33.7	35.4	33.8	34.9	31.9	33.7	0

What party expresses your interests? (% of the number of respondents)

Party	2007	Election to the RF State Duma 2007, fact	2011	Election to the RF State Duma 2011, fact	2012	June 2012	Aug. 2012	Oct. 2012	Dec. 2012	Feb. 2013	Apr. 2013	June 2013	Average for the last 6 surveys	Dynamics (+/-), last 6 surveys in comparison to 2012
United Russia	30.2	60.5	31.1	33.4	29.1	31.9	31.4	26.6	30.4	30.5	28.5	31.3	29.8	+1
KPRF	7.0	9.3	10.3	16.8	10.6	10.0	9.5	10.4	12.2	9.7	11.0	11.3	10.7	0
LDPR	7.5	11.0	7.8	15.4	7.8	7.7	6.7	6.8	7.2	6.3	7.1	6.6	6.8	-1
Just Russia	7.8	8.8	5.6	27.2	6.6	4.6	5.6	5.5	5.5	5.3	5.1	4.7	5.3	-1
Other	1.8	–	1.9	–	2.1	2.8	2.3	2.4	3.5	3.5	3.4	2.0	2.9	+1
No party	17.8	–	29.4	–	31.3	31.5	33.2	36.1	32.5	35.3	37.1	31.7	34.3	+3
It's difficult to answer	21.2	–	13.2	–	11.7	11.6	11.1	12.3	8.7	9.3	7.8	12.3	10.3	-1

Estimation of social condition (% of the number of respondents)

Indicator	2007	2011	2012	June 2012	Aug. 2012	Oct. 2012	Dec. 2012	Feb. 2013	Apr. 2013	June 2013	Average for the last 6 surveys	Dynamics (+/-), last 6 surveys in comparison to 2012
Mood												
Usual condition, good mood	63.6	63.1	67.3	69.0	71.3	69.0	68.0	66.6	68.6	66.4	68.3	+1
Feeling stress, anger, fear, depression	27.8	28.9	27.0	23.4	23.3	25.5	26.5	30.5	26.0	25.9	26.3	-1
Stock of patience												
Everything is not so bad; it's difficult to live, but it's possible to stand it	74.1	74.8	76.6	77.3	73.2	77.5	79.9	75.5	77.9	77.8	77.0	0
It's impossible to bear such plight	13.6	15.3	15.8	13.6	17.0	15.6	13.7	16.1	16.5	13.7	15.4	0
Social self-definition												
The share of people who consider themselves to be poor and extremely poor	42.4	44.3	44.5	45.0	44.2	44.1	47.0	45.9	48.2	48.3	46.3	+2
The share of people who consider themselves to have average income	48.2	43.1	44.7	45.3	43.4	44.7	43.4	44.3	42.6	41.9	43.4	-1
Consumer Sentiment Index												
Index value, points	105.9	89.6	91.5	93.4	92.3	91.7	91.7	92.3	90.4	89.8	91.4	0

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As in the previous issues, we publish the journal articles rating in this one.

The first ten articles, published in 2010-2013, according to the frequency of their viewing for the recent 12 months (July 2012 — June 2013)

Rating	Article	Total time of reading for the recent 12 months, minutes	Total time of reading, for the whole accounting period*, minutes	Number of views for the whole accounting period	Number of views for the recent 12 months	Number of views for the recent 3 months	Average time of viewing for the whole accounting period*, minutes	Issue	Release date	Authors
1	Agriculture of the Vologda Oblast on the eve of Russia's accession to the World Trade Organisation	7066	7066	212	212	4	33	No. 21	June 2012	Anishchenko Nikolay Ivanovich Ivanova Marina Nikolayevna Bilkov Valentin Alekseyevich
2	Demographic problems of the Republic of Belarus and their solutions	901	1602	115	66	15	14	No. 16	August 2011	Shakhotko Lyudmila Petrovna
3	Threats to the region's economic security and the ways to overcome them	883	3357	174	41	11	20	No.14	April 2011	Uskova Tamara Vitalyevna Kondakov Igor Anatolyevich
4	The budget process as a tool for managing the public and municipal finances	784	870	26	18	9	33	No. 19	February 2012	Avetisyan Ishkhan Artashovich
5	Methodology of the comparative estimation of the scientific and technical potential of the region	758	3658	192	30	9	19	No.12	December 2010	Zadumkin Konstantin Alekseyevich Kondakov Igor Anatolyevich
6	Assessment of the critical threshold values of the indicators of the state of Russian society and their use in the socio-economic development management	754	754	42	42	9	18	No. 22	August 2012	Glazyev Sergey Yuryevich Lokosov Vyacheslav Veniaminovich
7	Problems of sustainable development of rural areas in the Vologda Oblast	655	763	43	30	7	18	No. 17	October 2011	Shestakov Sergey Aleksandrovich
8	Methodological foundations of sustainable development of the agricultural sector	655	825	31	15	7	27	No. 16	August 2011	Ivanov Valentin Aleksandrovich Ponomareva Anna Sergeyevna
9	On the strategy of sustainable development of Russia's economy	604	604	14	14	14	43	No. 25	February 2013	Glazyev Sergey Yuryevich Fetisov Gleb Gennadyevich
10	Public-private partnership in the scientific and technological sphere of defense industry: Russian and foreign experience	503	503	36	36	4	14	No. 20	April 2012	Nikolayev Aleksey Yevgenyevich

* Account of the site's viewing has been carried out since 2009, December, 12.

Oleg A. KUVSHINNIKOV
Vologda Oblast Governor

Welcome address
by the Vologda Oblast Governor O.A. Kuvshinnikov to participants of the 9th Session of the Russia-Belarus InterAcademy Council on the Issues of Development of the Union State and the International Research-to-Practice Conference "Integration within the Union State as the main tool for the implementation of Russia and Belarus security strategy

Dear participants of the 9th Session of the Russia-Belarus InterAcademy Council on the Issues of Development of the Union State and the International Research-to-Practice Conference "Integration within the Union State as the main tool for the implementation of Russia and Belarus security strategy"!

I am delighted to convey my greetings to the distinguished scholars, representatives of academic science from the National Academy of Sciences of Belarus and the Russian Academy of Sciences, representatives of the management bodies of the Union State. It is my pleasure to welcome you to the hospitable Vologda land.

The declared topic of the event is devoted to integration and security; undoubtedly, it is important and relevant for Belarus and Russia in general and for their constituent regions in particular. By restoring the links, broken after the collapse of the USSR, by opening new spheres of interaction, we use each other's strong points, thus enhancing our security.

The Vologda Oblast and the Republic of Belarus have long-standing and extensive relations in economic sphere and other spheres of social life. We can state with confidence that the Republic of Belarus is the most important strategic partner of our region.

So we have gladly accepted the offer of the Vice President of RAS, Academician A.D. Nekipelov, to host the Session of the InterAcademy Council and the Conference in the Vologda Oblast. Especially since we already have a positive experience of holding such events: one of the previous sessions of the InterAcademy Council and the International Research-to-Practice Conference "Economic and scientific innovation cooperation of the regions of Russia and Belarus" was held in the Vologda Oblast five years ago, in June 2008.

In comparison with the CIS states, the Republic of Belarus is the leader according to the volume of trade with the Vologda Oblast with a total share of 52.4%. The Republic's share in the total foreign trade turnover of the region in 2012 amounted to 8.4%. Trade turnover between the Vologda Oblast and the Republic of Belarus was 535.2 million US dollars. The export of goods from the Vologda Oblast reached 416.4 million US dollars, and the import of goods from the Republic of Belarus amounted to 118.6 million US dollars.

Such major enterprises of the Vologda Oblast as OAO Severstal, Severstal-metiz, OAO Cherepovets Casting and Mechanical Plant, JSC Vologda Optical and Mechanical Plant, OJSC Severny Kommunar, OJSC Vologda Machine-Building Plant, CJSC Vologda Bearing Factory, LLC Agrosnab Vologodsky, OAO Sheksninskaya Selkhoztekhnika take the most active part in foreign economic relations of the Vologda Oblast and the Republic of Belarus.

The cooperation between the Vologda Oblast and the Republic of Belarus in the spheres of education, science, culture is expanding as well. It is very important that these processes involve young people, since this lays the foundation for good-neighbourly relations between our peoples. Development of humanitarian cooperation is one of our most important tasks.

The Vologda Oblast has a large Belarusian association of fellow-countrymen. Its members, maintaining close ties with the Republic of Belarus, efficiently participate in the development of the economy and cultural life of the Vologda land.

In general, the cooperation between the Vologda Oblast and the Republic of Belarus is very active, businesslike, and most importantly, systemic in its essence. We are constantly coordinating our positions by holding annual sessions at the governmental level, where the progress of the joint work is discussed.

It is necessary to point out that both parties are interested in the enhancement of cooperation and establishment of new contacts for expanding the spheres of interaction. The development of flax industry is a promising and priority area of cooperation for us.

The Permanent Committee of Union State decided to develop a joint programme for the complex development of flax industry in Belarus and Russia with participation of the interested departments and science centres. It has been planned that the concept of the programme "Innovation development of flax industry of the Russian Federation and Belarus" will be approved in October – November 2013.

This union programme is aimed at innovation breakthrough and introduction of new technologies. Of course, it can be achieved only through the cooperation between the branches of the Russian Academy of Sciences and the National Academy of Sciences of Belarus.

The new programme promises a great technological breakthrough not only in the production of flax, but in the textile industry of the Union State as well, which will allow Russia and Belarus in the coming years to become reputable suppliers of linen products to the European market.

The Vologda Oblast, being the leader in handling the issues of support and development of flax cultivation in the Russian Federation, has accumulated great experience in implementing the priority investment project "Development of the Vologda Oblast flax complex through inter-sectoral and inter-territorial co-operation". The Belarusian party, in turn, as the generally recognized leader in the sector, is searching for modern methods of enhancing the efficiency of flax industry in general. Uniting the efforts will help the two leaders rapidly and cost effectively meet the challenges of the comprehensive modernization of all the links of the production chain 'from a field to a counter'. Furthermore, it will contribute to the introduction of advanced technologies, enhancement of competitiveness of the goods and their promotion in the foreign markets, improvement of the financial state of flax enterprises and increase of payments to the budgets.

It should also be noted that the session of the Council and the Conference are held in the framework of the "Agreement on cooperation of the Vologda Oblast Government and the Russian

Academy of Sciences in academic, scientific-educational and innovation spheres". The planned activities include the visits to industrial enterprises aimed at defining the guidelines for the use of technological developments of the leading RAS institutions at the largest industrial enterprises in the region with purpose of production diversification and enhancement of its efficiency. Preliminary work in this regard is already going on: in April – June 2013 RAS expert groups visited the Vologda Oblast. We hope that more extended contacts will be established with the National Academy of Sciences of Belarus as well.

I wish all the participants of the Conference and the Session of the InterAcademy Council fruitful work!

Sergey M. ALDOSHIN
RAS Academician,
RAS Vice President

Dear colleagues! Dear friends!

I am delighted to convey my greetings to all the participants of the 9th Session of the Russia-Belarus InterAcademy Council on the Issues of Development of the Union State and members of the International Research-to-Practice Conference "Integration within the Union State as the main tool for the implementation of Russia and Belarus security strategy".

The historic treaty on the creation of a Union State of Russia and Belarus was signed nearly fourteen years ago. Over all these years, despite the difficult political and economic situation, the relations between our countries have always been strengthening, while remaining truly brotherly. The academic community contributes significantly to the cooperation; the academic science is integrated in the socio-economic complex of the states and plays an important social role. The similarity of the priority directions of the scientific and technological development of our countries offers great opportunities for integration. The Russian Academy of Sciences and the National Academy of Sciences of Belarus actively conduct joint fundamental and applied research, implement specific innovation projects. The work is carried out in the energy and energy saving areas, in the sphere of creating new materials and nanosystems, in biology and medicine, information and telecommunication systems, environmental management, etc. Intellectual resources are unified for resolving the most important socio-economic tasks, such as the improvement of the security and competitiveness of our countries.

The relations between specific regions and main scientific organizations have been sustainably developing.

Successful interaction between Belarusian, Russian scientists and specialists is strongly exemplified by the developments of space technologies (programmes 'Kosmos-BR', 'Kosmos-SG', Kosmos-NT'), nanotechnologies (Nanotechnologies-SG), development and production of supercomputer models with a wide productivity range (programmes 'SKIF', 'SKIF-GRID', implemented with the participation of the Programme Systems Institute of RAS named after A.K. Ailamazyan).

The cooperation experience between the scientists and specialists with regard to genetic engineering and biotechnology issues (projects and programmes 'BelRosTransgen', 'BelRosTransgen-2') is extremely important, as it enabled us to obtain a number of new scientific results, including the organization of the manufacture of highly effective and biologically safe new generation medicines and food products based on human lactoferrin, purified from milk produced by animals .On the basis of the survey results, we plan to launch a new joint programme 'BelRosFarm' for the purpose of industrial production of medicines, using human lactoferrin.

The accomplished developments are in many ways unique and highly assessed at the international level.

Separate agreements between the National Academy of Sciences of Belarus and RAS branches, in particular the Siberian branch of RAS, are being developed. The projects on the catalytic systems for isomerization of products after wood chemical processing and clean solid fuel burning, the projects on new materials, and on a number of other promising directions are being implemented here.

The InterAcademy Council on the Issues of Development of the Union State (IAC) successfully acts as a coordinator and expert of the scientific programmes. On the whole, it is important to emphasize that it is the State academies of sciences – the Russian Academy of Sciences and the National Academy of Sciences of Belarus with high intellectual potential, the established system of scientific organizations, that are the driving forces of the implementation of state innovation development programmes. They are responsible not only for fundamental and applied research, but also for the interaction with the state scientific funds, development institutions, business, state structures.

It is important to note the successful examples of cooperation at separate levels of innovation system: collaboration and competition of the scientific projects of the Belarusian Republican Foundation for Fundamental Research and the Russian Foundation for Basic Research (BRFFR – RFBR) that have executed about 1000 of projects during its lifetime. The Russian Foundation 'Skolkovo' is gradually taking the road of success in the Union State.

The Russian experience in creating technology platforms (communication platforms for business, scientific and educational institutions, state and society communication platforms) for the purpose of supporting the scientific and technological activities, forming new partnerships in the innovation sphere and enhancing scientific and production cooperation is considered for application in the Union State.

First of all, at present Russia and Belarus are to face the pressing issue of introducing scientific developments into production, accelerating the development of high- tech industries. We are to focus our efforts in this very field. It is necessary to create not only joint research centres and laboratories, but production sites, engineering centres, centres of shared equipment, as well; to increase the number of small innovation companies, integrated research and production companies.

The training of scientific staff, attraction of the youth into science is another acute issue, requiring an urgent solution. We need to expand contacts between schoolchildren and students, to develop internship and exchange practice. The Agreement between the Council of Young Scientists of the National Academy of Sciences of Belarus and the Council of Young Scientists of the Russian Academy of Sciences has a high development potential.

I am confident that our joint research activities, the existing successful experience in implementing scientific and technological programmes will boost national economies, enhance the security and competitiveness of our countries.

I wish all the participants of the Session and Research-to-Practice Conference interesting and productive work, success and new achievements for the benefit of the Union of Russia and Belarus!

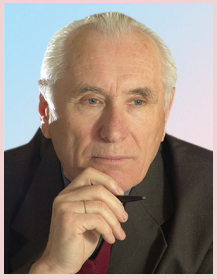
RUSSIA-BELARUS INTEGRATION AS A TOOL OF SECURITY STRATEGY

UDC [001.83 + 339.924 + 316.4.063.3](476 + 470 + 571)
LBC65.54 (4Bel+2+5Chin)

Problems of designing new types of integration spaces

The article analyses the conceptual content of the concept 'space', the widespread use of which in different fields of scientific knowledge is the most obvious indication of 'spatial turn', which was outlined in modern science in the late 1980s. The structure of the integration spaces formation theory, developed by the Belarusian researchers, is revealed. The necessity of designing the new types of integration spaces, the main economic resource of which is the latest scientific knowledge, is justified.

Concept of space, spatial turn in modern science, integration spaces of different types, integration spaces formation theory.



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1. The concept of 'space' as a cognitive basis for 'spatial turn' in modern science

In recent decades, researchers, who study integration processes going on in the different regions of the world, more and more often use such general categorical concept, as *space* to describe the results of these processes: "Recognizing space as a phenomenon and addressing this category is connected with the functional and social structure of modern society that is rapidly becoming more complex – from a country to the global world, the society, in which various types of spaces are beginning to play an increasingly important and often

leading role in comparison with traditional types of territorial and socio-economic organization"[1].

For example, within one and the same country, the category of space is used by different social groups to achieve quite different goals: "The people in power create spaces, where they can use their 'force' – cities, shopping centres, schools, jobs, homes. The weak create their own spaces within them, appropriating them for a time, moving through them, occupying them as much as they need"[2]. On the other hand, the division, for example, of the country's political space can be based not on social groups, but on political and administrative-territorial factors: "Organization of the country's political space implies its division into two main levels of political power: first, the central level embodied in the system of state (national) political institutions, political groups and leaders acting within their framework; second, the regional level, which is understood as political-territorial communities of the country that include political institutions, leaders, citizens, etc., living within certain political or administrative-territorial formations"[3].

The world community is guided by the most global objectives, using the category of space for handling demographic and geopolitical issues: "Mankind escaped from the deadlock of endless self-destructive strife for space and resources by reorganising the strategy of living, finding new instructional decisions. A new formation for humanity is akin to a new ecological niche for biological species in nature. It allows people to penetrate 'new spaces', avoiding overpopulation and associated danger of mutual extermination... Having moved into the new space-time, humanity will abandon current geopolitical disputes as something minor"[4].

Due to the above-mentioned multipurpose and multilevel usage of the category of space, the researchers have come to the opinion that 'space is a complicated concept"[5]. Moreover, the complexities, which researchers have to overcome when dealing with the categorical notion of *space*, are to a great extent connected with an extremely high ontological status of the category behind the term. We recall that Aristotle included it in the first ten basic philosophic categories[6]. Later, in the 19th century, English sociologist H. Spencer confirmed a high ontological level of this categorical concept: "Space is the abstract of all relations of co-existence"[7].

However, the greatest difficulties in defining the concept of *space* arise out of exceptional variety of approaches to the interpretation of the essence of this concept in different fields of science. In particular, hundreds of different types of spaces can be analysed within the framework of one monograph[8]. For example, today there are more than a hundred types of integration spaces alone[9]. It is a pressing necessity of systematizing such typological

[1] Transnational political spaces: phenomenon and practice. Executive Editor M.S. Strezhneva. Moscow: Publishing house "Ves mir", 2011. P. 7.

[2] Shapinskaya Ye.N. Power and resistance in the space of contemporary culture. Filosofskiye nauki. 2012. No. 10. P. 121.

[3] Semchenkov A.S. Cycles of reorganisation of political space and the ways to prevent internal conflicts in Russia. The Moscow University herald. Series 12. 2009. No. 2. P. 4.

[4] Panarin A.S. Revenge of history: Russia's strategic initiative in the 21st century. Moscow: Publishing Corporation "Logos", 1998. P. 15-16.

[5] Lossau J. Räume von Bedeutung. Spatial turn, cultural turn und Kulturgeographie. Translated from German. Germeneya: zhurnal filosofskikh perevodov. 2012. No. 1. P. 99.

[6] Aristotle. Categories: With the "Introduction" of Porphyry to Aristotle's "Categories": translated from ancient Greek. 3rd ed. Moscow: Publishing House "LIBROKOM", 2012. P. 6.

[7] Spencer H. The classification of the sciences. Translated from English. Moscow: Vuzovskaya kniga, 2006. P. 4.

[8] See, for example: Language and space: problems of ontology and epistemology: monograph. Ed. by A.E. Levitskiy, S.I. Potapenko. Nizhyn: Publishing house of Nizhyn Gogol State University, 2011.

[9] Shcherbin V.K. Typology of integration spaces in the aspect of content-analysis. Language and space: problems of ontology and epistemology: monograph. Ed. by A.E. Levitskiy, S.I. Potapenko. Nizhyn: Publishing house of Nizhyn Gogol State University, 2011. P. 130-174.

diversity of existing spatial structures that urges individual researchers to reduce numerous interpretations of the concept of *space* to several major classes of meanings.

So, Russian sociologist V.N. Yarskaya believes that "the category of space inherits all the semantic wealth accumulated in the intellectual battles of cultures. In substantive tradition, in the first semantic cut, space serves as a special substance, the main parameters are the measurement, geopolitics, geography, statistics, the research task is to create an object, a measuring instrument. At the other semantic level space is interpreted as a subjective reality, representing what exists in the mental aspect, carrying out scaling and creating subjective scales. And the main semantic level is the space of symbols and meanings, and social organization of space"[10]. A similar approach to the classification of the main meanings of the concept *space* is proposed by Russian political scientist N.Yu. Zamyatina: "The concept *space* in scientific practice is used in various meanings. The two most common meanings are 'physical' space and space as a metaphor (and a conceptual design) used to describe the structure of some phenomenon in accordance with a certain conditional coordinate system (see, for instance, an example of creating the electoral space described in the coordinates 'left' – 'right', 'Zapadniki' (Westernists) – 'Pochvenniki' (the 'native soil' movement), etc)"[11].

Moreover, some foreign and domestic philosophers go even further, claiming that the two basic semantic classes of specific meanings of the concept of *space* allocated above (physical, geographical space and metaphorical, symbolic space) are inextricably linked through the presence of general structural properties. In particular, according to the American philosopher M. Wartofsky, "regardless of whether we understand space in physical and geometrical sense, or as a sociological or psychological 'space', an important thing is that all these concepts of space, used in various sciences, have important common structural properties"[12]. In turn, Belarusian researchers V.K. Lukashevich and T.Ye. Novitskaya reveal the relationship of these semantic classes of spatial meanings as follows: "Physical space, on the one hand, is the ground for the existence of social space, and on the other hand, as human environment, it is a projection of social relations. Besides, the later approaches to social space initially contain provisions of philosophical concepts of space due to the application of some of the properties of physical space to the socio-spatial organization of society"[13].

The representatives of geographical science, who study land surface most profoundly, also have their own opinion concerning the vectors of interaction of two basic semantic classes of spatial meanings: "German geography is concerned with the elaboration of the correct attitude toward the spatial turn. On the one hand, it observes the 'return to space' in related disciplines with great attention and interest... On the other hand, geography, in fact, is involved in interdisciplinary discussions about space only to some degree"[14]. This, according to J. Lossau, is conditioned by the following reasons: "Contrary to the popular understanding of geography, cultural geography

[10] Yarskaya V.N. Globalization of social space. In: Integration processes in modern society (according to the materials of the all-Russian scientific and practical conference). Ed. by M.E. Elutina. Saratov: Aquarius, 2003. P. 4.

[11] Zamyatina N.Yu. Spaces of power: physical, metaphorical, mental. In: Space of power: Russia's historical experience and modern challenges. Ed by B.V. Ananyich, S.I. Barzilov. Moscow: MPSF, 2001. P. 64.

[12] Wartofsky M. Metaphysics as heuristic for science. Structure and development of a science: Boston studies in the philosophy of science: translated from English. Moscow: Progress, 1978. P. 83.

[13] Lukashevich V.K., Novitskaya T.Ye. Structure and dynamics of innovation space. Vesnik BGEU. 2010. No. 5. P. 104.

[14] Lossau J. Räume von Bedeutung. Spatial turn, cultural turn und Kulturgeographie. Translated from German. Germeneya: zhurnal filosofskikh perevodov. 2012. No. 1. P. 102.

doesn't raise the issue concerning the qualities of certain space and the extent, to which it can influence social reality or define it. It rather examines how the spaces are designed as symbolic espacements in the course of verbal communication or everyday practice.

Thus, we can say that the cultural turn inside geography led to the culturalization of space, in the context of which the old geographical 'realistic' view of the physical space of the earth's surface loses its meaning. In social and culturological sciences, on the contrary, the opposite situation can be observed. Here the spatial turn led to the espacement of cultural meanings, so that the 'rough' concrete side of social reality, and not least its physical, material foundations are reconsidered more closely"[15]. And speaking about the starting point of formation of 'spatial turn' in contemporary science, Ye.G. Trubina points out that "the beginning of the 'turn' can be dated March 1967, when Michel Foucault delivered his lecture, which was later called 'Of other spaces', and which was first published in the original language in October 1984"[16].

The aforementioned methodological and cognitive-conceptual possibilities of spatial turn, in our opinion, are implemented to the fullest extent when considering complex, interdisciplinary phenomena, including, of course, modern international integration. The interdisciplinary nature of the phenomenon of international integration, first of all, is reflected in the fact that its consideration requires comprehensive application of different specific approaches and knowledge: political, economic, sociological, ethnographic, geographical, historical, military, etc.

At that, such comprehensive package concept as *space* acts as one of the key conceptual dominants of this set of different specific knowledge. According to the Russian philosopher A.I. Rakitov, the main peculiarity of such package concepts "consists in the fact that one and the same term, in essence, means a whole family or package, in a certain relation of similar concepts that are, as a rule, impossible to differentiate by purely formal, structural characteristics"[17].

In this particular case (when considering the phenomenon of international integration) the package concept *space* serves as a common cognitive basis for the unification of a number of specific spaces (spiritual, political, economic, social, military, geographic, historical, linguistic and other), in the framework of which the knowledge of various academic disciplines about the processes of formation and development of international integration structures is localized, which makes it possible to give a versatile characteristic of the mentioned processes. The complexity of the work with such package concept as *space* consists in the necessity to consider the 'family' sets of more split up concepts, adopted from various disciplines and fields of scientific knowledge, in the inseparable unity of the common and individual, the synchronic and diachronic, general scientific and specific interpretations of all the components of the package concept. It is possible to overcome the mentioned difficulty by creating more specialised theories (the theory of formation of integration spaces[18], the theory of economic space[19], etc.)

[15] Lossau J. Ibidem. P. 105.

[16] Trubina Ye. G. Turn to the space: an interdisciplinary movement and problems with its promotion. The political conceptology: journal of metadisciplinary research. 2011. No. 4. P. 40.

[17] Rakitov A.I. Historical cognition. System-gnosiological approach. Moscow: Politizdat, 1982. P. 28.

[18] Report on the research work "The theory of the formation of integration spaces of different types and mechanisms of their interaction" Academic advisor S.M. Dedkov. Minsk: The Centre for System Analysis and Strategic Research of the NAS of Belarus, 2013 (manuscript copyright).

[19] Chekmarev V.V. On the theory of economic space. Problemy novoy politicheskoy ekonomii. 1999. No. 3. P. 25-38; Biyakov O.A. Theory of economic space: methodological and regional aspects. Tomsk: Tomsk University, 2004; Chekmarev V.V., Gulbasov A.V. The theory of economic space. Kostroma: Nekrasov Kostroma State University, Smolensk State University, 2006.

in addition to the existing general theories of international integration[20].

In any case, the very definition of a theory (as 'a complex of views, notions, ideas aimed at interpretation and explanation of any phenomenon'[21]) suggests that giving the status of a theory to a forming set of views, ideas and notions concerning different types of integration spaces, will endow it with additional explanatory power and will allow it to reveal a complex and multidimensional phenomenon of integration spaces in more detail.

2. Integration spaces formation theory

In 2011 – 2013 the researchers at the Centre for System Analysis and Strategic Research of the NAS of Belarus carried out a grant research on the topic "The theory of forming integration spaces of different types and mechanisms of their interaction" with the financial support of the Belarusian Republican Foundation for Fundamental Research. This made it possible to outline the framework of such a theory[22]. In particular, according to the authors of this study, the structure of the specified theory should be represented by the following sections:

1) *the fundamentals of international integration*, i.e. general ideas about the basic principles, forms and aspects of international cooperation[23], as well as information about the content of the key integration concepts and notions[24];

2) *the history of international integration* (it is based on the collection of works on the chronology of integration process[25]; on the issue concerning the periodization of the history of integration[26]; the history of individual integration associations and unions[27]);

3) *the typology of integration spaces*, which is based on the identification of specific characteristics of these spaces, distinguishing

[20] See, for example: Balassa B. The theory of economic integration. Homewood: Richard D. Irwin, 1961; Shishkov Yu.V. Theories of regional capitalist integration. Moscow: Mysl, 1978; Yakobait K. Theory of integral integration. Regional integration in Central Asia: collection of articles. Berlin: German Foundation for International Development, 1995. P. 1-22; Rosamond B. Theories of European Iitegration. New York: Palgrave Macmillan, 2000; Shishkov Yu.V. Domestic theory of regional integration: the experience of the past and a look into the future. World economy and international relations. 2006. No. 4. P. 54-63.

[21] Shvyrev V.S. Theory. New encyclopaedia of philosophy: in 4 volumes. Vol. 4. Moscow: Mysl, 2001. P. 42.

[22] Report on the research work "The theory of the formation of integration spaces of different types and mechanisms of their interaction" Academic advisor S.M. Dedkov. Minsk: The Centre for System Analysis and Strategic Research of the NAS of Belarus, 2013 (manuscript copyright).

[23] See, for example: Vityaz P.A., Shcherbin V.K. Promotion of inter-academic cooperation – the real way to the creation of a common scientific and technological space of the CIS. Bulletin of the Foundation for Fundamental Research. 2001. No. 4. P.68-87; Vityaz P.A., Shcherbin V.K. Inter-academic cooperation and the problem of formation of common scientific space of the CIS. Naukovedeniye. 2001. No. 4. P. 32-49; Dedkov S.M. System approach to the geo-economic aspects of integration. Security & Eurasia. A journal of individual, national and collective security. 2002. No. 2. P. 142-145; Zhibulevskaya S.A., Shcherbin V.K. "Akademk-niga" – one of the forms of integration of Belarusian and Russian science. Nauchnaya kniga. 2002. No. 2. P. 8-10, etc.

24 See, for example: Mikhaylenko A., Vertlib Ye. Factor as the key concept of integration in the CIS. Belarus – Russia: neo-Soviet phenomenon of integration. Ed. by L. Zaiko. Minsk: Paradox, 2004. P. 327-347; Danilov A.N., Shcherbin V.K. Integration. The Republic of Belarus: encyclopaedia. In 6 volumes. Vol. 3. Minsk: BelEn, 2006. P. 778-780; . Rybalka Ye.A. Concepts of space in social philosophy. Gumanitarniye i socialno-ekonomcheskiye nauki. 2009. No. 3. P. 39-44; Shcherbin V.K. Concept of 'post-Soviet space' and its concept-variables. The post-Soviet space in the world order of the 21st century: priorities, specifics, prospects: materials of the international scientific-practical conference. Minsk: Mediafakt, 2011. P. 82-91.

[25] See, for example: Shcherbin V.K. Comparative chronology of integration activities for the creation of a common scientific and technological space of the CIS-states (1991-2001). Problemy upravleniya. 2003. No. 1. P. 33-40.

[26] See, for example: Morozov I. Post-Soviet economic space: historical view. Theoretical and practical issues of management. 2013. No. 2. P. 40-48.

[27] See, for example: Strezhneva M.V. European Union and the CIS: Comparative analysis of institutions. Moscow: Moscow Public Science Foundation, 1999; Sheleg N.S., Yenin Yu.I. Formation of regional integration associations in the post-Soviet space. Moscow: the Permanent Committee of the Union State, 2003; Illustrated history of the Union State. Moscow: Rossiyskaya Gazeta, 2004; Shumskiy N.N. Regional economic associations of the post-Soviet states: organizational and legal support of integration process. Minsk: Belaruskaya navuka, 2010.

them from the spaces of other types[28], and which is aimed at creating a scientific classification of integration spaces[29];

4) *the doctrine of the structure of integration space* (the contents of this section cover the issues dealing with structuration of various integration spaces[30], their parameterization and measurement using different classification and webometric criteria[31], and also revealing the peculiarities of its architectonics[32]);

5) *the doctrine of the mechanisms of interaction between different types of integration spaces* (at present, two types of such mechanisms have been identified and described: the horizontal, or network mechanism of integration spaces interaction and the vertical or hierarchical mechanism of interaction of such spaces[33]);

6) *the integration prognostics*, in the framework of which the three main areas are developed: a) development, improvement, and optimization of using already existing integration spaces of different types[34]; b) designing new types of integration spaces[35]; c) detection of integration tendencies and megatrends and their extrapolation to the future development of integration processes[36].

In the future it is possible to define other sections in the structure of the considered theory of integration spaces formation (such as a methodology for integration research, integration ethics, integration statistics, etc.). Currently, however, the empirical data is not sufficient enough for giving the above-mentioned sections the status of independent structural units. As for the branches of the integration spaces formation theory that have already obtained this status in our study, the last section (integration prognostics) is the least developed of them; and such sphere as the design of new types of spaces was the least studied among the areas developed within its framework. Although the practice of designing spaces that was very successful in some historical periods was implemented even in the USSR, which has to be admitted by modern critics of the 'Soviet civilization': "It is the construction of space that first promoted the true triumph of the USSR, but then facilitated the collapse of

[28] See, for example: Dedkov S.M., Shcherbin V.K. Integration spaces: reasons for formation; specifics; the major classes. The Union State in the context of world integration processes: scientific materials of the Inter-Academic Council on the Issues of Development of the Union State. Vol. 2. Ed. by S.M. Dedkov, V.K. Yegorov. Minsk: The Centre for System Analysis and Strategic Research of the NAS of Belarus, 2011. P. 8-22.

[29] See, for example: Shcherbin V.K. Typology of integration spaces in the aspect of content-analysis. Language and space: problems of ontology and epistemology: monograph. Ed. by A. E. Levitskiy, S.I. Potapenko. Nizhyn: Publishing house of Nizhyn Gogol State University, 2011. P. 130-174.

[30] See, for example: Zevin L. Structuring of the economic space of the CIS. Svobodnaya mysl. 2004. No. 11. P. 124-135; Lysenko V. Territorial aspects of structuring social space. Sotsialno-gumanitarniye znaniya. 2010. No. 6. P. 253-262, etc.

[31] See, for example: Melnikov V.A. Metrization of economic space. Ekonomika i proizvodstvo. 2004. No. 2. P. 4-6; Isakova N.B. Webification of innovation space and technology transfer. Problemy nauki (Kyiv). 2009. No. 10. P. 2-5.

[32] Geyets V.M. Post-crisis architectonics of the European economic space. The world of transformations. 2011. No. 1. P. 137-151.

[33] Report on the research work "The theory of the formation of integration spaces of different types and mechanisms of their interaction" Academic advisor S.M. Dedkov. Minsk: The Centre for System Analysis and Strategic Research of the NAS of Belarus, 2013. P. 61-73 (manuscript copyright).

[34] See, for example: Nedilko V.I. Problems and prospects of reconstruction of a common scientific and technological space of the CIS. Vestnik of the Foundation for Fundamental Research. 1997. No. 2. P. 33-38; Burnyasheva L.A. Problems of renovation of spiritual space in contemporary Russia. Sotsialno-gumanitarniye znaniya. 2010. No. 5. P. 265-273; Nevostruyeva A.F. Development of the social nature of information and communication space at the present stage. Vlast. 2013. No. 2. P. 38-42.

[35] See, for example: Krasina O. Construction of transnational space as a theoretical and methodological problem in the modern theory of world politics. Vlast. 2010. No. 11. P. 69-74; Rogozin D.M. How to design a social space by contingent valuation method. Sociological journal. 2010. No. 4. P. 169-173.

[36] See, for example: Shmelev V.V. Developing countries: tendencies and contradictions of economic integration. Moscow: Mysl, 1979; Integrative tendencies in the modern world and social progress. Ed. by M. A. Rozov. Moscow: Publishing house of Moscow University, 1989; Bakushev V.V. Integration trends in the policy of the leading international organizations and the new Russia. Moscow: Russian Academy of State Service under the President of the Russian Federation, 1997.

this structure: the USSR authorities were not growing space, they were 'making' it[37]. Due to the above reasons, the study of the main theoretical problems of designing new types of integration spaces was elected the main topic of this article.

3. Creation of new types of integration spaces as the practice of cultural engineering

Despite the lack of theoretical development of the above directions of integration forecasting in the CIS countries, international practice has a long-term tradition of designing new types of spaces. In particular, the Austrian theorist of 'information anti-globalism' K. Becker wrote about this activity of European scientists the following: "The traditional practice of cultural engineering consists in creating cultural memory and establishing a nominal order through the establishment of mental and ideological spaces; symbolic scenarios generate reality through mediating an implicit political narrative and logic... Abundant evidence of fictitious cultural reconstruction can be found already in the Middle Ages... In retrospect, the whole empires may be the fruit of cultural engineering. Moreover, such writers as Martin Bernal, the author of *The Fabrication of Ancient Greece,* clearly showed how deeply cultural propaganda and historical disinformation are integrated into the work of European scientists. To support the ideological hegemony of certain European elites on the basis of racist ideas and hidden political interests, the entire historical scenarios were framed up and cultural links were broken"[38].

However, if earlier the political ambitions of ruling elites of some European countries were a stimulus to the cultural engineering of new types of spaces (mental, ideological, etc.), then at the end of the 20th century the main reason for this engineering could be found in economic and political imperatives of globalisation: 'Spaces' appear in political practice, when the territories are divided and the countries have to switch from extensive to intensive development of territories, ways and forms of their use. Another important reason for the emergence of 'spaces' lies in the fact that more and more types of activity, forms of ownership are going beyond national borders. The main problem is not that the government loses something (taxes, control, etc.), although such losses may happen to a certain extent. The more important fact is that the degree of predictability of the country's economic situation is reduced (especially in the medium and long term), as well as the ability of the government to implement sustained programmes for socio-economic development; the internal sphere of the country becomes vulnerable to external influences (spontaneous and often targeted); and the type of activity – the industry, the sphere etc. can't be monitored and directed comprehensively"[39].

In particular, according to the observations of domestic science theorists, large-scale integration of Russia's leading scientific organizations in the world market space shows that it is not Russia that becomes the main owner of the scientific product created by these organizations: "Integration of Russian scientific organizations in the financial 'metabolism' of Western capital (public or private) has a very real prospect of turning the domestic science into a branch of foreign companies. Ironically, the cherished dream of many of our scientists and science managers to make Russia a kind of laboratory for producing and selling fundamental knowledge in the international division of labour becomes clearly tangible today.

[37] Kaganskiy V.L. Russia – the USSR today? A comparative portrait of spaces. Article 3. The Russian Federation and Russian space. Obshchestvenniye nauki i sovremennost. 2005. No. 4. P. 100.

[38] Becker K. Tactical Reality Dictionary: cultural intelligence and social control: translated from English. Moscow: Ultra. Kultura, 2004. P. 15, 17-18.

[39] Transnational political spaces: phenomenon and practice. Executive Editor M.S. Strezhneva. Moscow: Publishing house "Ves mir", 2011. P. 25.

It's just that in such circumstances our country will lose whatever has been left of the opportunities to conduct an independent policy in the sphere of science and technology. Russia's scientific community increasingly produces the knowledge ordered by foreign companies for implementing their existing technologies and products rather than the knowledge which is necessary for the country itself"[40]. Moreover, the calculations of Russian economists show that while domestic scientific organizations and individual scientists make their products available in the world market, Russia annually loses 600 – 700 million US dollars, because domestic scientists use their own equipment for executing the orders of foreign investors; as a result, the self cost of the works performed is higher than the amount paid to them by foreign customers[41].

By the way, foreign investors in Belarus prefer to finance those science-intensive sectors (e.g. offshore programming), which require the least expenditure on equipment and ensure a minimal risk for investors: "Certain success of Belarusian programmers is explained quite simply. On the one hand, we have quite good and cheap 'brains', on the other – it is not necessary to import a large amount of equipment in this case. The main assets, i.e. intellectual property and profit are left abroad. And in Belarus there are only rooms and programmers, a cheap workforce by Western standards. Accordingly, the risk for the investor is minimal. Chipsets manufacturers are in much worse conditions. They have to build premises and install expensive equipment on the production site. And investors won't spend much money on costly equipment without having firm guarantees"[42].

According to V.M. Geyets, Academician of the NAS of Ukraine, the numerous financial benefits obtained by foreign investors as a result of using domestic scientific, educational, intellectual and other spaces of the CIS countries, will be the main reason for drastic changes in the expansionist policy of the European Union, which will soon change its policy of direct territorial expansion to the East and move to the practice of large-scale construction of new types of integration spaces with the involvement of scientists and science-intensive business of the CIS states: "Further EU enlargement to the East, under the previous ideology of the Union's formation through the admission of new members, even such as Turkey and/or Ukraine, will lead to escalation of tension in the internal, foreign political, economic, social and cultural aspects and to the emergence of new factors of destabilization in the EU and in the globalizing world.

That's why the expansion to the East must be aimed at not so much as receiving the membership, but at allocating separate areas (sectors), in the framework of which the coordinated actions will to some extent be similar to the conditions of formation of the European Coal and Steel Community. At that time cross-border mergers and acquisitions will become the dominant transactions, which will be lobbied at the government level in the interests of their countries, but they will increasingly promote the creation of the single market by overcoming economic differences"[43].

Russian researchers name other reasons why the West is constructing new types of spaces instead of traditionally used military annexation of territories and resources: "The new military strongarm territorial division of the world is quite possible.

[40] Vaganov A.G. Western investments and structure of Russian science. Naukovedeniye. 2001. No. 3. P. 86.

[41] Ushkalov I.G., Malakha I.A. Interstate migration of scientific personnel and the problems of development of scientific and technological potential of Russia. Naukovedeniye. 1999. No. 1. P. 34.

[42] Balykin S. Integral is being prepared for sale. Director. 2008. No. 1. P. 21.

[43] Geyets V.M. Post-crisis architectonics of the European economic space. The world of transformations. 2011. No. 1. P. 148.

However, today's war is a costly issue, disruptive to the social and natural environment; and besides, it is officially condemned morally and politically in accordance with the UN Charter. In conditions of globalization a greater importance is attached to the possibility of practical use of a territory and/or its resources, rather than to their possession, because such possession for various reasons (costs of distances, taxes, social responsibility to local communities, etc.) can be a burden. Space as a phenomenon provides an answer to all of the above. It provides the way out of the seemingly insurmountable dichotomy 'formal – informal' through the principal opportunity to combine an officially recognized (and therefore a formal) validity of socially demanded diversity of actual (and therefore, informal) relations"[44].

The rapid development of information technologies (virtual networks, the Internet, etc.) highly contributed to the mass establishment of such informal relations between foreign customers and domestic scientists. According to O.V. Krasina, "the virtual multinational networks are being especially developed in the sphere of economy and scientific-technological cooperation, for example, the EU project *cordis.eu*, in the framework of which it is possible to develop contacts not only at the level of individual researchers or entrepreneurs, but also at the level of organizations (universities, business startup companies, business corporations, etc.). This trend indicates the extension in the measurement of transnational space, since an individual doesn't need to cross the border in the physical aspect to be included in the transnational activity, and, remaining, in fact, in his/her original cultural environment, the individual becomes a kind of 'citizen of the world', where the only deterrent factor in his/her participation in transnational interactions becomes the availability of leisure time (in the situation, when such activity isn't a job or a source of income) and the presence of language and cultural barriers that impede communication by certain socio-cultural contexts"[45].

For example, the EU at its highest level handles the issues concerning the creation of organizational and financial capabilities for using the creative potential of researchers of the CIS for the purposes of Western corporations. In particular, A. Mitsos, the Head of the Directorate General for Research of the European Commission says the following on the subject: "A few years ago the EU launched a new initiative, and we hope that in the near future it will be transformed into a more tangible goal at the state level. It relates to the full opening of frontiers for science and enhancing international cooperation between the EU and its Eastern and southern neighbours, which are not part of the EU, and developing countries. How can we provide the best researchers in all parts of Europe, not only in the EU, with an opportunity to use their potential to the fullest? This can be done only through cooperation, finding such scientists and creating appropriate infrastructure environment for them"[46].

The research of domestic science theorists show how successfully the European Union is creating this infrastructure for the needs of scientists from the former USSR countries: "According to the results of a research project carried out at G.M. Dobrov Centre for Scientific and Technological Potential and Science History Studies of the National Academy of Sciences of Ukraine, more than half of the institutes had contracts with foreign customers.

[44] Transnational political spaces: phenomenon and practice. Executive Editor M.S. Strezhneva. Moscow: Publishing house "Ves mir", 2011. P. 24.

[45] Krasina O. Construction of transnational space as a theoretical and methodological problem in the modern theory of world politics. Vlast. 2010. No. 11. P. 71.

[46] Mitsos A. European strategy for the movement towards knowledge-based economy and society. Knowledge-based society: new challenges for science and scientists: Materials of the international conference (Kyiv, 23 – 27 November 2005). Kyiv: Phoenix, 2006. P. 53-54.

On average, an institute has seven contracts, according to which the scientists work abroad, and five foreign contracts, according to which the scientists work in Ukraine[47]. Moreover, "the authors sent the most important publications abroad (this trend has already been observed in a number of research areas)"[48]. The latter is largely facilitated by the fact that all the expenses on the prompt publication of scientific books and articles of the post-Soviet scientists are usually effected by Western European publishers. While at home, these scientists wait years for their turn to publish their research results; moreover they often have to pay for these publications on their own.

The above reasons led to the fact that post-Soviet science now has an actual tendency of 'brain drain' to Western countries, as well as the 'leak of knowledge', obtained in the framework of scientific programmes and individual projects funded by the CIS. The Ukrainian scientific theorists V.I. Onopriyenko and M.V. Onopriyenko point out that "among domestic scientists there are many of those who, staying in their homeland in their institutions, execute the orders of foreign science centres and companies, having been engaged in international Internet communications.

This process increasingly replaces the notorious 'brain drain' and goes far beyond it. Using obsolete domestic scientific equipment, these scholars, nevertheless, obtain the results that satisfy Western manufacturers and pass these results directly to the customers. As a rule, these products have low added value. Consequently, the tendency of transformation of our countries into mere suppliers of raw materials to developed countries is carried out not only through the market, but also through scientific systems using the networking tools"[49].

In our opinion, to stop these negative processes and trends in post-Soviet science, the Commonwealth states should actively construct new types of research spaces on their own, and also implement the relevant infrastructure projects more often in the interests of national science. In particular, the President of the Republic of Belarus A.G. Lukashenko proposed to establish a High-Tech Park (HTP), modelled after the famous Silicon Valley. The strategic aim of this project was to create "a unique and favourable environment for the development of high technologies" in Belarus, a kind of analogue of the U.S. Silicon Valley, where the combination of economic, social and legal environment will exceed the present-day level achieved by the world community"[50]. Today HTP is one of the leaders of Belarusian innovation sphere: "By the end of last year, the incomes of the Park have reached a billion dollars. In 2012 six HTP companies were included in the list of top IT service providers in the world. 2.5 thousand new jobs were created here; the Park has about 14.5 thousand specialists in the field of information technologies. About a half of the resident companies of the Park are foreign firms and joint ventures. Over a half of the residents are engaged in the production of their own software. All this allowed Belarus to enter the top 30 countries with the most developed sphere of offshore programming, according to the Gartner analysts. Besides, the High-Tech Park is now among the largest IT-clusters in the countries of Central and Eastern Europe"[51].

[47] Isakova N.B. Webification of innovation space and technology transfer. Problemy nauki (Kyiv). 2009. No. 10. P. 4.

[48] Malitskiy B.A. How to evaluate the credibility of scientific achievements. Science and Science of Science. 2012. No. 3. P. 163.

[49] Onopriyenko V.I., Onopriyenko M.V. The Internet galaxy and science in the globalizing world. Science and Science of Science. 2008. No. 1. P. 168.

[50] The Address of the President of The Republic of Belarus Alexander Lukashenko to the Parliament. Available at: www.president.gov.by/press 29160.html.

[51] Tsepkalo V., Starzhinskiy V., Pavlova O. Leading cluster of IT-industry. The science and innovations. 2013. No. 4. P. 53.

Unlike the above innovation infrastructure project carried out in the 2000s, the Belarusian-Russian programmes "SKIF" and "SKIF-GRID" contributed essentially to the formation of a new type of integration space, because they created optimal conditions for a long-term joint work of Belarusian and Russian specialists in the field of designing supercomputers. According to L.B. Vardomskiy and A.V. Shurubovich, the realization of these and a number of other scientific programmes of the Union State of Russia and Belarus "made a considerable contribution to the development of the relevant branches of economy, science and technology of the Russian Federation and the Republic of Belarus. In particular, in the framework of the programmes "SKIF" and "SKIF-GRID" for the creation and introduction of supercomputers, 19 prototypes of advanced supercomputers "SKIF" series 1.2.3 have already been constructed. Five supercomputers "SKIF" were included in the global Top500 rating of most powerful computers. From 2002 to 2009, the performance of supercomputers "SKIF" increased from 0.423 to 60 trillion flops"[52].

Another new integration space was formed by the efforts of Belarusian and Russian scientists and manufacturers in the field of diesel automobile construction. Its development programmes "were implemented by about 20 leading automobile enterprises of Russia and Belarus, mass production of automobiles was established, in compliance with international modern and perspective standards of ecology, economy, security and reliability Euro-2, Euro-3 and Euro-4. By the end of 2008, the enterprises participating in the programme have produced 34296 trucks and 44773 diesel engines of Euro-3 standard; in subsequent years it is planned to shift to the industrial production of Euro-4 standard"[53].

The above examples of implementing major infrastructure projects and designing new types of research spaces in the framework of the Union State of Russia and Belarus represent only a small part of existing spaces and projects: "According to the initiative of the Scientific Council under the Executive Committee of the Union of Belarus and Russia and with the participation of the Ministry of Science of Russia, the State Committee for Science and Technology of the Republic of Belarus (SCST RB), the Russian Academy of Sciences (RAS), the National Academy of Sciences of Belarus (NAS of Belarus) and a wide range of scientific community, the Programme for the formation of common scientific and technological space of Belarus and Russia is being developed and implemented, the main common priorities for science and technology have been identified. A number of joint projects and programmes (over 30 in the framework of the Union in the fields of space technology, supercomputers, laser technology, biotechnology, agriculture, medicine, resource-saving technologies, etc.) have been worked out, agreed and are now being implemented"[54].

In our opinion, Russian and Belarusian scientists should carry on their research and achieve more. It is necessary to create new integration spaces in all the key directions of natural, technical and humanitarian sciences, developed by researchers of the two countries. The mass creation of such research spaces is

[52] Vardomskiy L.B., Shurubovich A.V. Post-Soviet integration projects as a factor in modernization of the CIS economies. Integration of science as a factor in the construction of the Union State: scientific materials of the Inter-Academic Council on the problems of development of the Union State. Vol. 3. Ed. by S.M. Dedkov, V.K Yegorov. Minsk: Centre for System Analysis and Strategic Research of the NAS of Belarus, 2011. P. 31.

[53] Ibidem.

[54] P.A. Vityaz – path in science. Ed. by O.V. Roman, A.F. Ilyushchenko, S.P. Vityaz. Minsk: Belorusskaya nauka, 2006. 89.

quite a solvable task, since, as international experience shows, "it's rather easy to construct a morphological space for any explicit scientific and technological sphere"[55]. The problem can be solved by using scientific-organizational, and purely political means and methods.

However, one should bear in mind that there are exclusively scientific rules and requirements in such research spaces: "All scientific statements, without exceptions, are based on a number of initial assumptions and therefore they are relevant only in a space bounded by these assumptions, sometimes multiple and difficult to observe"[56]. In other words, "the field of science can be defined as a relatively autonomous space with its own specific objectives and rates, among which the main ones are the accumulation of rational empirically grounded knowledge"[57].

This specifics and autonomy of scientific spaces does not mean that scientists are indifferent to the broad integration processes that are going on in the post-Soviet states. Discussing the role of the intelligentsia in the unification of the Russian space, V.L. Kaganskiy quite fairly, in our opinion, notes the following: "The federal government should ensure the unity of norms and the unity of the country's space, but not all the social groups of population, irrespective of their welfare, need a uniform coherent permeable space with uniform standards. This space is really necessary for those, who are disparagingly called 'public sector employees'. This is almost the only group that really needs a unified country with common rules... 'Federal intellectuals' can integrate the territory of the state and control regional elites 'from below' much more efficiently than power verticals"[58].

The leadership of the Union State of Russia and Belarus should consider the domestic scientific intellectuals as its main allies in the unification of the territories, economies, policy and culture of the two countries. Anyway, so does the leadership of the EU, actively supporting the process of construction of the European research space: "The formation of the European research area is a crucial step in the political and governmental integration of Europe for the political elite and the EU bureaucracy. Not in the least this means gaining control over large (tens of billions of euros) financial flows, which is another step of the transformation of the EU bureaucracy into the real executive power body. Neither politicians nor the EU officials actually imagine what a world scientific leadership of Europe is, but they are ready to support the implementation of this idea with resources in order to attract scientific elite on their side in the confrontation with national bureaucracies"[59].

In conclusion we consider it necessary to draw the readers' attention once again to the problems of constructing new types of knowledge-based integration spaces in the framework of the Union State. In our opinion, only by creating numerous research spaces and providing support to scientists, who are the main manufacturers of a key economic resource of modernity (scientific knowledge), "it will be possible to establish a civilization, oriented toward creating new wealth rather than fighting for the riches of others"[60].

[55] Ayres R. Technological forecasting and long-range planning. Translated from English. Moscow: Mir, 1971. P.113.

[56] Kustarev A. Science and politics. Neprikosnovenniy zapas. 2008. No. 6. P. 6.

[57] Shmatko N.A. Horizons of socio-analysis. Socio-analysis of Pierre Bourdieu. Moscow: Institute of experimental sociology; Saint Petersburg: Aleteya, 2001. P. 37.

[58] Kaganskiy V.L. Russia – the USSR today? A comparative portrait of spaces. Article 3. The Russian Federation and Russian space. Obshchestvenniye nauki i sovremennost. 2005. No. 4. P. 102.

[59] Mirskiy E.M., Barbotko L.M., Borisov V.V. Scientific policy of the 21st century: trends, policies and mechanisms. Available at: www.courier.com.ru/top/cras.htm.

[60] Selye H. From dream to discovery: On being a scientist. Translated from English. Moscow: Progress, 1987. P. 150.

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12. Geyets V.M. Post-crisis architectonics of the European economic space. The world of transformations. 2011. No. 1. P. 137-151.
13. Danilov A.N., Shcherbin V.K. Integration. The Republic of Belarus: encyclopaedia. In 6 volumes. Vol. 3. Minsk: BelEn, 2006. P. 778-780.
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Provision of safety – the priority in the sphere of fundamental and applied research

The authors are the members of the working group for the analysis of risks and security issues under the RAS President.

The article substantiates the necessity of transition to the new methodological framework and principles, which reduce the country's strategic risks, ensure and enhance the safety of anthropogenic and natural-anthropogenic spheres of human life and society from negative processes and phenomena. The article studies the issues of establishing a new criteria base for safety, methods, systems of preventing and overcoming threats and risk optimization.

Human life and society, technosphere, risks, disasters, safety.

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Modern development of the fundamental theory of safety justifies the need to change the existing traditional approaches to ensuring safe operating conditions of potentially dangerous objects of technosphere for new promising ones. They should be based on the standardized risks and safety parameters justified for technological systems according to the criteria of strength,

durability, survivability, reliability and security [1, 2]. The key factor in solving this problem is the use of the risk monitoring concept [3, 4] based on the control, diagnostics and monitoring of the basic operating parameters of technosphere objects and the comprehensive analysis of obtained results [2, 5].

Consequently, the development and implementation of large-scale projects in mechanical engineering, defence, energy, oil and gas sphere, transport and other sectors requires fundamentally new views on the problems of ensuring the reliability and safety of designed and operated machines, structures and mechanisms taking into account potential hazards of infrastructure and possible large-scale damage caused by anthropogenic accidents. The basic requirement for such projects and objects is ensuring their safe operation according to the acceptable risks criteria [1, 2, 6].

The results of fundamental and applied research on anthropogenic safety and risks are the basis for the transition from traditional methods and systems of ensuring durability, resource and reliability to the methods of risk assessment and management. One of the important elements in solving fundamental problems of security and risks is the integrated development and use of a comprehensive detection and monitoring system in normal and emergency situations, monitoring of emerging and ongoing risks of its operation at all stages of life cycle and the provision of preventive treatment of emerging threats to such objects on the basis of the risk management concept, as the current operational risks go beyond acceptable and approach the limit [1 – 8].

In the last years of the 20th century and the first decade of the 21st century, two major trends become widely acknowledged on the background of global dynamic processes taking place in the social, economic, natural and technology-related spheres of human life, society, country and mankind [1, 9]:

– desire to implement major international and national projects to improve the quality of life and sustainable environmental conservation;

– increase of a wide range of threats, further sustainable development of humanity and its environment.

These trends are reflected in the known resolutions of the UN, regional organizations and individual states on sustainable development (Rio de Janeiro 1992, Johannesburg 2002, Kobe 2005). However, in the 21st century, humanity has already faced global and regional natural disasters – tsunami in Southeast Asia in 2004, earthquake in China in 2008 and Haiti in 2010, military conflicts in Afghanistan, Yugoslavia, Iraq, Syria, national and international terrorism, the world economic crisis which started in 2008. They all indicate that the proposed strategies for forecasting and management of further development may prove to be insufficient, ineffective and unsafe without direct quantitative account of the ever-increasing threats [10].

In this respect, the great importance is attached to national and international basic and applied research on the issues of information security on the basis of risk analysis, aimed to develop and implement the principles of state policy in such strategically important areas as modernization of economy, priorities and priority spheres of technological development, critical and innovation technologies, national and intergovernmental projects [2]. Material and technological basis for the application of the results of such research is found in the objects and infrastructure of civil and military complexes included into a comprehensive social-natural-technological system of life support. This system forms and realizes technological and anthropogenic risks of its development and functioning, the risks of emergencies and disasters involving loss of life, destruction of objects and damage of the natural environment.

In the second half of the 20th century the largest catastrophes happened [1, 11, 12] in India (Bhopal), USA (the nuclear-powered submarine USS *Thresher*, the space shuttles *Columbia* and *Challenger*, the Three Mile Island nuclear power plant), in the USSR and Russia (the Chernobyl nuclear power plant, the nuclear-powered submarine *Komsomolets*, the rocket systems *Soyuz* and *N1*, the railways near Ufa, in Arzamas, and Sverdlovsk, at the Sayano-Shushenskaya hydroelectric power station), in Japan, Norway, Canada, Estonia (at the nuclear power station, offshore platforms, the largest tankers and ferries; *fig. 1*).

The above disasters took hundreds and tens of thousands of human lives, resulted in injury and loss of health for tens and hundreds of thousands of people, contaminated vast territories of the regions, states and continents [1, 9, 11]. At the same time, large-scale natural disasters occurred – earthquakes (in Armenia, Iraq, Japan, Central America), floods (in India, China, the USA, some European countries), storms, tsunamis [1, 12]. The damage consisted in numerous losses of human lives, destruction of infrastructure and environment.

These examples demonstrate that serious accidents and disasters become a permanent factor in modern civilization; moreover, they show that, unfortunately, the threats of their occurrence are increasing faster than the ability of scientists, specialists and state structures to predict and prevent man-caused accidents and natural disasters.

For Russia the main documents, defining the key goals of considered fundamental research and developments in the field of safety are the Russian Federation National Security Strategy [13] and the Fundamentals of strategic planning in the Russian Federation [14], elaborated by the Security Council of the Russian Federation and approved by the President of the Russian Federation in 2009.

Ensuring the conditions for safe operation of the objects of technosphere is inseparably linked with the analysis of conditions and risks of potential challenges, dangers, threats and their stage wise implementation [1 – 9]. The theory of safety assumes that the risks R are such combinations of the probability P of occurrence of adverse events (dangerous and crisis phenomena, catastrophes, accidents and emergencies), on the one hand, and the mathematic expectation of losses U generated by them on the other hand, that determine the change in the safety level and the state of the systems of protectability of human, infrastructure and the environment from threats and dangers, both internal and external – man-made, natural, anthropogenic [1, 2, 6]. Integral risks are calculated as the product, sum or integral:

$$R = PU = \sum_i P_i U_i = \int C(P)U(P)dP = \\ = \int C(U)P(U)dU, \qquad (1)$$

where P_i, U_i are probabilities and damage from the main (differentiated) adverse events;

C – weight functions.

The main tasks in the direction of providing security based on the concept of risk are [2, 6]:

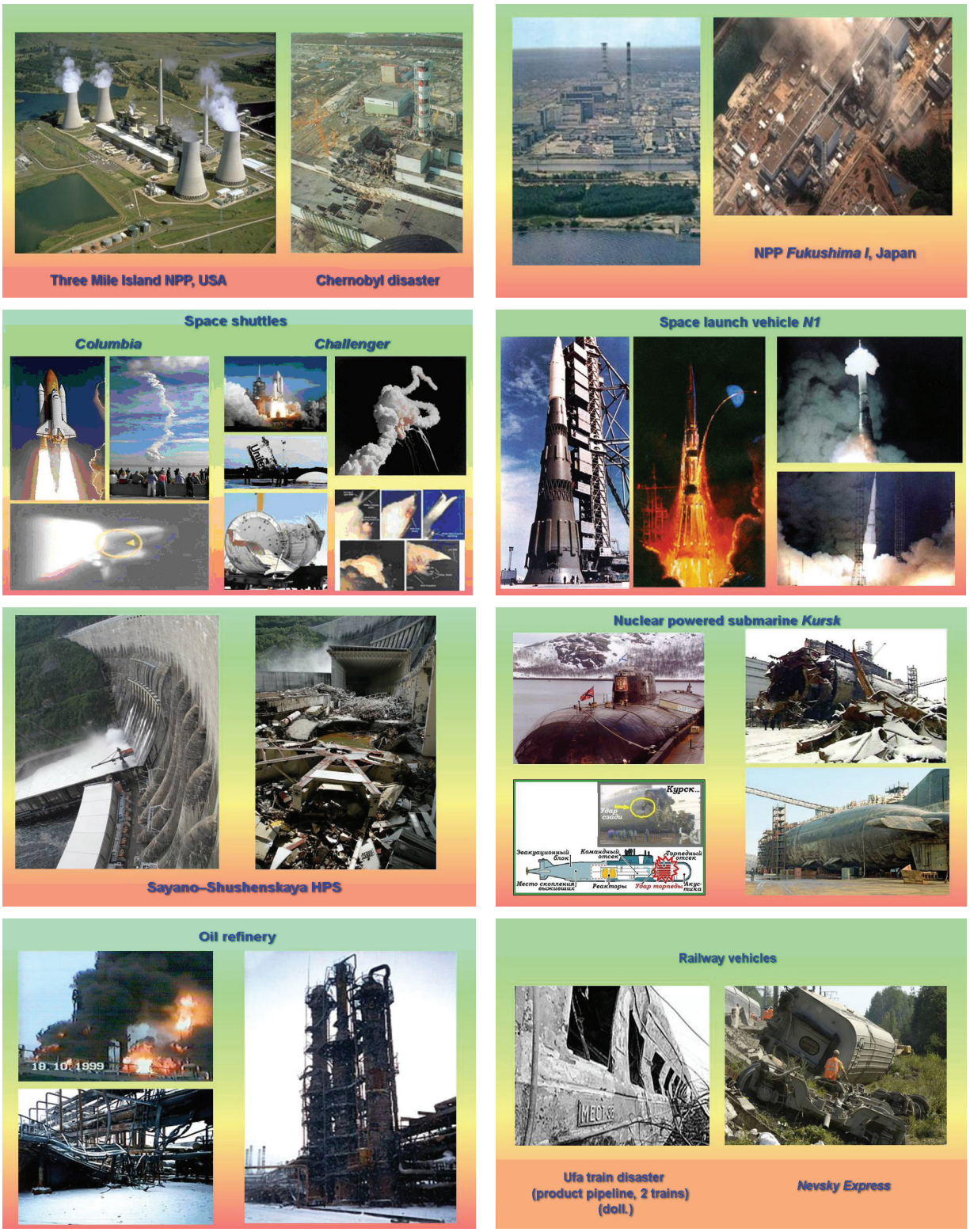
– formation of the fundamental base of risk analysis $R(t)$ in three main spheres – social (N), natural (O) and technological (T), which constitute a single, complex socio-natural-anthropogenic system "man – nature – infrastructure" and functioning in time t:

$$R(t)=F_R\{R_N(t), R_O(t), R_T(t)\}; \qquad (2)$$

– construction of the generalized model of the specified complex system with the definition of the roles of its main components N, O, T in terms of the basic parameters of risks $R(t)$ – the probabilities of occurrence $P(t)$ of adverse processes and events (dangers, challenges, threats, crises, catastrophes) and associated damages $U(t)$:

$$R(t)=F_R\{P(t), U(t)\}; \qquad (3)$$

Figure 1. Examples of grave disasters at the objects of technosphere



$$P(t)=F_P\{P_N(t),\ P_O(t),\ P_T(t)\}; \qquad (4)$$

$$U(t)=F_U\{U_N(t),\ U_O(t),\ U_T(t)\}; \qquad (5)$$

– creation of scenarios of the emergence and development of adverse events in the complex system and quantitative risk assessment *R(t)* through the parameters of the main initiating and damaging factors – hazardous energy *E(t)* substances *W(t)* and information flows *I(t)*:

$$R(t)=F_R\{E(t),\ W(t),\ I(t)\}. \qquad (6)$$

On the basis of the relations (1) – (6) the fundamentals of rating emergency situations, high-risk facilities and dangerous processes according to the values of risks *R(t)*.

Risks, as an interdisciplinary scientific basis for assessing integrated security, including the analysis of the initiating factors, the conditions of development and the nature of the consequences of accidents and disasters, are based on the patterns, methods, equations, and the criteria obtained in the fundamental fields of knowledge: mathematics, physics, chemistry, mechanics, informatics, engineering science, biology, geology, geophysics, physics of atmosphere and ocean, geography, economics, law, philosophy, sociology, psychology, physiology *(fig. 2)* [2, 6].

The developed theories of system analysis, theories of chaos and order, management theories, theories of catastrophes and creating protection, methods of mathematical and simulation modelling, forecasting, mathematical statistics, methods and systems for diagnostics and monitoring are generalizing for the analysis of integrated risks.

Accidents and disasters, depending on the severity of their consequences (damage) and the observed frequency of their occurrence are divided *(fig. 3)* into planetary, global, national, regional, areal, facility and local [1, 2]. The former create severe socio-economic and environmental consequences for neighbouring countries, the latter affect industrial and sanitary protection areas of the sites.

Accordingly, depending on the scale and consequences of accidents and disasters, seven (1 – 7) their classes are introduced in the risk analysis *R(t)* [1, 2]:

1 class – local ones, occurring on the components of the object (the parts, units, shops, buildings);

2 class – facility ones occurring on the territory of the object, which have impact on the object (enterprise, residential and industrial complexes, dams, hydroelectric stations, transport facilities and complexes);

3 class – areal ones occurring on the object of infrastructure and environment, which have impact on the territories, population and facilities, municipal entities (enterprises, transport, energy, municipal systems, landscape and natural sites);

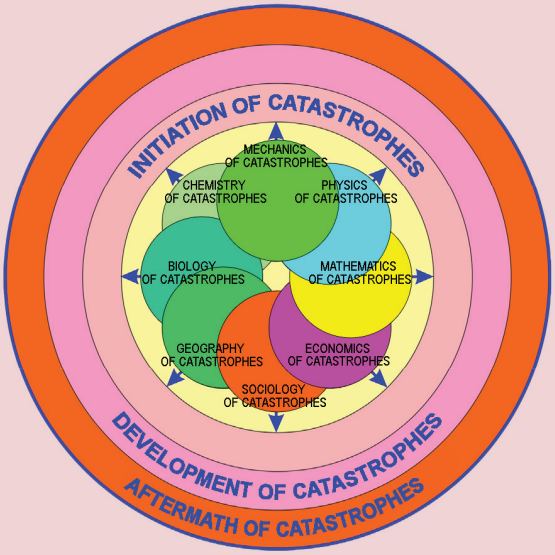
4 class – regional ones occurring on large objects of natural, man-made and social sphere, with negative consequences;

5 class – national ones occurring during the disasters on the unique objects of infrastructure during natural and anthropogenic emergencies and on vital objects during natural disasters, as well as in case of terrorist acts and military conflicts with severe socio-economic and environmental consequences for a number of regions and the country in general;

6 class – global ones occurring during the disasters on the objects of technosphere and during anthropogenic and natural disasters in the environment with severe socio-economic and environmental consequences for the country and a number of adjacent states;

7 class – planetary ones occurring under extreme impact of the military, anthropogenic or natural character with severe consequences for the countries, continents and the planet in general.

Figure 2. Structure of the fundamentals of the catastrophe theory and the analysis of their development scenarios



According to the level of potential hazard *(fig. 3)*, in compliance with the legislation and taking into account the risk of accidents and catastrophes, the objects of technosphere can be divided *(fig. 4)* in four main groups [1, 2], which have the following safety requirements:

– objects of technical regulation (OTR), the safety of operation of which is ensured by the law on technical regulation, their number is measured in millions and tens of millions;

– hazardous production facilities (HPF), the safety of operation of which is ensured by the law on industrial safety, their number is measured in hundreds of thousands;

– critically important objects (CIO), the safety of operation of which is ensured according to the decision of the Security Council of the Russian Federation, their number is measured in thousands;

– strategically important objects (SIO), safety of operation of which influences the country's national security, their number is measured in hundreds.

The data in fig. 3 and 4 show that at present the most relevant is the risk analysis of severe accidents (5 – 7 classes according to fig. 3) for critically (CIO) and strategically important objects (SIO).

In the cases when for the considered object of technosphere in accordance with the expression (2) the relative (per unit period of time) systemic risks $\overline{R}_S$ are defined (respectively for the population $\overline{R}_N$, for the objects of technosphere $\overline{R}_T$ and for the environment $\overline{R}_O$), then the surface areas of safe, dangerous and threshold conditions $\overline{R}_S$ can be created [2, 6] for the object using these data in terms of relative systemic risks can be constructed *(fig. 5)*:

$$\overline{R}_s = \sqrt{\overline{R}_N^2 + \overline{R}_T^2 + \overline{R}_O^2}. \qquad (7)$$

However, if we plot the above-mentioned classes of accidents and catastrophes 1 – 7 by the increase in their severity along the scales $\overline{R}_T$, $\overline{R}_N$ and $\overline{R}_O$, it will be possible to perform a quantitative assessment of the degree of safety of the considered object and any of its components on risk criteria. Such an assessment is characterized by the position of the radius-vector of this object in three-dimensional space "$\overline{R}_T$ - $\overline{R}_N$ - $\overline{R}_O$".

Figure 3. Types of accidents and disasters with the probabilities of their occurrence and possible damage

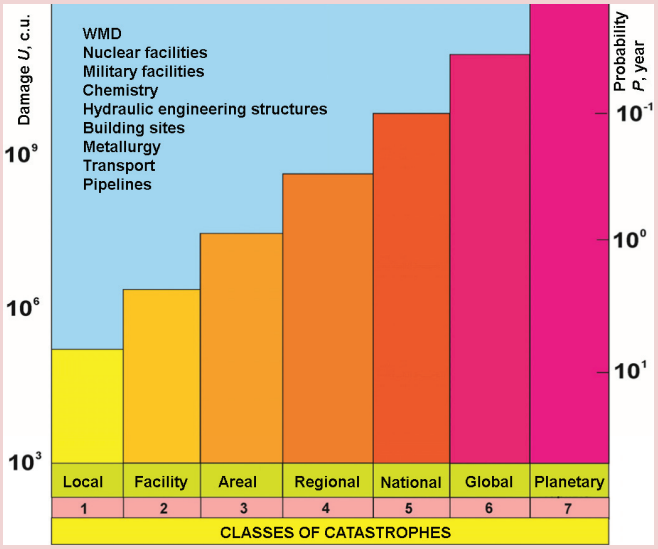


Figure 4. Structural scheme of analysis and categorization of potentially hazardous objects

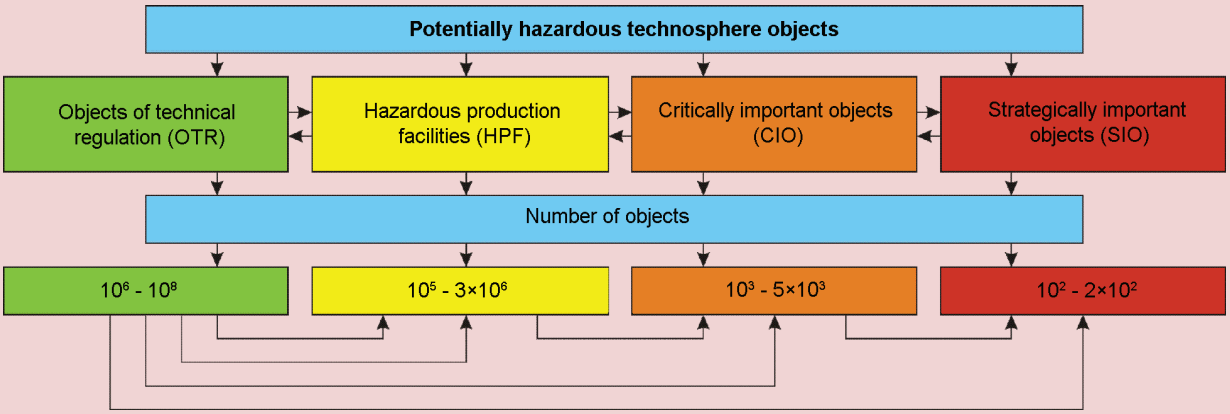
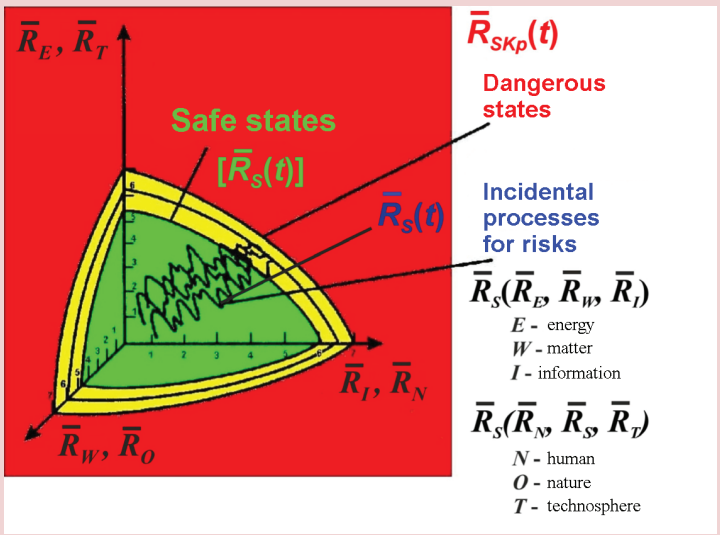


Figure 5. Areas of dangerous and safe conditions according to the indicators of relative risks



In order to transfer the object to the safe condition along with the use of the risks of the above mentioned risk components $\overline{R}_N$, $\overline{R}_T$, $\overline{R}_O$, and the systemic risk in general (see fig. 5) it is necessary to reduce the possibility of parameters of uncontrolled outputs of potentially hazardous substances W, energy E and information flows I on the corresponding components of the risk (8). These parameters condition the risks according to the expression (6):

$$\overline{R}_s = \sqrt{\overline{R}_W^2 + \overline{R}_E^2 + \overline{R}_I^2}. \qquad (8)$$

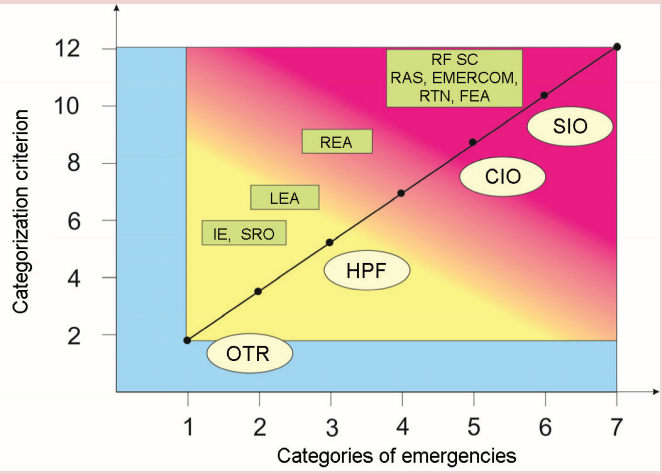
It follows that the analysis of conditions of safe operation of the objects of technosphere can be based on the indicators (classes, categories) of possible emergency situations (see fig. 2), or, on the other hand, the indicators categorizing potentially dangerous objects themselves (see fig. 4). The latter can be represented in the form of quantitative values *(fig. 6)*, determined by the ratio of the corresponding relative risk values for human lives, technosphere and the environment according to the expression (7). For the quantitative categorization of hazardous processes and objects, the expression (8) should be used for the components of the risk $\overline{R}_W$, $\overline{R}_E$, $\overline{R}_I$.

When changing the above-mentioned components of the systemic risk, that are changing in the range from 1 (local emergency situation) to 7 (planetary catastrophic situations), the relative value of systemic risk $\overline{R}_S(t)$ will vary from 1.86 (local accident) to 12.12 (planetary catastrophe).

If we accept that even one maximum component out of $\overline{R}_N$, $\overline{R}_T$, $\overline{R}_O$ and $\overline{R}_W$, $\overline{R}_E$, $\overline{R}_I$, of the systemic risk $\overline{R}_S(t)$ corresponds to this class of emergency, and the other components correspond to the lower class of the dangerous situation, the boundary values of relative risks will be in accordance with the expressions (7) and (8) the following: for local emergencies – from 1.86 to 2.45; for facility emergencies – from 2.46 to 3.16; for areal emergencies – from 3.17 to 4.24; for regional emergencies – from 4.25 to 5.19; for national emergencies – from 5.20 to 6.16; for global emergencies – from 6.17 to 7.14; planetary catastrophes – from 7.14 to 12.12.

The determination of appropriate indicators of categorization of hazardous objects by the values of risks and management of these indicators should be effected with the participation of administrative and supervisory bodies for different types of objects relevant to their jurisdiction, including for the

Figure 6. Categorization of the objects according to the values of risks



objects of OTR type they can be (see fig. 6) industrial enterprises (IE) or a self-regulatory organizations (SRO) for the objects of HPF type – local executive authorities (LEA), or regional executive authorities (REA), for the objects of CIO and SIO types – the Security Council of the Russian Federation (RF SC), the Russian Academy of Sciences (RAS), the Ministry of Emergency Situations (EMERCOM), the Federal Service for Ecological, Technological and Nuclear Supervision (Rostekhnadzor, RTN), federal executive authorities (FEA).

Considering the aforementioned, we can conclude that the integral economic risks, determined by the product of individual risks on the number of objects, are comparable for both global and facility-level disasters. The damages from single disasters of a global and on-site scale differ by 8 – 10 orders, risks differ by 4 – 6 orders and integral damages – by 1 – 3 orders at the seven classes of anthropogenic and natural-man-made disasters according to fig. 3, 5 and 6.

For the entire set of technosphere facilities of the types OTR, HPF, CIO and SIO, the types of accidents and disasters, the level of their safety, and related operational risks during the transition from normal operation to emergency can be characterized [2, 6] by the definitions according to fig. 7 as follows:

– normal situations, occurring in the functioning of the objects within the established norms and rules; the risks for them are controlled and the security is increased;

– regime emergencies, occurring in a deviation from the normal operating conditions during the normal functioning of potentially dangerous objects; their consequences are foreseeable, the risks – regulated, the safety – sufficient;

– designed accidents, which occur if the object goes beyond the regular functioning modes with predictable and acceptable consequences; the risks are analyzed, and safety is partial;

– accidents beyond the designed ones, which occur due to the irreversible damage of the critical elements of the object with high damage and loss of life and with the necessity of subsequent recovery works; the risks are increased, and the safety is insufficient;

– hypothetic accidents may occur under unexpected options and development scenarios with maximum possible damage and victims; they are characterized by high risks, the protection against them is low, the direct restoration of objects is not possible.

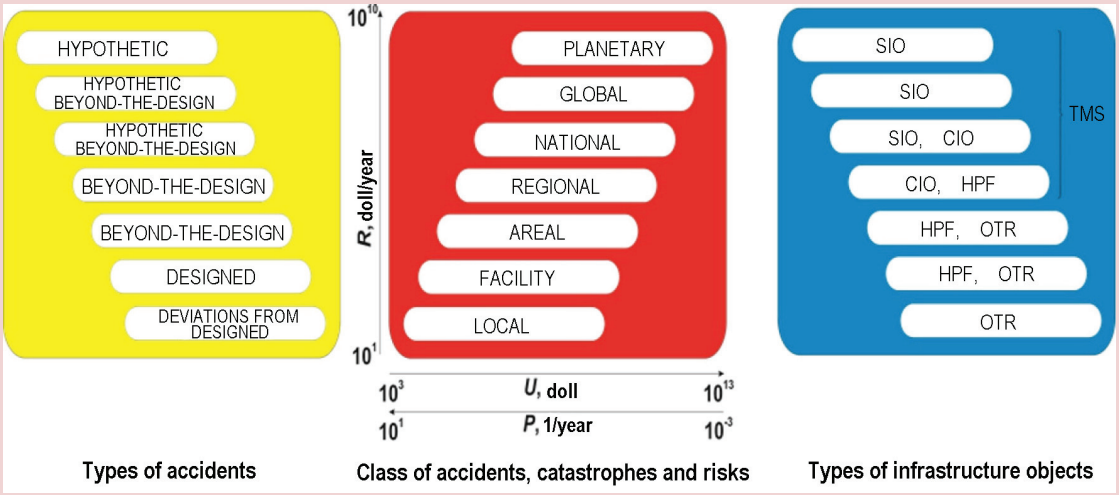
Thus, the overall structure of the analysis and management of potentially dangerous technosphere objects according to risk criteria includes the classification of types of emergencies and disasters, the definition of accidents and disasters by the levels of possible risks and damages, as well as the description of the types of potentially dangerous objects *(fig. 8)*.

In the considered structure, the characteristics of the types of accidents and disasters, shown in the left part of fig. 8, the related risks

Figure 7. Types of emergences and the degree of objects' safety

№ п/п	Emergencies	Safety	Risks
1.	Normal operating conditions	Increased	Controlled
2.	Deviations from normal conditions (regime emergences)	Sufficient	Regulated
3.	Designed accidents	Partial	Analyzed
4.	Beyond-the-design accidents	Insufficient	Increased
5.	Hypothetic accidents	Low	High

Figure 8. The overall structure of the analysis and management of objects according to risk criteria



and the degree of safety of the objects during the transition from their normal operation conditions to emergency conditions are presented in fig. 7.

The classification of types, objects and infrastructure (fig. 4 – the right part) is linked with the categories and classes of accidents, catastrophes (fig. 4 – central part), and levels of risks for the arising emergencies and disasters, and it can be elaborated according to the estimates of the degree of their severity and inflicted damage, as well as the parameter estimates of the probability of their occurrence and the levels of potential human and material losses. In this case, the situations of the positions 1 – 3 according to fig. 7 are analysed for OTR and the HPF, for CIO, respectively, the situations 1 – 4, for SIO – the situations 1 – 5.

As it has already been mentioned, the fundamental scientific research of the characteristics of safe operation of the technosphere objects according to the parameters of the risks of emergencies occurrence include, first of all, the study on criteria of strength, durability, survivability and security of considered machines and constructions with the analysis of the conditions for achieving the threshold state in the process of exploitation at different stages and modes of life cycle [2, 6, 8, 15]. The system of such criteria of the mechanics of deformation and destruction at different stages of the research and development of appropriate calculation methods in this field consistently included analysing and defining the basic characteri-stics of mechanical properties of materials, determining the conditions of reaching the threshold state in the increasingly complicated operating conditions, requiring the use of special approaches to the implementation of the relevant calculations, the highest degree of which is the definition of security, risk and safety parameters of the considered technosphere objects [8, 15].

Figure 9 presents the time scale beginning from the 1930s to the second decade of the 21st century, which shows the sections of fundamental scientific research of strength R_{σ},, resource $R_{N,\tau}$, reliability $P_{P,R}$, survivability $L_{l,d}$, safety S, risk R and protection Z for the various types of technosphere objects.

In the historical and scientific-technological terms, this direction has a stable chain of traditionally resolved and above mentioned problems [2, 6]:

$$R_{\sigma} \rightarrow R_{N,\tau} \rightarrow P_{P,R} \rightarrow L_{l,d} \rightarrow S \rightarrow R \rightarrow Z \rightarrow Z \quad (9)$$

The protection of the object Z is defined by the ability of equipment to fight the occurence and development of accidents in regular and emergency conditions and is described by the relevant functional from the basic criteria parameters of strength, durability, survivability, safety and risk:

$$Z(\tau)=F_z\{R(\tau), S(\tau), L_{ld}(\tau), P_{PR}(\tau), R_{N\tau}(\tau), R_\sigma(\tau)\}. \quad (10)$$

As follows from fig. 9, each subsequent step or stage in the development of science and technology uses the previous ones and is based on them. At that, the basic parameters of operational impacts $P^э$ are the equivalent operating stress $\sigma^э$, deformation $e^э$, the number of cycles $N^э$, time $\tau^э$, temperature $t^э$, the external environment $\Phi^э$ (radiation, corrosion, electromagnetic field), stress intensity factors and deformation intensity $K^э_{Ie}$ factors $K^э_{Ie}$:

$$\mathrm{P}^э = \left\{\sigma^э, e^э, N^э, \tau^э, t^э, \Phi^э, K^э_I, K^э_{Ie}\right\}. \quad (11)$$

The basic characteristics of mechanical properties include the limits of fluidity σ_T, the ultimate strength σ_B, the endurance limits σ_{-1}, the long-term strength $\sigma_{\partial n}$, tear resistance S_κ; the ultimate plasticity ψ_κ, the critical stress intensity factors K_{Ic} and deformation intensity factors K_{Iec}:

$$R_\sigma = F\{\sigma_T, \sigma_B, \sigma_{-1}, \sigma_{\partial n}, S_k, \psi_k, K_{Ic}, K_{Iec}\}. \quad (12)$$

The derivatives of the characteristics of the mechanical properties of the material, constructive forms and the loading conditions of the object are such characteristics as stress rupture ductility $\psi_{\kappa\tau}$, efficient stress concentration factors K_σ, sensitivity to the absolute sizes ε_σ and cycle asymmetry ψ_σ, variation coefficient υ_σ, crack growth by the number of cycles dl/dN and time $dN/d\tau$, sensitivity to the external environment β_c. Then the conditions of strength are written in the form:

$$P^э \le R_\sigma\{\psi_{k\tau}, K_\sigma, \varepsilon_\sigma, \psi_\sigma, \nu_\sigma, dl/dN, dl/d\tau, \beta_c\}. \quad (13)$$

To ensure the resource (in the cycle, time dimensions, or in the parameters of resistance to environment), the following requirement should be met:

$$R_{N,\tau,p} \le R^c_{N,\tau} = \left\{N^э/N_c, \tau^э/\tau_c, \Phi^э/\Phi_c\right\}, \quad (14)$$

where $R^c_{N,\tau}$ is the critical (limit) value of resource, expressed through critical (destructive) cycles N_c,, time τ_c or exposure to the environment Φ_c.

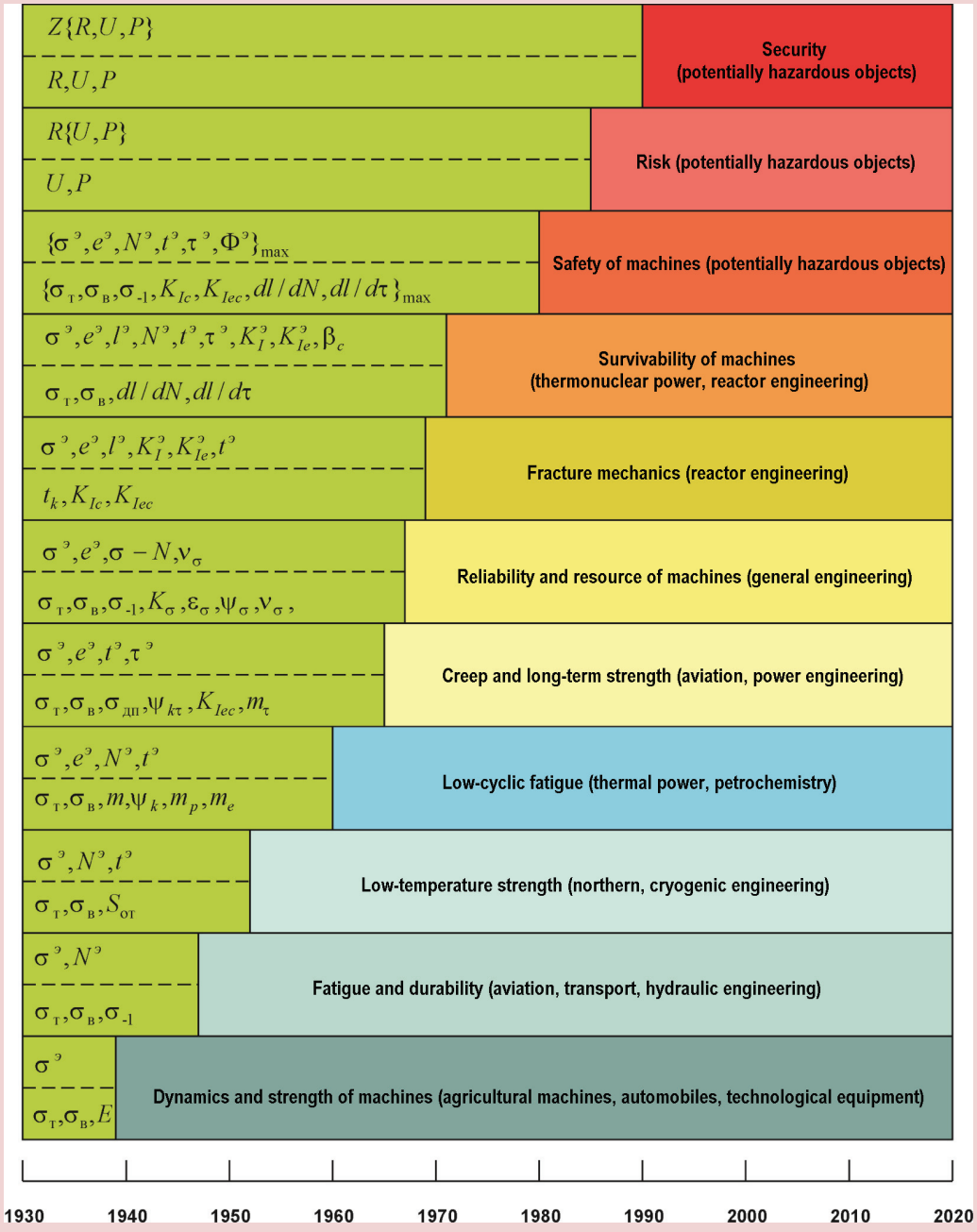
Durability parameters $P_{P,R}$ according to the criteria of strength R_σ and resource are determined by the expressions (10) – (14), with the introduction of probabilistic characteristics of strength, plasticity, operational loading taking into account the variation coefficient υ of these characteristics:

$$P_{P,R} = F\left\{P^э, R_\sigma, R_{N,\tau,\Phi}, \nu\right\}. \quad (15)$$

In accordance with the expression (15), mechanical testing of samples of the construction material for defining the scattering parameters (including the variation coefficient υ) becomes extremely labour-intensive. In some cases, to establish the distribution curves of the basic characteristics of mechanical properties σ_B, ψ_κ, σ_{-1}, $\sigma_{\partial n}$, the tests of 10 up to 2000 samples were conducted at one of loading modes.

When assessing the survivability, the major attention is focused on determining the level of accumulated damage d that is measured by the above relative parameters $N^э/N_c$, $\tau^э/\tau_c$, $\Phi^э/\Phi_c$, or crack (defects) growth from the initial sizes l_0 to the current $l^э$ and critical l_c. This crack growth is determined by their speeds dl/dN, $dl/d\tau$, which, in turn, depend on the scale of stress intensity factors ΔK_I or deformation intensity factors ΔK_{Ie}. Once this limit condition is achieved, the conditions of destruction according to the criteria of linear (K_{Ic}) and nonlinear (K_{Iec}) fracture mechanics.

Figure 9. Development stages of calculation methods and criteria of strength, resource, durability, survivability, safety, risk and security



Then the survivability $L_{d,l}$ of the objects taking into account the damage d and crack growth l will be estimated by the condition:

$$L_{d,l} = F\left\{P^э, R_\sigma, R_{N,\tau,\Phi}\right\} = F\left\{d, dl/d\tau, dl/dN\right\} \leq$$
$$\leq F\left\{N^э/Nc, \tau^э/\tau_c, \Phi^э/\Phi_c, K_I^э/K_{Ic}, K_{Ie}^э/K_{Iec}\right\}. \quad (16)$$

If statistical parameters are introduced in the expression (16), the characterisation of survivability $L_{d,l}$ acquires a probabilistic character. This task requires mechanical testing of large series of samples for verification regimes of loading in determining, primarily the parameters dl/dN, $dl/d\tau$, K_{Ic}, K_{Iec}.

In recent years the safety *S* of civil and military objects, technical systems, machines, structures, products and materials has become one of the defining parameters of industrial production, economy and life.

For a long time, requirements for the safety *S* have remained mostly qualitative or have been related to production safety. However, after a number of the largest man-made and natural-anthropogenic catastrophes and disasters at the atomic and thermal power engineering facilities, petrochemical complexes, rocket-space systems, nuclear-powered submarines, it has become evident that safety *S* should be a quantitatively defined, controlled and adjustable parameter. As it was mentioned above, to achieve this goal, it was proposed to use the quantitative characteristics of risks *R*. On the basis of the expressions (1) and (2), the risks *R(t)* for assessing the safety *S* of technosphere facilities are understood as the functional F_R, depending on the probability *P(t)* of anthropogenic accidents or disasters according to the criteria of strength and resource and the mathematical expectation of consequences (damages) *U(t)*, generated by these accidents and disasters [1, 2, 6].

In turn, the risk parameters *P(t)* at the stage of designing high-loaded machines and constructions of various purpose (nuclear (NPS), hydro (HPS), thermal (TPS) power stations, missile and space complexes (MSC), aircrafts (AC), nuclear-powered submarines (NPSs), chemical productions (CP), main pipelines (MP), etc.) are determined by the expression (15) in the form of the functional of operational loading P^p, fracture resistance R_σ, resource and their scattering characteristics υ *(fig. 10)*. For the stages of manufacture, tests and operation, in addition to the expression (15), the analysis of the likelihood of accidents or disasters is supplemented with survivability characteristics $L_{d,l}$ according to (16). Standard systems of diagnostics and monitoring of these parameters must ensure operation of the objects within the permissible values of these parameters and the automatic protection systems must activate them when these diagnosed parameters go beyond the permissible limits. Decommissioning of potentially dangerous objects should also be accompanied by the analysis of the whole complex of parameters determining the safety of this process and preventing their going beyond the established limits.

Damage *U(t)* associated with non-compliance of the terms of strength and resource depends on the type of ultimate state, attained by the object in operation. The most significant damage (for the life and health of operators, personnel, population, for the damage of the objects themselves and the environment) *U*(*t*) in the expressions (1), (3) and (5) occurs in those cases when there are extensive brittle fractures, the global loss of stability, gliding fractures after growth of cracks during the cyclic and sustained loading.

In-depth analysis of the largest man-made and natural-technogenic catastrophes of the last years shows the necessity of improving the scientific, engineering, technological, regulatory, supervisory and legal solutions in the field of ensuring the safety and security of engineering objects with high levels of risks. One of the ways of such improvement can be a detailed consideration of the considered (see fig. 9) historically established sequence of forming the fundamental scientific foundations for the development of engineering methods of calculation and testing, creation of norms and rules of designing and manufacturing the technosphere facilities, ensuring their functioning within the set limits of design modes and parameters in the direction of its application to the tasks of regulating the relevant characteristics *(fig. 11)*.

The basic, gradually increasing, demands to the standard (normal) operation and design parameters of functioning for the high risk

Figure 10. Structural scheme of the analysis of durability and safety of technosphere facilities at various stages of life cycle

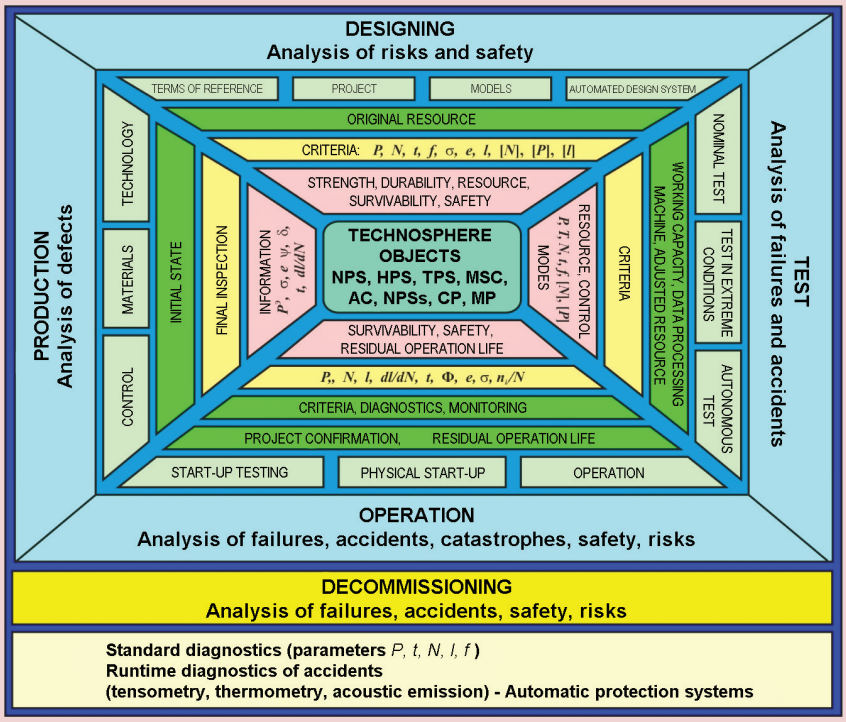
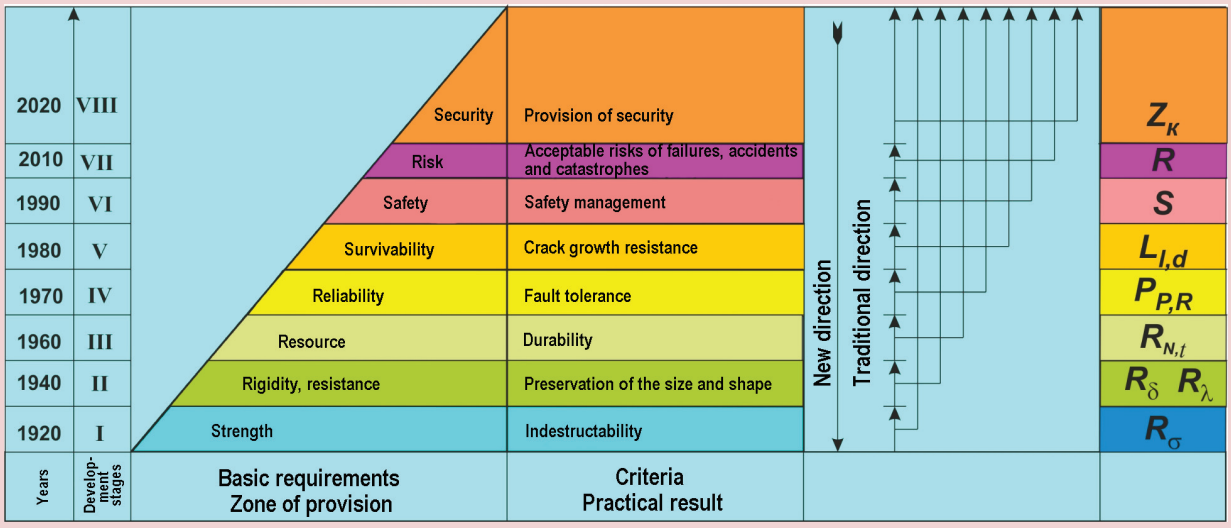


Figure 11. Hierarchical structure of the criteria ensuring the operability of equipment



technosphere facilities at all the stages of their life cycle (see expression (9)) at present are as follows "strength → rigidity → resistance → resource → reliability → survivability → safety → risk → security". At that, the following definitions, which are included in this sequence (see fig. 11), can be assumed:

R_σ – strength, determined by the resistance of supporting elements of the equipment to the damage during normal and emergency actions;

R_λ – resistance, determined by the resistance to the loss of initial forms λ of load-bearing elements of the equipment under normal or emergency load;

R_δ – rigidity, determined by the resistance of the load-bearing elements of the equipment to the achievement of inadmissible deformations δ under normal or emergency load;

$R_{N,\tau}$ – resource (service life), determined by the time τ or number of cycles N before the destruction or loss of stability;

$P_{P,R}$ – reliability, which is determined by the ability of the equipment to perform specified functions in a normal or corrupted condition, under the specified loads R or resource $R_{N\tau}$;

$L_{l,d}$ – survivability, which is determined by the ability of the equipment to function to a limited capacity under the injuries d and sizes of defects (cracks) l, inadmissible according to the standards;

S – safety, which is determined by the ability of the equipment to not go into the emergency or catastrophic state with the infliction of considerable damage to the population, technosphere and natural environment;

R – risk, defined as the probability of occurrence of adverse situations on the equipment with possible damages from these situations in normal and emergency conditions;

Z_κ – security, defined by the ability of the equipment to counteract the emergence and development of adverse situations in normal and emergency conditions.

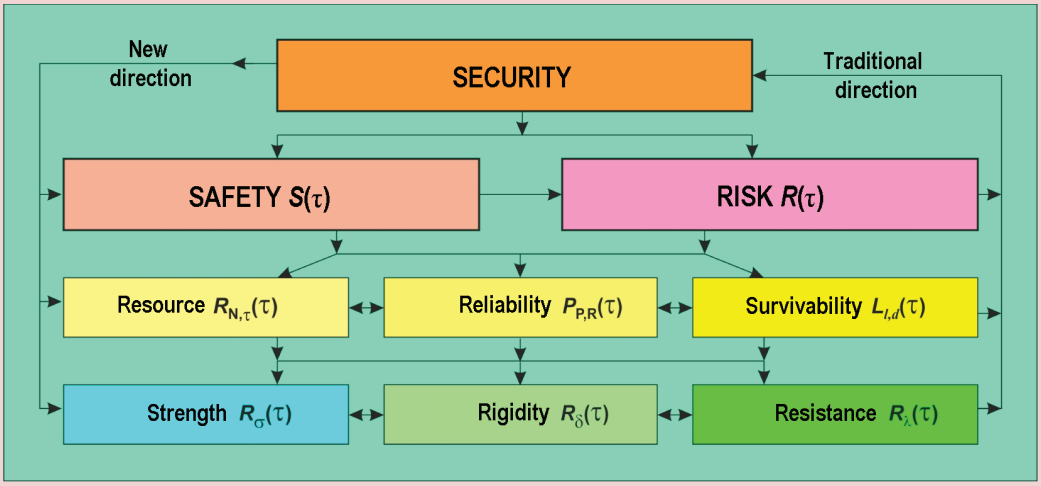
The above-mentioned operability parameters are functions of time τ, and the last one of them, i.e. security Z_κ (τ), is the most important for extremely loaded high-risk equipment (see fig. 10).

The diagram shown in figure 11 highlights the periods and main stages of development (I – VIII), basic requirements, the main practical results and sequences of implementation of the considered approaches. It is clear that each upstream element relies on downstream elements as the foundation. This means that the solution of security, risk and safety problems should fully rely on the solution of the problems of "survivability → reliability → resource → rigidity → resistance → strength" going through the traditional stages of their interaction. It should be emphasized that the fundamental results of determining and ensuring strength (stage I) were obtained in their present-day form at the beginning of the 20th century, and the closed analysis of rigidity and resistance (stage II) ended in the mid-1990s. In the 20th century the theory and practice of ensuring "resource → reliability → survivability" were formed (stages III, IV, V). Recently, the fundamental problem of analysing and providing safety and risk (stage VI) was formulated for all potentially dangerous objects with the transition (phase VII) to security managing according to risk criteria. The requirement for ensuring safety was set forth as a crucial one, which required the development of a new direction in promoting the operability of anthropogenic infrastructure "VII→I" as a promising one to ensure the conditions for its safe functioning. In accordance with the Russian Federation National Security Strategy [13, 14], ensuring the safety and security of the country's infrastructure is one of the objectives of the state science and technology policy, in this connection the task of ensuring the safety and security of high-loaded, potentially hazardous objects against accidents and catastrophes of natural and anthropogenic origin (phase VIII) is put forward as a new and urgent one at the present stage.

The basic algorithm for analysing and providing the security of equipment from adverse situations *(fig. 12)* taking into account the expression (10) consists in the implementation of the main above mentioned approaches to the substantiation of their operational safety in regular, emergency and catastrophic situations.

New perspective direction to ensure the security of high-risk of technosphere facilities from adverse situations is the one (the left branch in fig. 12), which initially forms the

Figure 12. Traditional and promising algorithms of analysing and providing security of technosphere facilities



level of security $Z_{\kappa}(\tau)$ and defines all the main groups of requirements [1, 2, 6]:

– safety $S(\tau)$ and risks $R(\tau)$;

– resource $R_{N\tau}(\tau)$, reliability $P_{PR}(\tau)$, survivability $L_{ld}(\tau)$;

- strength $R_{\sigma}(\tau)$, rigidity $R_{\delta}(\tau)$, resistance $R_{\lambda}(\tau)$.

In the framework of the traditional approach, the following groups of requirements are initially provided: strength → rigidity → resistance; resource → reliability → survivability; safety → risks. Each of the traditional "I→VIII" and new "VIII→I" (fig. 11) stages corresponded to a practical result in scientific research, design, creation and operation of technosphere objects: "indestructability → preservation of the size and shape → durability → fault tolerance →crack growth resistance → safety → acceptable risks → protectability against failures, accidents and catastrophes".

The specified sequence of adverse events causing damage to objects and leading to a catastrophe, may have a different view *(fig. 13)*, characterized by the increase in time *t* of risks *R(t)*, characterized in their analysis by the relevant parameters considered above.

The presence of a potential hazard with regard to a given object is not always accompanied by its negative impact on the object's most important elements. The realization of danger requires the fulfilment of at least three conditions: the danger actually works (is present); the object is in the danger zone; the object doesn't have a sufficient level of security $Z_{\kappa}(t)$. In the latter case the new requirements, criteria and methods should be applied in order to enhance the security up to the specified level.

Generally, a comprehensive analysis of safe operation conditions of technosphere objects by the criteria of strength and resource on the basis of the results of the corresponding fundamental and applied research was proposed to be conducted using a generalized diagram of strength, static, cyclic and temporary resource, survivability and safety *(fig. 14)* taking into account the impact of the corrosion environment, radiation, vibration, fatigue, dynamics and statics of loads application [1, 2, 6, 16 – 18].

The analysis of strength, resource and safety based on this diagram has been performed using the relevant provisions concerning the resistance of materials, theory of elasticity, fatigue, plasticity, creep, linear and nonlinear fracture mechanics, mechanics of catastrophes and theory of risks. In accordance with this

Figure 13. The algorithm for the analysis of damage to the objects and the corresponding risks

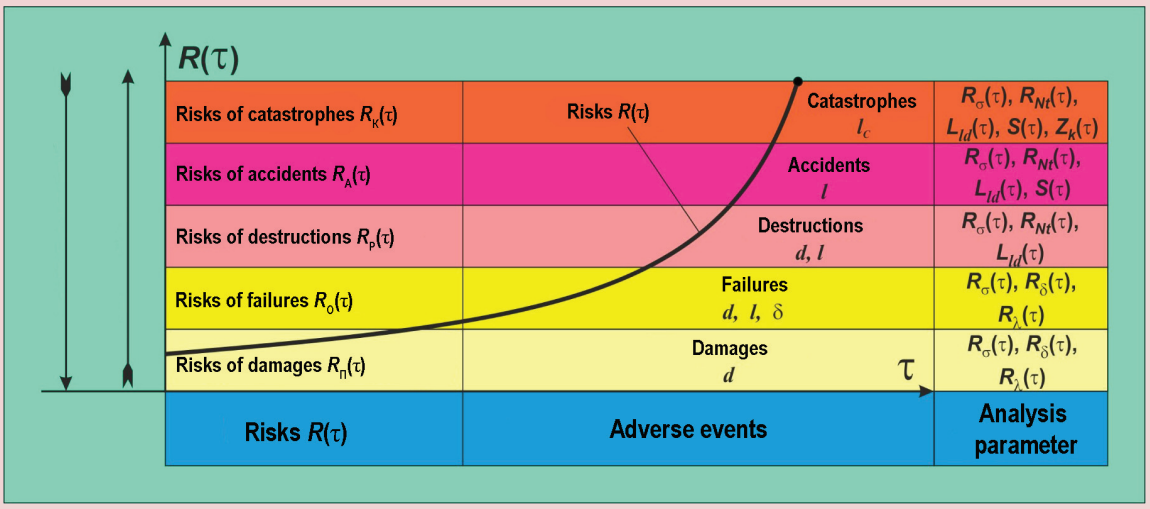
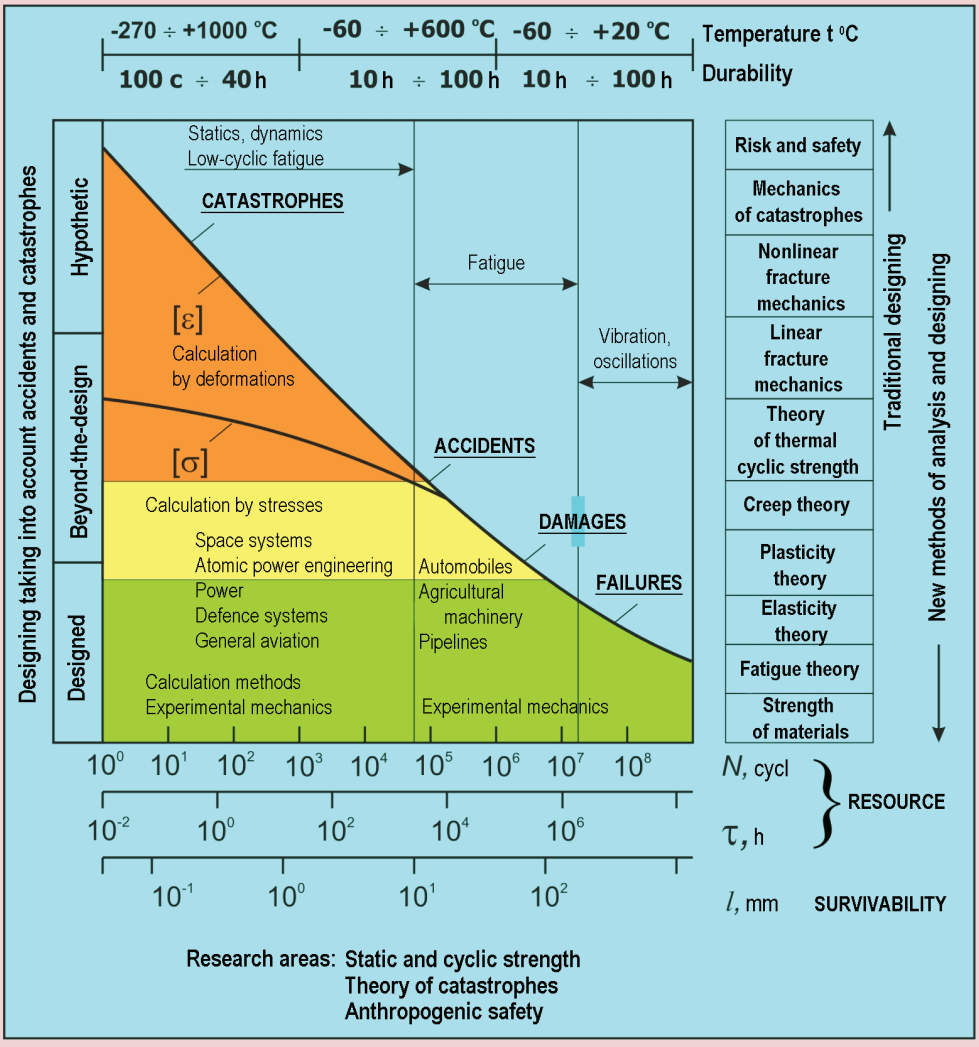


Figure 14. Generalized diagram of hazardous and extreme states for technosphere facilities



approach, the durability of structures ranging from 100 seconds to hundreds and thousands of hours at temperatures t from -270°C to 1000 degrees°C, at the numbers of cycles N from 10^0 to $10^9 – 10^{10}$, temporary resource τ from 10^{-2} to 10^6 hours, at the linear dimensions of defects l from 10^{-2} to 10^3 mm.

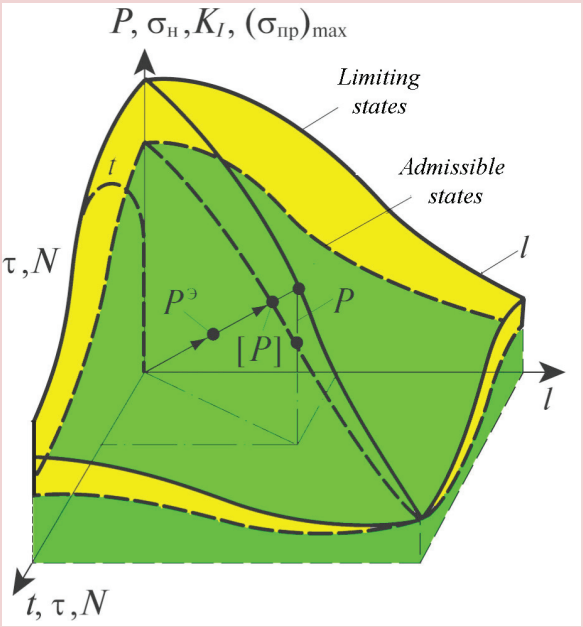
This comprehensive analysis includes routine, emergency and catastrophic situations (designed, beyond-the-design, and hypothetical). At that, the traditional rules of calculations and design prove sufficient for routine situations; emergency and catastrophic situations require new methods of analysis and design. As we move from routine to emergency and catastrophic situations, the calculations of the permissible stress [σ] turn out to be not sensitive enough to variable parameters (N, τ, l) due to the development of plastic deformation and creep deformation, and this circumstance requires the transition from the calculations of permitted stress [σ] to the calculations of the permitted deformations [ε]=[e].

In accordance with the described algorithm, the conditions for achieving the threshold states have been analysed according to the criteria of strength, resource, survivability and safety in general case, taking into account expressions (7) – (16) and by analogy with the approach toward the construction of fig. 5 for limited surfaces of risks.

According to the results of this analysis, it is possible to construct *(fig. 15)* spatial surfaces of limit and permissible states in a three-dimensional coordinate system [2, 6], the axes of which are: the axis of operational loading indicators (force P, nominal stress $\sigma_н$, stress intensity factors K_I, reduced local maximum stress $(\sigma_{пр})_{max,k}$ in the concentration areas); the axis of time-temperature and cyclic operation parameters (temperature t, time τ, the number of load cycles N); the axis of defectiveness status (sizes of defects l, taking into account their shape and location).

According to this interpretation, the formation of destruction, inadmissible plastic

Figure 15. Scheme for constructing the surfaces of limit and admissible states according to the parameters of strength, resource and survivability



deformations or cracks corresponds to the limit status (surfaces of limit states). Limit load P in this case is the vector going through the origin of the coordinates with angles corresponding to the given state of construction (according to the parameters l, t, τ, N, $\sigma_н$, K_I, $(\sigma_{пр})_{max,k}$). If we introduce the required reserves n on the specified parameters into the expressions (11) – (16), then it will be possible to move from the surface of limiting states to the surface of admissible states and admissible load [P]. On the basis of the provisions set forth, the strength, resource and survivability can be considered secured, if the vector of operational $P^э$ load is less than or equal to the vector of permissible [P] load ($P^э \leq [P]$).

Classic (traditional) methods of calculating strength and resource evolved under the assumption that the construction material has no defects (l=0). In this case, it is possible to move from the limit and admissible surfaces to two-dimensional limit and admissible curves (in the plane "P, $\sigma_н$, K_I, $(\sigma_{пр})_{max,k} - t$, τ, N") of static (at a given temperature t), prolonged static (according to the set time τ) and cyclic (for the given number of cycles N) strength (see fig. 15). The strength and survivability at the first stages were determined according to the criteria of linear fracture mechanics (static crack resistance) for the plane "P, $\sigma_н$, K_I, $(\sigma_{пр})_{max,k} - l$".

For modern calculations of strength, durability and survivability with the use of limit and permissible states (see fig. 15) it becomes important to accept the uniform state equations, uniform fracture criteria and uniform complexes of calculated characteristics in the expressions (11) – (16) regardless of the type of construction, properties of structural materials and conditions of operational loading. The most promising, as noted above, is a gradual transition from calculations in stress (that is so far accepted in most of the regulations) to calculations in strains [2, 6].

For more accurate estimates of residual strength, resource, survivability and safety, the basic source equations should include the stress and limit states changing during the operation, taking into account their dependence on the operating conditions, i.e. current characteristics of mechanical properties of materials, the numbers of cycles, time, temperatures, environments [2, 6, 15, 19]. At that, if the statistical characteristics (distribution functions and their parameters) of loading, mechanical properties of materials and the faultiness of details are introduced in the calculations at the stage of design or operation, it will be possible to determine the probability initial characteristics of strength, resource and survivability, resistance, risk and safety of the considered constructions.

A special role in ensuring the safety of operation conditions of technosphere facilities, their reliability and the quality of operation belongs to the systems of diagnostics and monitoring of the actual status of the parts and units of machines and structures according to the parameters specified above [2 – 6, 19, 20] during their use in all the modes and stages of the life cycle (see fig. 10). When using the existing diagnostic systems and developing the new ones in relation to each class of disasters and each type of emergency situations, the following types of measurable characteristics should be defined:

– characteristics of the state of the most important systems of potentially hazardous equipment in normal and emergency situations;

– characteristics of damaging and destructive factors in the emergence and development of accidents;

– characteristics of the continuous change in the state of structural materials and their properties.

The most important diagnosed features and parameters of the state of operated objects are connected with their most loaded ele-

ments: stress σ (deformation *e*), temperature *t*, dimensions, form and place of occurrence of defects (cracks) *l*, which can be changed in time τ. These parameters depend on operational loading conditions (pressure *p*, mechanical, thermal and electromagnetic efforts, velocities, accelerations), geometrical shapes and sizes of structural elements, the properties of construction materials [2, 3, 5, 8, 19].

Since the beginning and development of practically all emergencies starts with the damage of bearing elements (destruction, deformation, decompression, loss of stability), then in the course of diagnostics it is necessary to define the maximum (σ_{max}, e_{max}, t_{max}) and amplitude values (σ_a, e_a, t_a) of the basic parameters – stress σ, deformations *e*, temperatures *t (fig. 16)*.

Figure 16. Potential capabilities of the methods of experimental determination of the parameters of strength, resource and safety in diagnostic and monitoring systems

METHODS OF RESOURCE DIAGNOSTICS

Parameter / Methods	Stresses			Temperature			Defects		
	Value σ_a	Cycles N	Time τ	Value t	Cycles $\tau_ц$	Time τ	Size l	Shape a/l	Place S
USD	- +	-	-	-	-	-	+ +	- +	- +
MPFD	-	-	-	-	-	-	+ -	-	-
Vis. contr.	-	-	-	-	-	-	+ -	-	-
X-ray	- +	-	-	-	-	-	- +	- +	- +
Vibrometry	+ -	-	-	-	-	-	+ -	-	+ -
Acoust. contr.	+ -	-	-	-	-	-	+ -	-	+ -
Acoust. emiss.	+ +	-	-	-	-	-	+ +	+ -	+ +
Photoelasticity	+ +	- +	-	- +	-	-	+ +	+ +	+ +
Holography	+ -	+ +	+ -	+ -	-	-	-	- +	+ -
Thermovision	+ -	+ -	+ +	+ +	+ +	+ +	+ -	-	+ -
Tomography	-	-	-	-	-	-	+ +	+ +	+ +
Natur. tens.	+ +	+ +	+ +	+ +	+ +	+ +	+ -	+ -	+ -

CALCULATING RATIOS

$N_p = f(\sigma_a, t, \tau, l, \Phi)$	- natural tensometry
$T = f(\sigma_a, N, \tau, l)$	- thermovision
$AЭ = f(\sigma_a, e_p, K_{Ie}, l)$	- acoustic emission
$G = f(\sigma_a, t, N, \tau)$	- holography

For the measurements in real-time operation or during routine maintenance works with the suspension of work of the objects, it is possible to apply ("+" in fig. 16) widely used and new methods and means of diagnostics – optical, physical, mechanical, electromechanical. These include: external visual control, examination, ultrasonic (USD) and magnetic powder flaw (MPFD) detection, methods of liquid penetrants and photoelasticity, strain metering, vibrometry, thermometry, acoustic emission, thermovision, X-ray radiography, tomography, holography, etc. [2, 6, 19]. It also should be pointed out that there are currently no sign ("–" in fig. 16) universal methods, allowing to conduct simultaneous measurements of all the above-mentioned determining parameters σ, t, l at different stages of the life cycle (according to the time τ and the number of loading cycles N).

So, in fig. 16 the plus "+" points out the methods, which allow determining the appropriate diagnosed parameter with sufficient accuracy. The minus "–" shows the absence of such a possibility in the given method. While a combination of two pluses (+ +) corresponds to a good applicability and credibility in determining the diagnosed parameter by this method, the combination of minus and plus (– +) corresponds to the reduced possibility of application but good information content, and the combination of plus and minus (+ –) shows the possibility of using the method, but with reduced information content. Methods of natural tensometry, thermometry, acoustic emission, thermovision and holography, designed and developed for many decades possess the greatest opportunities in this direction.

In the general case, to provide the required parameters of strength, resource, reliability, survivability, risk and safety of technosphere facilities it is possible to use certain ratios of deformable body mechanics and fracture mechanics, to carry out the relevant calculations and obtain the assessments of the technical condition of the object [2, 6, 15 – 19]. At that, basic design parameters are the parameters of stress, temperature and defects, which must in the first place be determined using diagnostic and monitoring systems.

The parameter of stress has the following important characteristics: amplitude, the number of load cycles and the time during which these amplitudes are realised in cycles. The parameter of temperature has such important characteristics as the absolute value of this temperature, the form of heat cycle, the rate of temperature changes and the time of the temperature-time impacts and exposures in operating cycles. The parameter of defects requires the knowledge of their dimensions, shape and location.

When setting the objectives for the multivariate diagnostics of the state of technical systems, of primary interest is the obtaining of operational information about the parameters mentioned above, taking into account all the specifics of functioning of these objects. For the implementation of diagnostics and monitoring of condition during the operation of the objects it is possible to apply certain conventional methods known in the practice of solving such tasks. However, if there is a necessity to have a full set of the considered operational information, it turns out that using certain methods do not always guarantee the obtaining of the entire set of required information in full. The data presented in fig. 16 show that there is no universal method for solving this problem, and if there are any particular special developments, they tend to be very complex, costly and time-consuming in their implementation.

When analysing the state of the considered technical system according to the results of application of diagnostics and monitoring of its dangerous objects, one should bear in mind that only the knowledge of the complete information about the combination of all the required parameters in their direct interaction allows assessing the extent of its damage, and further development of the given defects

Figure 17. Multivolume publication Safety of Russia, 40 volumes (1998 – 2012)

depends on the nature of the damage already occurring. The accounting of such interaction of diagnosed parameters of the objects' condition is very important, and obtaining objective data reflecting such cooperation is possible only with the comprehensive use of different methods, monitoring their condition. For example, the use of a widely known ultrasonic testing (see fig. 16) allows obtaining sufficiently complete information about the sizes of defects, but the information about their location and configuration is not always sufficient for their reliable identification. And each of the methods analysed in fig. 16, including powder flaw detection, visual inspection, radiography, vibrometry, acoustic testing, acoustic emission, holography, thermovision, tomography and natural tensometry, has its own range of applications and makes it possible, either directly or through corresponding calculated ratios, to receive a specific amount of information on the specific analysed parameters, including the ones considered above, and also on the destroying number of cycles N_p, nominal stress σ_n, factors of the aggressiveness of the environment Φ, presence of plastic deformation zones e_p, deformation intensity coefficients K_{Ie}. It should be noted that the method of natural tensometry to the greatest extent ensures the comprehensive diagnostics and monitoring of the considered technical system. In a number of cases in routine and emergency situations an increasing importance is attached to the diagnostics of structural states of construction materials and their chemical composition with the use of optical and electron microscopy.

Thus, the solution of the considered fundamental problems of ensuring conditions for safe operation of technosphere facilities lays the scientific foundations for the concept of creating and developing a new perspective integrated approach to the objective assessment (according to the risk criteria) of the country's existing infrastructure and designed prospective infrastructure projects in the future [1, 2, 6]. Taking into account the aforementioned, the results of fundamental research, already received to date, show the need for a transition to a new methodological framework and principles of providing and enhancing the security of anthropogenic and natural-anthropogenic spheres of human life and society in general from the negative processes and phenomena, decreasing, ultimately, the country's strategic risks [1, 2, 6, 21]. Their decrease in all the directions is possible on the basis of profound fundamental and applied research of dangerous processes, creating new criteria base for security, methods, systems of counteracting threats and risk optimization.

In accordance to the recommendations of the Security Council of the Russian Federation, the Russian Academy of Sciences, the Ministry of Emergency Situations of Russia and the International Fund "Znanie" in the period from 1998 to 2013, Russia prepared and published 40 volumes of the unique edition of the series

"Russia's security. The legal, socio-economic and scientific-technical issues" [1], containing the results of relevant studies, conducted by a large group of organizations, experts and scientists on a wide range of fundamental problems of safety and risk analysis *(fig. 17)*.

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ECONOMIC FRAMEWORK OF RUSSIA-BELARUS INTEGRATION COOPERATION

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Strategic priorities of the integration between Russia and Belarus in terms of food security issue

The article dwells on the scientific and practical aspects of cross-border cooperation, as well as the existing challenges and threats in the agro-food sector of Russia and Belarus in the context of food security. According to the authors, the choice of strategic priorities for interaction significantly determines the efficiency of the integration process. Special attention is given to the problem of quality and safety of modern food and beverages in the conditions of the activities of transnational companies and open market.

Integration processes, Single Economic Space, Russia, Belarus, food security, agricultural market, technical regulations, strategic priorities.

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Russian-Belarusian cooperation is in the process of active development. That requires a coordinated formation of science and technology, institutional and organizational policy, capable of creating conditions for modernization and increasing efficiency of the economies of the two countries.

Development prospects of the Single Economic Space will be determined, primarily, by the ability of parties to develop mutually beneficial mechanism of coordination of interests, the possibility of joint economic policy-making through special institutions of inter-state bodies.

Thus, at the first stage of integration in September, 2003 the Agreement on the formation of the Single Economic Space (SES) and the concept of its formation on the territory of Belarus, Kazakhstan, Russia and Ukraine was adopted.

The second stage of integration falls on November 2009 – January 2010 and is connected with the revitalization of the work on the creation of the Single Customs Union of Russia, Belarus, Kazakhstan. In this period a number of important international agreements on the Customs Union were ratified, and approximately 40 international treaties constituting the basis of the Customs Union were accepted.

The third stage of integration is associated with the creation of the Unified Customs Code of the Customs Union of Russia, Kazakhstan and Belarus within the framework of EurAsEC Summit on July 6, 2010.

The Unified methodology of customs statistics for the members of the Customs Union with third countries and the states mutual trade statistics were developed and adopted by the decision of the Customs Union Commission on January 28, 2011. This measure was aimed at the unification of approaches towards determination of mutual trade volumes.

Seven technical regulations in the field of food industry ('On safety of food products', 'Food products labelling', 'Technical regulations on fruit or vegetable juices', 'Technical regulations for oil and fat products', 'On safety of certain types of specialized food products, including dietary therapeutic and dietary preventive nutrition', 'Requirements for safety of food additives, flavourings' and 'On safety of grain') will come into force starting from July 1, 2013. This indicates that serious steps were taken with regard to regulation of the food market of supranational level to ensure a coherent policy in terms of standards, technical regulations, quality and safety of products.

At present, trade-economic connections between the two allied nations indicate a serious positive dynamics. Thus, the trade turnover between Russia and Belarus by the end of 2012 amounted to more than 40 billion dollars, thus exceeding the indicators of previous years [1].

Thus, the share of mutual trade between the countries in their total foreign trade turnover is the quantitative sign of integration, so the real integration between the countries will be achieved if the mutual exchange of Russia and Belarus prevails in the structure of foreign trade turnover.

Within the framework of the further development of Russian-Belarusian cooperation the systematic work on determining the priorities of the integration development is required, science-based approaches to the assessment and forecasting of integration development, including the development of the modern tools of quantitative assessment of macroeconomic decisions for socio-economic development of the two countries are needed.

Agro-food sector as a priority of cross-country interactions.

Among the problems studied by the specialists with high scientific qualification, it is possible to single out the task of predicting the development of the Single Economic Space of Russia, Belarus, Kazakhstan and Ukraine with the use of cross-country models of structural interaction [2], which were conducted by scientists of RAS Institute of Economic Forecasting headed by F.N. Klotsvog.

The given cross-country model has the form of a large-scale linear programming problem and is an integrated complex of functionally interrelated country models. The model of each country contains the settings for the production and distribution of the products of the most important branches of national economy and industry, and of basic industrial and agricultural products in natural units in aggravate nomenclature. The model also includes the expanded block of foreign economic relations of

Russia, Belarus, Kazakhstan and Ukraine with foreign countries, countries of CIS, including the relations among the countries themselves. The model includes the equations of the foreign trade balance of each of the four countries in dollar terms, that allows monitoring the level of equivalence of each country's foreign trade exchange.

The results of the research team scenario calculations show that the intensification of the integration process requires the reorientation of Russian energy and primary resources from the market of Western countries to the market of the SES countries. Integration effect is achieved due to the expansion of the market of mutual turnover of products of the processing industries and agricultural products, which by its competitive abilities, can be sold on the market of other countries. This applies primarily to the production of mechanical engineering, agriculture and food industry.

Along with the econometric models of emerging technologies for the development of a coherent strategy of Russia-Belarus macroeconomic integration, the authors consider the development of a forecast model of socio-economic processes within the Single Economic Space on the basis of computable general equilibrium models (CGE models), which include both the benefits of information technology, and the possibility of simulating complex systems, as well as allow reflecting the multiplicative effect of the influence of the estimated factors to the fuller degree. These models can use the new tools to work out the forecast scenarios of the countries interaction development in the context of ensuring the coordinated development of the Single Economic Space.

The author of the article Serdyukova Yu.S. had worked out the forecast model of socio-economic processes within the Single Economic Space model, using CGE models within the framework of the project, executed under the RFBR grant [3]. The objective of the model was to obtain the quantitative assessment of macroeconomic management decisions in foreign trade exchange within Russia-Belarus space in order to ensure the physical and economic accessibility of production for the population, on the one hand, and to ensure economic performance of the market players, functioning in the conditions of the market economy, on the other hand.

The CGE model, developed by RAS Central Economic Mathematical Institute (Makarov V.L., Bakhtizin A.R.), and combining the Arrow–Debreu model (Walras-type model) and game-theoretical approach to the modelling of the economy, were used as the basis for the purposes of the project.

Preliminary results of the calculations have shown that the intensification of the integration process on the creation of Russia-Belarus Single Economic Space is of high economic efficiency for both integrate countries in general and for each of them individually. The analysis of the results of preliminary calculations showed that the basic effect of integration interaction on Russia-Belarus space will be accomplished by expanding the market of mutual turnover of agro-food and machine-building products (including agriculture).

Thus, the results of these studies indicate the necessity of the focused work in the selected priority areas on the formation of a single supranational food policy in terms of integration interaction on Russia-Belarus space, as the integration fact will most reveal itself in the given sphere, therefore, the implemented development efforts will bring the most significant results.

Food security: definition, measurement, regulation

International economic integration is an important factor of the world economic development. The European Union (EU) that underwent classic stages of economic integration from a free trade zone to the monetary union is an example of active integration group.

The EU experience with regard to the formation of institutions regulating and coordinating the interests of integrating countries shows the complexity and diversity considering the peculiarities of the countries' economic development and cooperation, including the food market functioning sphere. The food market is characterized and fundamentally differs from other markets by the set of sold products that converge in a group of interchangeable food products, i.e. it represents a set of various commodity markets.

The functioning of the market, its expansion or contraction, changing price level of goods, supply and demand depend on the current situation, revealing itself in the dynamics of agricultural and industrial production, investments, price changes, the dynamics and structure of internal and external trade volumes, etc. Food market in terms of the system perspective acts as both an organizational structure, and a regulatory market mechanism. Specific management tools are determined by the peculiarities of the individual segments and sectors of the food market areas and rely on the structures, formed for ensuring the functioning of these instruments.

Special attention within the EU is given to the issues regulating relations concerning the quality and safety of food products, which are important indicators of food security. Since the 1970s food security has been regarded by the world community as an integral part of sustainable development. The UN system, international institutions and nongovernmental sector initiated the process of developing global strategies and policies on food security.

The approaches, approved for assessing the present state of the food market in terms of food security are based on four basic principles: availability, accessibility (physical and economic), stability, security.

Physical accessibility of food assumes food provision by production, supply or import at least at the level sufficient to satisfy physiological needs of the population. Economic accessibility of food comprises providing such living standards in the country, which would enable the population to acquire food products at reasonable prices without compromising health. The stability of the food market means sustainable access to food. Food products, consumed by the population must be of acceptable quality and safe-health level.

The concept of food security has several definitions and paradigms. At present, this concept is interpreted not only as total food supply (or deficit) at the regional, national or global level. Since recently, this term is more often used at the level of cities, settlements, households and individuals [4].

Food market is distinguished by the fact that its goods are extremely vital. That is why the food market falls within not only economic and social interests, but political ones, as well. In the conditions of an open economy it is impossible to rely on the food supply from other countries. In this case, a country may be vulnerable in the conditions of an unfavourable situation at the world markets. The consequences can appear in the country's dependence in the economic and political sphere, and in the lack of food and poor life quality. The internal problems of the food market development also affect the resolution of food security issues [5].

A lot of publications, both in Russia and in Belarus, were devoted to the issues on scientific and methodological consideration of food security problems. It should be noted that the overwhelming majority of authors examines food security at the national or regional level. The approaches towards the assessment of the economic security level in the food sphere and towards determination of the security system, presented in the work [6] and set forth by the specialists of the Institute of Economics of the National Academy of Sciences of Belarus, can serve as an example.

As for the peculiarities of the systems assessing and ensuring food safety within the

Single Economic Space, there are much fewer publications devoted to this question. In this regard, the approaches towards the formation of the integration field of food competitiveness in the conditions of the SES customs union member states functioning, set forth in the work of Belarusian scientists of the Institute of System Research in Agroindustrial Complex and the Presidium of the NAS of Belarus, are of particular interest [7]. Industry questions of the agricultural market development and the peculiarities of grain markets organization within the Single Economic Space are covered in the Report on SES grain policies that was prepared with the participation of the specialists of the Russian Grain Union, the Union of grain processors and bakers of Kazakhstan; Institute of Economics and Forecasting of the NAS of Ukraine, Centre for Integration Research of the Eurasian Development Bank [8]. The paper, published by the Fund of the First President of the Republic of Kazakhstan, analyses the problems and risks for Kazakhstan with regard to the promotion of integration in the SES, analyses agreements in the framework of the SES creation in terms of positive effects and threats for Russia, Belarus and Kazakhstan, comprising the agro-food sector [9].

The main factors ensuring food security are examined in the article 'Food security in Russia: current status and trends in provision' [10]. Of special attention is the author's suggestion on the transition to civilized constructive forms of international control and regulation of transnational companies' activities in food markets in the conditions of the global food market monopolization.

At present, a considerable share of Russia's modern food industry is concentrated in the hands of transnational companies (TNCs), most of which are multifunctional corporations. During the past two decades a significant segment of food products with high content of chemical additives and ingredients, identical to natural products, which have strong and ambiguous effect on cells, tissues and systems of the organism, i.e. on the biosafety of an individual has been practically implanted in the structure of the Russian food market. At the same time, the problem of food quality and safety has been growing, especially in the conditions of modern technical regulations, when only the manufacturer is responsible for the quality of products. It is obvious that the quality issue of food products with consumer attributes not meeting the requirements and principles of healthy eating currently comes to the fore in the context of providing the population with safe products [11].

How to explain the paradox that the output of many leading enterprises operating in the food industry, where the most advanced quality control systems have been introduced, adversely affect consumers' health? Or do manufacturers interpret product quality in their own way?

During the transition to the new conditions of the market economy, the quality of products was assumed to be the basis of business competitiveness, therefore the following statement was considered valid: a company is competitive and successful, if it produces high quality products. Is the converse true in the market of manufactured food products? Do successful enterprises always produce products of the highest quality?

Today almost all world leading companies, producing food, beverages and tobacco products, run the manufacturing in Russia. It is possible to distinguish both positive and negative impact of TNCs on the economic processes occurring in the country *(tab. 1)*.

The share of foreign capital in the Russian food industry accounts for about 60% and has been steadily growing, largely due to consolidations and takeovers. Among foreign companies with Russian divisions are the following: Unilever, Nestle, Unimilk-Danone, Coca-Cola company, PepsiCo, Bonduelle, Hortex, le Groupe Cecab, Orkla Brands Russia, Mars company, Kraft foods, Ahmad tea, SUN InBev, SAB Miller RUS, etc.

Table 1. Pros and cons of TNCs

Positive effect	Negative effect
Saturate the market of the host country with goods and services	oust from the market or absorb national producers, due to economies of scale, high productivity and large financial resources
Import capital, equipment, technology for the industrial development and modernization	Occupy a dominant position in the market through consolidation and takeover policy
Provide additional revenues to the budget of the host country	Strain after market monopolization and price policy dictate, while achieving the goal
Introduce advanced management, increase the culture of production, create new jobs	Have many more opportunities, including financial and political ones for lobbying their interests in the host country

Table 2. Factors affecting the production of food with low nutritional value

Factors contributing to the production growth	Factors constraining the production growth
Low level of income and living standards of the population	Normative and regulatory acts, tightening the introduction of chemical additives and the 'replacement' of natural primary materials
Efficiency strategy implemented by food manufacturers	Implementation of technical regulations for products, enabling the consumer to determine the group affiliation of the product by the on-pack information
High level of monopoly, accompanied by price dumping	Support for the manufacturing of products with natural ingredients
The growth of the industry producing chemical ingredients for the food industry	Formation of trade motivation to increase sales of healthy food
Low culture of consumption	Awareness-raising work on rational eating behaviour and various hazardous additives

Product policy on major food enterprises stipulates the development and production of products with specified organoleptic properties at minimal cost as a priority. The peculiarities of the products manufactured by these companies include attractive look due to colourful packing, pronounced flavour, and maximally extended storage period.

Innovation development is held in the form of product formulas, ensuring the achievement of the maximum functionality, the company's profit, to be exact. Manufacturers regularly carry out experiments, aimed at the integration of cheaper formulation that 'replace' natural primary materials, but at the same time guarantee the same (or even better) flavour characteristics of the finished product by the introduction of chemical additives and ingredients, identical to natural.

Table 2 shows the factors influencing the structure formation of the product offering; the so-called 'active' factors are presented in the left half of the table. A whole system of measures and legislative initiatives is needed, so that the factors of the right half of the table have a real impact on the structure of food products.

In the current situation it is a dangerous policy to use the definition of food quality at the legislative level without assessing its impact on human biosafety, thus enabling companies to implement their commercial interests that will damage the consumers. Obviously, it is a positive sign that the Customs Union has made serious steps with regard to the regulation of the food market of supra-national level, in order to ensure a coherent policy in terms of the standards, technical regulations, quality and safety of products *(tab. 3)*. However, it should be noted that unfortunately, the technical regulations (on labelling) entering into force on July 1, 2013, only partially solves the defined problems. Artificial colours, flavours and preservatives are an integral feature and 'the curse' of modern food products. However, their use is not neutral to the human body. Thus, a group of specialists from the University of Southampton examined the most popular food additives used in the food industry and submitted the obtained results to the UK Food Standards Agency (FSA). According to the results a number of food additives (dyes – E102, E104, E110, E122, E129) cause hyperactive behaviour in children [11].

Table 3. Application specifics of harmful food additives

Food additives	Application specifics
Ponceau 4R (brilliant scarlet 4R, cochineal red A; new coccine (eng., ger.), ponceau 4R (fr.) is a food additive, a dye. It is registered as a food additive **E-124.**	In Russia the additive E124 is prohibited for dying medicines but is allowed as a food dye. In the USA, Finland, Norway and several other countries the dye E124 (Ponceau 4R) is listed as a banned substance, as it is considered a carcinogenic that may instigate cancer. Moreover, the additive E124 is a fierce allergen and may cause an anaphylactic shock or asthma attack in people with intolerance to aspirin.
Allura Red AC is a food additive with the number – **E-129.** the dye E129 is now mostly produced from petroleum products.	Dye E129 sometimes can cause the attention deficit hyperactivity disorder in children. Food additive E129 is forbidden for use in the food industry in nine European countries and some other countries, but is permitted for use in Russia's food industry.
Indigo carmine (food additive **E-132**) is water-soluble blue salt, exhibiting properties of acid-base indicator. Depending on the acidity level it changes colour from bright blue to yellow.	Indigo carmine is considered a carcinogenic and is not recommended for use in preparing food for children. Moreover, it may cause hyperactivity, heart problems, nausea. Triggers asthma attacks in people with asthma and cause serious allergic reactions. In the food industry it is used as a dye in the production of soft drinks in glass bottles, ice cream. It is added in the manufacture of biscuits, pastry, confectionery.
Green S (a green synthetic substance) It is registered as a food additive **E-142.**	In the food industry it is used as a dye in the production of mint sauce and canned peas, vegetables. It is also added in ice-cream (for example, fruit ice), desserts. It is used in the production of dry soups, fish forcemeat, dry appetizers on the basis of potatoes, spices, crustaceans semi-finished products. It is added in mustard, fish ROE, spicy snacks. Green S is banned as a food additive in Canada, USA, Japan and Norway, as its consumption can cause allergic reactions. In Russia, this additive is permitted. This is one of the additives that is recommended to be excluded from children's food ration, in order to prevent hyperactivity.

Let us quote short lines of the new technical regulations: 'Food products containing the dyes (Azorubine E122, Quinoline Yellow E104, Sunset Yellow FCF E110, Allura Red AC E129, Ponceau 4R E124 and Tartrazine E102) must have a warning labelling: Contains a dye (dyes) that may have an adverse effect on activity and attention of children'. In what kind of products are these dyes mostly used, and who such products are targeted at? As the table shows, a significant part of colourful and attractive products (confectionery, sparkling water, ice cream) is designed for children. So, wouldn't it be better to solve this issue more radically and listen not only to manufacturers, but to the medical community, which is increasingly concerned with the hyperactivity of modern children, their inability to concentrate that interferes with the process of learning and leads to difficulties in their social adaptation.

In this context, the Belarusian food market differs significantly from the Russian one, as the presence of foreign players in the food market and foreign investments in the food industry are substantially limited by the state. Without going into the analysis and assessment of macro-economic decisions of the Belarus government, it should be noted that foreign capital plays a significant role in the functioning of the Belarusian economy and is mainly concentrated in the banking sector.

In Belarus TNCs are presented in the food market mainly in the segment of soft drinks and beer production: Heineken N.V. (the owner of the brewing companies Retchitsabeer and Syabar), Carlsberg Group (owner of the brewery Olivaria), Coca-Cola beverages Belarus, KK beverages holdings Ltd.

However, it should be noted that Belarusian food products will not only go to the Russian market, but in the nearest future Belarusian producers will have to face competition in the market from Russian units of global Western companies.

A particular difficulty in ensuring food security on Russia-Belarus space is mainly connected with serious differentiation, peculiarities of formation and functioning of the agricultural market of the two countries. Traditionally the coefficient of food dependence is calculated by the following formula:

$$C = I/N,$$

where I is import volume of the given product,

and N is requirement quantity of the country in the product.

However, the authors suggest that when calculating the food security of Russia and Belarus, the assessment of food self-sufficiency is to be complemented by the coefficient of food dependence, which is calculated for each country considering integration interaction within the Single Economic Space. Provided that the governments of the two countries adopt single food policy in the conditions of integration interaction, it is necessary to introduce a special adjustment indicator adjusting food import of the food products supplied from Belarus. Thus, the indicator can be calculated by the following formula:

$$Fdj = (Ivol - Ii)/N, \quad (1)$$

where $Ivol$ – total volume of imported products,

j – index denoting the country, for which the coefficient of food dependence is calculated,

i – index denoting a member state of the Customs union,

Ii – Volume of import from the country-j to the country-i,

Fdj – food dependence of the country-j.

Thus, the authors distinguish the following three levels of food dependency:

1. The level of food dependence is considered safe, if the coefficient of food dependence is in the 0.1-0.2 range;

2. The level of food dependence is threshold, if the coefficient of food dependence is in the 0.25-0.3 range;

3. The level of food dependence is dangerous, if the coefficient of food dependence is higher than 0.5.

According to the authors, the indicator *(Fdj)* should be calculated by the goods of the priority list, which are the most effective in terms of trade exchange and co-production.

Ensuring the openness and transparency of information on the activities of the state apparatus, the extension of public control over the decision-making process, in particular through the involvement of competent experts, is one of the current directions of efficient public administration. In this regard, it is necessary to enhance the role of the expertise during the development and review of regulatory documents and drafts concerning state decisions on the development of the national food market. It is necessary to develop information databases in the sphere of food products regulation, which can and must be used when elaborating draft technical regulations as the evidence-base of the principles, provisions and requirements underlying the regulations.

According to the authors, in order to provide the population with quality and safe food, it is necessary to move from declarations, proclaimed by the Food Security Doctrine of the Russian Federation [12], to the balanced and scientifically-grounded programme of activities at the national and supranational levels, to make greater use of the possibilities of such state regulation instruments as reserve and distribution funds.

The authors believe that the scientists of the Russian Academy of Sciences, Russian Academy of Agricultural Sciences, Russian Academy of Medical Sciences, higher education institutions of the Ministry of Agriculture, agrarian educational institutions, technological institutes of the food industry, the scientific interests of which affect the solution of food security issues, can and should participate more actively in the implementation of the scientific expertise, as the absence of visa and customs

borders of the Union State of Russia and Belarus create favourable conditions for joint scientific and innovation activity of Belarusian and Russian partners.

It should be noted that discussion platforms for the debates over a broad range of issues (for example, sittings of the standing seminar under the Parliamentary Assembly of the Union of Belarus and Russia on the building of the Union State) have been established and have been successfully functioning. However the authors consider it necessary to stimulate the young scientists of the two countries to more active participation in expert councils and to the work on projects and programmes at the supranational level. At present, within the framework of new breakthrough technologies young researchers of the two countries have expertise in the field of biosafety, breeding, production technologies, green economy and energy. Given the fact that food issues affect everyone, this topic could be the catalyst for developing new integration studies on Russia-Belarus space.

In order to realize the effects of the integration interaction of the two countries to the fuller degree, a new level of macroeconomic decision-making in the conditions of divergent interests is required, so it is important that the choice of priorities of the agreed food policy would be understood and accepted by the population, including young people. In this case the understanding and the image of the joint future of Russia and Belarus may coincide.

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Economic realities and development perspectives of small-scale power generation in the Republic of Belarus

The article analyses the efficiency and economic feasibility of autonomous power supply by the example of several cogeneration plants (mini-CHPs) operating in the industrial and municipal enterprises of the Republic of Belarus. The article also focuses on some important features of the energy sector, in particular the problem of cross-subsidies and tariffs in the energy sector. The results and main economic indicators of the exploitation of a number of cogeneration plants, constructed in the Republic over the last eight years, are presented and analysed in detail. The article is based on the detailed study of the economy of each object in particular and on the comparison of the results by the parameters of economic efficiency of all of the objects under study in general. Certain disadvantages and advantages of this direction in the energy sector of the country are defined. A number of problems and tasks, revealed on the basis of a long-standing generalised experience in designing, construction and exploitation of cogeneration plants in the Republic, and requiring thorough investigation and resolution are identified.

Cogeneration plants, tariffs, gas turbine plants, energy, maintenance and servicing, electricity supply, electricity.

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During Soviet times, economic regions (districts), cities, large-scale industrial objects were mainly supplied with heat and energy centrally from large sources of the country's energy system. A large number (nationwide) of objects of the local energy supply (as a rule industrial and utility boilers, etc.), was built in the areas where connection to the 'central plant' was impossible due to technical, technological reasons and unjustified high cost. The vast majority of these plants are socialist construction objects, survived to the present

day, which are physically, technologically, and morally obsolete and therefore, absolutely unprofitable. They either require modernization or decommissioning, or complete replacement by modern, effective sources of energy. In the current conditions of the serious transformation of the state economy and transition to market conditions of management, it became possible for enterprises to independently choose the options of energy supply.

It should be noted that the electric power industry of Belarus is the only one on the post-Soviet space that has preserved a vertically integrated model, where the state exercises centralized control over production and economic activities of power enterprises. The total installed capacity of power system of the Republic of Belarus on January 1, 2010 was 8261.68 MW and independent block-stations that are not in the national union Belenergo produced about 409.0 MW or 5% of the total capacity, which indicates a complete state control over the Belarusian energy market [1].

At the 17th Belarusian Energy and Ecology Congress, held in Minsk in October of 2012, Deputy Energy Minister of the Republic of Belarus Mikhail Mikhadiuk announced in his report 'The state and the prospects of the Belarusian energy complex' that the capacity of power plants of the Republic is more than 8300 MW, 7895 MW of which are produced by Belenergo power plants. So, the situation on the energy market of the country has not changed for the past three years: 95% of the facilities are still owned by the state, while individual enterprises have in their ownership only 5% of all existing in the Republic capacities.

Electricity and heat cogeneration plants have been used in recent years as autonomous power supply at industrial and municipal enterprises. Such equipment for production of supplementary electricity and heat energy at the industrial enterprises is commonly called cogeneration plants or installations of small-scale power generation [2].

When considering the small-scale power generation, it should be noted that there is a system of state regulation of electricity tariffs, which creates certain price opportunities for the construction of new generating facilities. At present, electrical energy pricing in Belarus has not changed since the planned economy of the Soviet period.

Since January 1, 2013, the Government of Belarus was going to reduce electricity tariffs for industrial consumers, as stated by Vice Prime Minister V. Semashko in May of 2012 at the Plenary Session of the Belarusian Industrial Forum. Energy tariffs for industrialists are planned to be reduced by the funds, released as a result of a gradual shift away from cross-subsidization in the power industry. Cross-subsidisation in the power sector is a harmful phenomenon, adversely affecting the economy of the whole country. It not only distorts the price targets for the population, leading to inefficient energy consumption, but is also hidden tax on business, as a result of which its competitiveness reduces.

Energy tariffs shall consider the economic interests of both producers and consumers of energy, as well as create the incentives to save energy at all stages of its production and consumption, which will ultimately enhance the efficiency of the national economy. The issue concerning the necessity to eliminate cross-subsidization between the commercial and the residential sector has been long discussed in the country, but significant results have not been achieved yet.

The State programme for the development of the Belarusian energy system until 2016, approved by the Decree of the Council of Ministers of the Republic of Belarus No.194 of February 29, 2012 entered into force in Belarus on March 20, 2012. The Programme stipulates that the level of reimbursement of the cost of electricity production and supply by the population is expected to reach 47.9% in 2013, 72.7% in 2014, and 100% in 2015.

While the government prepares the population to the full payment of energy tariffs, heat tariffs are expected to increase gradually, and 100% recovery is not an issue in this case. It is planned that the level of heat supply costs reimbursed by the population will amount to 19% in 2013, 23.6% in 2014, and 30% in 2015.

On the whole, the level of cost recovery electricity and heat tariffs should reach 32.4% in 2013, 45.9% in 2014, and 61.7% in 2015. In 2011, 38.5% of electricity costs and 21.4% of heat costs were recovered by the population of Belarus. Previously it was expected, that the Law "On electric energy" would be adopted in Belarus in 2012, the Law "On state regulation of electric and thermal energy tariffs" in 2013, the Law "On Heat Supply" in 2012.

Some Belarusian sources state that energy tariffs in the Republic are distorted in comparison with neighbouring countries: the average electricity tariff for industrial consumers amounted to 3.73 cents per 1 kWh, while for the population it made up 25.9 cents per 1 kWh. By comparison: in the EU countries, the average electricity tariff for industrial consumers in the first half of 2011 was 12.8 cents per kWh, for the population – 2.56 cents per kWh. For example, in Poland the tariffs made up 11.8 and 21.3 cents per kWh respectively, in Lithuania – 14.6 and 17.6, in Latvia – 12.9 and 16.9, in Ukraine – 9.2 and 3.1, in Russia – 8.3 and 7.2 [3].

However, in order to make comparisons by certain EU countries, let us depart from Belarusian sources, statistics, statements of officials and turn to the following data. Thus, according to "Europe's Energy Portal" (www.energy.eu), the tariffs for industrial enterprises and for the population as of May 2012, for example, in Austria amounted to 10.47 eurocents per 1 kWh for the industry, and 17.98 eurocents per 1 kWh for the population; in Bulgaria – 5.22 and 8.23 respectively; in Germany – 10.24 and 24.06 respectively; in Denmark – 9.13 and 25.62; in the UK – 8.82 and 12.65; in Poland – 8.37 and 14.19; in Lithuania – 10.17 and 12.01; in Estonia – 6.81 and 9.48; in Finland – 6.78, and 13.69; in France – 7.42 and 12.79; in Belgium – 8.71 and 19.40. So, as follows from the data of "Europe's Energy Portal", energy tariffs for the population 1.5–2.5 times higher than for the industry in the EU countries.

At this stage, such important social factor should be taken into account, as the need for a substantial increase in population real incomes, which could provide full energy cost recovery of residential customers in the process of energy pricing in Belarus. Significant costs of power connection, cross-subsidization of population at the expense of industrial consumers, electricity transmission tariffs, undoubtedly, form incentives of industrial consumers to establish their own generation.

At present, the economic essence of cogeneration equipment implementation is reduced to alleged energy cost-cutting, which is defined as the difference between the set tariff per 1 kWh and the prime cost of electricity produced by cogeneration plant, while fuel economy is defined respectively as the difference between brake specific fuel consumption per 1 kWh of energy, produced by Lukomlskaya SDPS and Berezovskaya SDPS, considering the fuel equivalent consumption of 320 g/kWh [4]. Due to technical re-equipment of the Lukomlskaya SDPS in 2007, the brake specific fuel consumption for electricity production decreased to 312.8 g c.t. per 1 kWh (in 2006 – 316.3 g c.t. per 1 kWh). At the Lukomlskaya SDPS this indicator is significantly lower than at the thermal power stations of OAO MOSENERGO, where in 2006 the brake specific fuel consumption in the condensation mode amounted to 377.9 g c.t./(kWh), for electricity – 252.6 g c.t./(kWh); in the Republic of Belarus this index amounted to 274.6 g c.t./(kWh), i.e. higher by 22 g c.t./(kWh).

As a result of OAO MOSENERGO restructuring, specific consumption for electricity is reduced through the increase in the share of cogeneration electricity and the decrease in the share of condensation generation [5].

It is important to note that the justification of investment of the projects do not include the comparisons of brake specific fuel consumption per 1 kWh of energy and 1 Gcal of heat with the existing CHPs of the Republic of Belarus that are much closer to cogeneration equipment by their technical specifications as the base of comparison. Cogeneration is defined as a combined production of electricity and thermal energy, CHPs of the power system of the Republic of Belarus perform a similar function.

According to Belenergo, brake specific fuel consumption for electricity and heat production on the individual CHP of the country is lower, in comparison with gas reciprocating and gas turbine units, where the estimated fuel equivalent consumption amounts to 160 and 170 g/kWh.

The calculations of industrial enterprises and design organizations in the justification of investment show that the cost of own production is 2–3 times lower in comparison with the electricity tariff, and indicate 2–2.5 times reduction in the consumption of fuel and energy resources, in comparison with brake specific fuel consumption when producing 1 kWh of electricity at Lukomlskaya SDPS and Berezovskaya SDPS. According to the authors, it is impossible to compare objects, incompatible in functions and tasks, as well as the various constituent levels by total costs for generation of 1 kWh of electricity. The tasks and functions of the Lukomlskaya SDPS are much more large-scale for resolving the issue of providing the country with energy and are not of local character. In addition, the power supplying companies (SDPS, CHP) contain the reserve of capacities, in case of emergency failure and periodic maintenance, current and capital repair of mini-CHPs.

Business entities, owing cogeneration plants and denying the reservation of capacities in the power system, are forced to put into operation additional amount of gas reciprocating and gas turbine units, in order to provide continuous technological process of energy production. In this context, the volume of capital investments in mini-CHPs is increased by 35–40%, operating costs increase correspondently. Moreover, the number of backup units is not taken into account in the justification of investments, and the efficiency calculation is adjusted to the maximum output of each unit by generated energy in total. Obviously, it distorts the real costs in the justification of investments in the construction of mini-CHPs, and accordingly the indicators of economic efficiency in the course of maintenance. Therefore, it is very important to consider maintenance costs in operating costs, as their share in total costs is about 30%.

Maintenance costs should be determined on the basis of repair cycle regulations. Planned repairs, usually vary in the volume of repair works, therefore, they are divided into certain groups. The repair works of certain types and volumes in practice for specific gas reciprocating and gas turbine units of different manufacturers are performed on the basis of actual technical condition of the equipment, determined by periodic technical inspections with the use of diagnostic tools.

The structure of repair cycle is a sequence of certain types of repair between the moment, when the product had been put into operation and the first major overhaul. Repair cycle is calculated in actually worked hours, therefore, it is necessary to keep record of the operating time of the details for objective repair works planning in the operating conditions of gas reciprocating and gas-turbine units. Constant efficiency of gas reciprocating and gas turbine engines up to their depreciation and write-offs must be maintained through current and capital repairs. Interrepair maintenance is carried out in the intervals between routine and

periodic maintenance, the purpose of which is to reduce equipment failure rate in this time period to the greatest extent possible and quickly eliminate any failures.

It should be noted that downtime during periodic maintenance and repairs is 720–760 hours per year. The current repair is carried out at the place of installation of cogeneration equipment, and capital repairs are performed at the base of the plant-manufacturer. On average, the labour-intensiveness of one operating repair of 8–10 calendar days makes up 200–220 people per hour, a repair is made within 8–10 months. For example, after four years of operation of gas turbine unit GTU-15c, owned by the Republican unitary production enterprise Belarusian Cement Plant (Kastsyukovichy), with total run of 26700 hours (average annual operating time amounted to 6675 hours, that is by 17% lower than the design one) had been dismantled and sent to the overhaul to the factory Zorya-Mashproekt (Nikolaev, Ukraine). The cement plant acquired another installation as a backup, due to the long repair period of GTU–15c. However, it is not taken into account, when justifying the investments in the volume of capital investments, therefore the effectiveness of the technical and economic indicators of the construction of cogeneration plants is distorted. The capital investments payback period increases by 50–60%, when the acquired standby unit is included in the investment volume. Therefore, given the high share of expenditures for the maintenance in total operating costs, it is necessary to follow common maintenance and repair standards, set in accordance with the repair cycle regulations, when substantiating the investments for the construction of mini-CHPs. In the absence of normative documents and materials, the average ratios by type of repair for the entire repair cycle period must be developed, based on operational observations and statistical data. The example above confirms that the enterprise that owns a mini-CHP (gas turbine unit), also should have a standby unit of a gas turbine or a reserved capacity in the power system.

According to the "Declaration on the level of tariffs for 2008" the fee for the capacity reserve maintenance increased by 12.3%, as compared to 2007. The inclusion of expenses for reserve capacity increases the total amount of operational costs of the mini-CHP by 30–35%.

It should be noted that for the four years of gas turbine unit operation at the Republican unitary production enterprise BCP (Kastsyukovichy), the costs only for maintenance, current and capital repairs exceed 2.4-fold the initial cost of the purchased equipment. When the cost of the capacity reserve maintenance is included, the costs incurred in this period under the above-stated article reach fourfold value relative to the cost of the gas turbine unit.

Based on observations and calculations, scientists and production workers in their publications express different points of view on the issue of capacity reservation. Some authors believe that the non-inclusion of the cost of reserve capacity maintainance from the prime cost of electricity produced by own local energy sources may lead to nonoptimal decisions for the national economy in terms of economic effect [6]. Others believe that the consumer can minimize the amount of electricity consumption from the power station, or refuse to use it, in case the own capacity is sufficient, and in force majeure circumstances to reserve power from the power system and to reimburse the costs of the reserve maintenance. These costs should consider the part of the cost that is directly relevant to the consumer [7].

According to the authors, it is unreasonable to set individual tariffs on the maintenance capacity reserve for each consumer, because the comparability of capacity reservation costs will not be observed. A single average rate for the Republic is to be set. That will enable the planners to get the initial data for calculations and the equivalent approach to feasibility study.

In 2007, the gas turbine unit (GTU-15c) at the Republican unitary production enterprise BCP (Kastsyukovichy), worked off 7900 hours and approached the preliminary estimate of 8000 hours, the most effective economic indicators have been achieved, and the running time time increased by 83%, as compared to 2004 [2, 8, 9, 11]. Then all values will be presented in convenient units (in US monetary units in prices of the year specified for the calculation). Annual electricity production amounted to 119 million kWh, at the prime cost of 4.13 US cents/kWh, excluding the costs for reserve capacity maintainance. When the cost of reserve capacity is included, the cost of 1 kWh of electricity increases by 1.35 US cents.

Currently the construction of mini-CHP gas reciprocating and gas turbine units is mainly financed by the Republican and local budgets, innovation funds – their equity participation is 65–75%, and own means of the enterprises – 25–35%. Therefore, you first need to determine the economic effect from the implementation of the above activities. In order to do this (by power system), let us compare the power production cost of Mogilevenergo and the local source of energy at the Republican unitary production enterprise BCP. The cost of 1 kWh of electricity of Mogilevenergo amounted to 6.72 US cents, and of the BCP, taking into account the cost of reserve capacity maintainance was equal to of 5.48 US cents in 2007, when the dollar exchange rate was equal to 21.50 Belarusian rubles. The economic effect for the national economy is calculated by the following formula:

$$Eef = (Cps - Cle) \times Vle, \qquad (1)$$

where *Eef* – annual economic effect, US dollars;

Cps – prime cost of 1 kWh of electricity by the power system (Mogilevenergo), US dollars;

Cle – cost of 1 kWh of electricity by local energy source (BCP), US dollars;

Vle – annual electricity volume generated by the local energy source, kWh.

Annual economic effect of the enterprise is defined on the basis of the electricity price (tariff) for 1 kWh by the formula:

$$Eefe = (Sp - Cle) \times Vle, \qquad (2)$$

where *Eefe*– annual economic effect of the enterprise, US dollars;

Sp – sale price of 1 kWh of electricity by the power system (Mogilevenergo), US dollars;

Cle – cost of 1 kWh of electricity by local energy source (BCP), US dollars;

Vle – annual electricity volume generated by the local energy source, kWh

Let us substitute the original data in the formula (1) and obtain the results of the annual national economic effect that will amount to 1.071 million US dollars. BCP spent about 15.4 million US dollars in capital investments on the construction of a cogeneration plant. The simple payback period of the investments makes up 10.4 years, and it increases to 14.3 years, when the prime cost of 1 kWh of electricity generated by BCP certain suppliers is taken into account in the calculations. The service life of a gas reciprocating unit GTU–15c is defined by the manufacturing factory as 100000 hours, respectively, with the annual operating time of 7500–8000 hours a physical life of the unit will make up 12.5–13.5 years. The authors draw as an example a mini-CHP, which is one of the best by operational and economic indicators in the Republic and the initial data in the calculations are assumed with regard to the most effective year out of the four years of operation. It should be noted that even under these most favourable payment conditions, the mini-CHP (GTU-15c) is paid off only within physical life limits in the context of national economy [2, 8, 10].

Let us estimate the economic effect for the company and substitute the value of the tariff for 1 kWh of active electric energy in formula (2). The 2007 tariff level amounted to 7.79 US cents per kWh, and as a result, the economic effect

of the company made up 3.884 million US dollars. Physical payback period of the mini-CHP (GTU-15c) at the Republican unitary production enterprise BCP was defined as 5.6 years, assuming that the work is not less than 7900 hours per year.

The analysis of calculations show that, if the annual operating time of GTU–15c is below 5500 hours, the economic benefit for the company will be sharply reduced and the payback period will exceed the physical lifetime of the installation, and this means that the exploitation of the unit in this mode is economically inexpedient.

Consider anorther example on defining the economic effect, when designing and constructinng a mini-CHP with an electric capacity of 21 MW at JSC Polymir. When determining the comparative economic efficiency, the indicators of the Novopolotsk CHP are adopted as a comparison base, as it provides electricity and heat energy to JSC Polymir. The cost of 1 kWh of electricity at the Novopolotsk plant was 5.17 US cents at that time, and thermal energy per 1 Gcal made up 28.9 million US dollars respectively. The prime cost of 1 kWh of electricity cogeneration plant with the annual output of 160 million kWh within 3 US cents without considering spare capacity, while taking into account the sum of 1.48 US cents and will make up 4.48 US cents. Let us substitute the original data in the above formula (1) and get the result of the economic effect in the amount of 1.104 US million dollars. The project cost of the local energy source at JSC Polymir is estimated in the range of 22 US million dollars. Physical payback period of the implementation of this project in terms of national economy will make up 19.9 years. When determining the economic effect, the efficiency of the steam of 40 t.a. generated by the own cogeneration plant, is not given in the calculations, as the share of 40 t.a. in the thermal balance of the energy of the enterprise is 8–9%.

At the same time, brake specific fuel consumption for producing 40 t.a. of steam production is almost the same: CHP – 171 kg/Gcal, and the cogeneration unit – 170 kg/Gcal, and it will not affect the final result of efficiency [2, 10].

In order to reduce energy expenses, OAO Mogilevkhimvolokno within two years planned and built an energy complex with a capacity of 14.7 MW in total consumption of 67 MW of electricity. Power consumption is provided by CHP-2 (Minsk cogeneration plant-2) and the closing energy system of condensing power plant, with the share of 7–10% provided by the power plant-2 and the rest supplied by the condensing generation (CPP). In the structure of annual energy resources consumption, the largest share is constituted by electricity – 40–42%; steam – 31–33%; while fuel for heating high-temperature organic heat transfer agent accounts for the smallest share (6–8%). The state spent about 17.6 million US dollars on the construction of the energy complex, including 5.6 million US dollars out of OAO Mogilevkhimvolokno own funds, which accounted for 31.5% of the total amount. The prime cost of 1 kWh of electricity generated by local energy source will amount to 2.86 US cents, and taking into account the cost of maintaining the reserve power it will increase by 1.43 US cents correspondingly at an annual electricity production of 116 million kWh and the running time of each unit (4 units by 3.7 MW) of 8,000 hours per year and the prime cost of 1 Gcal of heat – 26.81 US dollars. The calculation of costs on the production of 1 kWh of electric energy according to the economic method for 2008 in Minsk cogeneration plant-2 was 5.48 US cents, with the brake specific fuel consumption of 328 g/(kWh) and, accordingly, the costs of thermal energy per 1 Gcal made up 21.37 U.S. dollars. The prime cost of 1 Gcal of heat energy in 2007 at the Republican unitary production enterprise Mogilevenergo amounted to 28.17 US dollars.

Based on these data, the cost of production of 1 Gcal at the Minsk cogeneration plant-2 was estimated to be by 21% lower than in the energy sector of OAO Mogilevkhimvolokno, and according to the system of the Republican unitary production enterprise Mogilevenergo the excess is only 5%. Therefore, in determining the economic effect for the national economy and enterprise by the specified position the calculations are not held, because the impact is insignificant and almost reduced to zero. Let us substitute the original data in the formula (1) and see that the economic economic effect will amount to approximately 2.8 million US dollars.

The simple payback of the cost of 6.3 years is ensured by high level of the prime cost of 1 kWh of electricity at the Republican unitary production enterprise Mogilevenergo, which greatly exceeds the costs of the power system of the Republic of Belarus, in comparison with the Minsk cogeneration plant-2 excess of 22.6%. When calculating the economic effect, if the prime cost of 1 kWh of electricity at the Minsk cogeneration plant-2 is taken as a comparison base, the economic effect of the energy complex is reduced to 1.38 million US dollars and the payback will amount to 12.8 years.

Therefore, it is possible to say that the main type of the energy produced by the Minsk cogeneration plant-2 is thermal energy and a small amount of electric power. As the Minsk cogeneration plant-2 is located two kilometres away from OAO Mogilevkhimvolokno, the calculations show that if capital investments, spent on the construction of a local energy source, were focused on the reconstruction of Minsk cogeneration plant-2, the effectiveness of the pay-off could increase 3–4 times. Only savings on thermal energy would amount to 5.5 million US dollars per 1 Gcal. When providing thermal energy for OAO Mogilevkhimvolokno, even within 50% of the total demand, the annual economic effect for this position will be approximately 2.8 million US dollars [2, 10].

The economic analysis and calculations on other objects, including the complex for submicron production at the unitary enterprise Semiconductor device factory of Minsk Scientific Production Association Integral, have been carried out in the similar way. The energy technological complex should provide the enterprise not only with power, and heating, but with cooling as well (CCHP). Specific capital investment makes up 1512 US dollars per 1 kW of power that is higher by 57% as compared with the equipment installed at the Republican unitary production enterprise BCP in Kastsyukovichy. The recoupment of capital investments in terms of the economic effect will amount to 16.1 years. It should be noted that the share of project works in the total cost of construction makes up 3.7–4.9%, while in relation to the installation and construction works it amounts to 14–20%, and that is higher than in the countries with the developed economies like France, Germany, etc.

In addition, the engineering company during the planning usually reviews the estimated cost of the works in the direction of increasing the original value 2.5–3.5 times. When determining the design documentation cost for the calculation, the design capacity, which remains practically unchanged from the initial design and until the end of the construction, is used as the basis. For example, the initial cost estimate for the architectural and construction projects "The energy technological complex of the polyester yarn plant of OAO Mogilevkhimvolokno" increased 2.44 times for two years. At the same time, during the construction of a similar object with the value of over 10 million US dollars in Germany, the share of the design work made up 2.1–3.6%; while at that, the salaries of the design engineers are 6–7 times higher than the salaries of our design engineers. The high cost of design and construction works in our country depends on many factors: the qualifications, performance and productivity.

For the 2006–2008 period design and construction of the energy technological complex for submicron production at the unitary enterprise Semiconductor device factory of Minsk Scientific Production Association Integral, held about 70 production meetings with design engineers and construction companies.

The main point of all the issues can be reduced to presenting mutual claims (i.e. the customer submits a claim to the design engineer that high-quality construction and project documents have not been given within the time limits set, and the designer, in turn, presents a claim to the null initial data for designing, etc). In addition, about two dozen of various meetings on the specified object have been additionally held at the Ministry of Industry, Ministry of Energy and in the Council of Ministers of the Republic of Belarus in order to facilitate the construction of this energy complex. All of this suggests that there is no qualified general contractor, who would be able to build such objects on a turnkey basis. The construction of turn-key facilities would reduce the construction period and the expenditures on design works, construction and installation works 2–3 times [10].

It is not only domestic design and construction organisations, but also foreign companies that are engaged in the planning and construction of mini-CHPs with natural gas applications in the country.

In order to compare the results in terms of efficiency indicators, the example on modernization of local boiler house in the city of Zhlobin is given in the article. The conversion of the boiler house of the Zhlobin power networks into a modern CHP was somewhat a unique project for Belarus. The delivery of complete equipment is the peculiarity of this project. The Finnish company Wärtsilä, a world renowned manufacturer of gas and diesel powered electrical generators, had won the competitive tendering for its maintenance.

Equipment turnkey projects are not typical for Belarus. A modern power plant is a whole complex of complex units and aggregates. In order to cut costs, the equipment is often purchased in parts, from different manufacturers. However, this approach is not always economically beneficial. Various inconsistencies and discrepancies appear during the equipment installation, to remove which, the engineering solutions, requiring additional investment, are to be found.

When implementing the project in Zhlobin, all major equipment was supplied by Finnish company, which was responsible for warranty service of units and aggregates, and their design. Three gas reciprocating units with a capacity of 8.7 MW each were assembled on the Zhlobin-based CHP and were launched into operation less than in 4 months. Finnish experts argue that the standard period of such construction is 6 months. In January, 2009 the power plant was officially launched. Now all three installations function nominally [11]. The Finnish company Wärtsilä has put into operation the object with the 1.7-fold exceeding capacity, reduced the construction time 8-fold, in comparison with the design and construction terms of the power complex of OAO Mogilevkhimvolokno presented by domestic organizations. Specific capital investment has been reduced by almost twice. A similar pattern is observed, when comparing and analyzing other objects. The operation of gas-engine installations practically does not provide any savings of imported gas, when compared to the existing CHPs in the Republic of Belarus.

In the production costs of electricity generated by local sources, it is necessary to consider not only the operating costs, but also the costs of capacity provisioning. The economic effect from the implementation of gas-engine cogeneration plants is determined as the difference of the prime cost of 1 kWh of electricity in the region (oblast) and the costs of local sources, and respectively as the

difference between the tariff and the cost of electricity produced by the local source in terms of the enterprise. The results of the economic efficiency of certain gas-engine cogeneration plants in the Republic of Belarus are presented in the *table*.

A reasonable economic approach at all stages of design, construction and operation of mini-CHP allows the invested funds, presented on an example of two upgraded mini-CHPs (rather significant 2–3-fold decline in specific capital investment and 3–4-fold decrease in payback period of capital investments) to be used accurately, scientifically sound, and ultimately, most effectively [12]. According to the results of the analysis of the operation of mini-CHPs, built over the last decade, one can conclude that they do not affect the reduction of electricity tariffs (prices) for consumers. At the same time it should be noted that the operation of gas-engine installations practically does not provide any savings of imported conventional fuels – natural gas, when compared to the CHPs, operating in the Republic of Belarus. In addition, the results of the construction and operation of a number of mini-cogeneration plants on the base of gas-engine installations did not affect the fulfillment of the task of reducing the country's dependence on imported energy, formulated in the "Concept of Energy Security of the Republic of Belarus", approved by Presidential Decree No. 433 dated September 17, 2007 that stipulated the provision of at least 25% of the overall production of electric and thermal energy through the use of local fuels and alternative energy sources for the period until 2012, as well as the conversion of the existing boiler-houses into mini-CHPs. The development of new technological processes and new technical equipment was required to fulfill the target programme.

According to the authors, in order to maximize the efficient use of the budget (innovation) sources of financing and funds of the enterprises, not only domestic enterprises

Results by certain indicators of economic efficiency from the implementation of a number of gas-engine cogeneration plants at the industrial enterprises of the Republic of Belarus

Indicators	Gas-engine cogeneration plants					
	I-stage of BCP, Kastsyukovichy (Mogilev Voblast)	JSC Polymir, Navapolatsk (Vitebsk Voblast)	OAO Mogilevkhimvolokno, Mogilev	Scientific Production Association Integral, Minsk	Modernization of the associated gas CHP of the production Association Belorusneft	Zhlobin CHP following the modernization of the local boiler-house
1. Installed capacity , MW	16	21	14.7	17.4	24.4	26.1
2. Annual electricity production, million kWh	119	160	116	139	191	206
3. The prime cost of electricity, US cents/kWh	5.48	4.48	4.29	4.12	4.02	3.87
4. Specific consumption of fuel equivalent for production of electricity, G/kWh	197	164.5	160.9	161.7	163.1	158.1
5. Specific capital investment, US dollars/kWh	961	1051	1195	1512	510	654
6. Payback period of capital investments, years	14.3	19.9	12.8	16.1	8.6	4.4
7. National economic effect, thousand US dollars	1071	1104	1380	1626	1446	3605
8. Economic effect of the enterprise, thousand US dollars	3884	6432	5162	7260	7201	8075
9. Payback period of capital investments, considering the economic effect of an enterprise, years	5.6	3.4	6.3	3.6	2.9	2.1
10. The share of project works in the total cost of construction, %	3.7	3.9	4	3.8	4.9	3.8

are to be involved in the implementation of projects, but also prestigious foreign companies, which, having rich experience in this field, could put similar objects into operation in the shortest possible time. However, it is necessary to consider the possibility of involving various national specialists (designers, constructors, etc.) in undertaking an internship (training) in well-known foreign companies, which will obviously not only allow saving a lot of resources during the construction of such objects, but also permits training highly qualified specialists in the energy sphere.

The construction of mini-CHPs at the base of gas reciprocating and gas turbine units by domestic organizations is not sufficient for the economy of the Republic is only a financial assistance from the state to individual organizations (sometimes losing) for the maintenance and possible recovery of their economies due to the allocation of investment and later due to the possibility to pay for the consumed electric and thermal energy input, already generated by own source, at cost price and not as per tariff.

Obviously, national energy requires systematic and long-term development policy and a more thorough approach in terms of design, construction and operation of such facilities. This approach should be accompanied by profound, scientifically based and comprehensive researches of economic efficiency at all stages of creation of a small-scale power generation object and further stages of its 'life'. It is not enough to implement a list of investment programmes in this area, oriented at the individual enterprises, and sometimes aimed only for a short-term facilitation through a set of financial measures provided to their economies. As a result, these investment projects become, in fact, a complex of 'resuscitation procedures' provided by the state in order to rescue the economy of a particular enterprise by building a mini-CHP at its base. Thus, the funds are withdrawn from other, perhaps, more important and effective programmes on the development of the Belarusian energy system.

Obviously, it is not reasonable to abandon the implementation of gas-engine cogeneration plants completely. The effectiveness of such stations increases significantly, when they are deployed at oil wells with associated gas, oil refineries, agricultural enterprises, where they are maximally close to the heat energy consumers, that considerably reduces the losses during transportation of [10, 13].

The authors consider that the more efficient spending of budgetary and other resources from multiple investment sources, as well as own funds of enterprises, requires the development of the package of normative and technical documentation, describing in detail and taking into account all aspects and specific features of the designed objects of small-scale energy, when justifying investments and setting forth a clear procedure for including these or that costs of the CHP operation in the calculations. These measures will allow scientifically, economically balanced and optimal decisions concerning the direction of the budget (innovation) funds to be chosen: either for the creation of a mini-CHPs, effective, indeed, not only for the economy of the enterprises, but for the economy of the whole country; or for the reconstruction and modernization of the existing CHP; or other key programs on the development of the energy complex of the Republic of Belarus.

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UDC 339.32(470.2+47b)
LBC 65.59(2Rus-12+4Bel)

Forecast of trade and economic relations in the regions of Russia's Northwestern Federal District and the Republic of Belarus

The article is devoted to the topical issues of trade and economic integration of the Northwestern Federal District of the Russian Federation and the Republic of Belarus. It studies the trends in the development of trade and economic activity in their regions. The article describes the mathematical tool of gravity modelling of the trade and economic cooperation, approved by the materials of statistical reporting of NWFD regions and the Republic of Belarus. A forecast of development of trade and economic activity in these regions has been elaborated.

Trade and economic activities, integration, goods turnover, economic-mathematical modelling, forecasting.

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International integration processes, strengthening in the modern world and, one way or another, affecting all countries, had a direct impact on the post-Soviet space. The Creation of the Union State of Russia and Belarus on the basis of the formation of the Common Economic Space, ensuring the free movement of capital, labour, goods and services, made it possible to bring together the economies of the two countries and strengthen the processes of trade and economic integration.

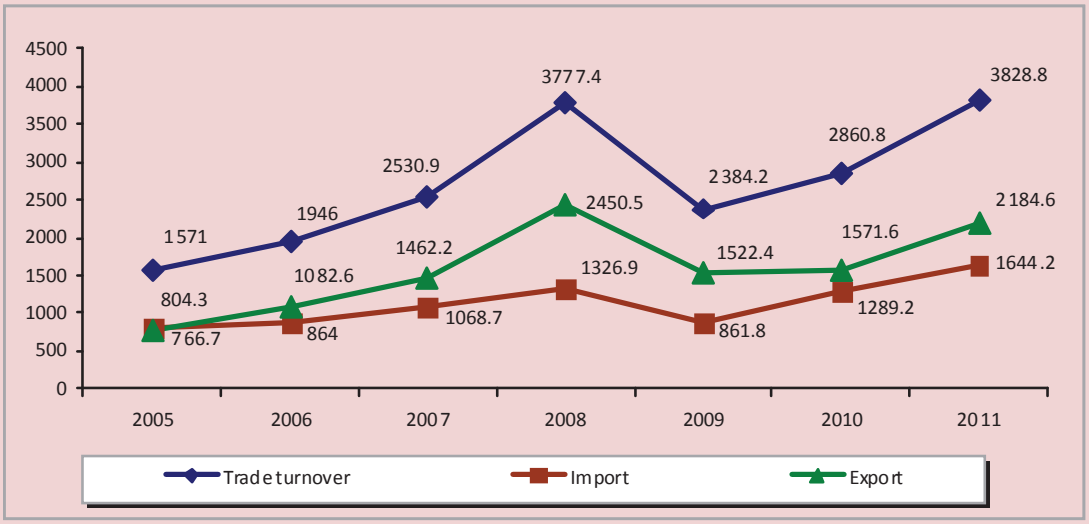
It should be underlined that it would be impossible to achieve economic integration in the Union State without activating mutually beneficial cooperation at the regional level. Russian regions and Belarus have chosen the tactics of direct ties, having established business contacts and having signed cooperation programmes.

The results of the mutual trade of the Republic of Belarus with the federal districts of the Russian Federation in 2005–2011, are presented in *table 1*.

Table 1. The results of the mutual trade of the Republic of Belarus with the federal districts of the Russian Federation

Federal District	Export, million US dollars			Import, million US dollars		
	2005	2011	Position	2005	2011	Position
Central FD	3409.7	7638.7	1	2607.7	4610.6	3
Northwestern FD	804.3	1644.2	2	766.7	2184.6	4
Southern FD	227.6	510.4	5	178	263.8	6
North Caucasian FD	115.2	208.8	7	25.7	86.3	7
Volga FD	618.7	1522.3	3	1292.1	4872.1	2
Ural FD	206.7	455.4	6	5091.7	12408	1
Siberian FD	296.5	970.5	4	155.9	332.4	5
Far Eastern FD	37.1	108.2	8	0.4	0.6	8
Russia in total	5715.8	13058.5		10118.2	24758.4	

Figure 1. Foreign trade relations of NWFD regions with the Republic of Belarus, million US dollars [11]



In Russia the leading position on turnover with Belarus is occupied by the Ural and Central federal districts (12 863.4 and 12 249.3 million US dollars in 2011, respectively). The northwestern regions are on the fourth place (3828.8 million US dollars).

Dynamic development of foreign economic activities of the regions of Russia's North-West and the Republic of Belarus is noted in the period under review. However, the global financial crisis in 2008 had a significant impact on the processes of their trade and economic interaction. In this period the trade turnover between the regions of the Northwestern Federal District and the Republic of Belarus fell by almost 40% in 2009 and amounted to 2.4 billion US dollars *(fig. 1)*. Moreover, the pre-crisis level of trade turnover was achieved only in 2011.

However, the level of trade and economic integration of NWFD regions and the Republic of Belarus in the post-crisis period (2008–2011) decreased. Foreign trade quota declined in five subjects of the Northwestern Federal District. Trade turnover growth with the partner country has been observed only in the Vologda, Novgorod and Arkhangelsk oblasts, and in the Komi Republic *(tab. 2)*.

Table 2. Regional foreign trade quota of NWFD regions and the Republic of Belarus, %

Region	2005	2006	2007	2008	2009	2010	2011	2011 to 2008, p.p.
Pskov Oblast	4.49	6.04	6.78	8.91	4.15	4.30	8.53	-0.38
Vologda Oblast	3.75	4.15	3.93	4.29	3.34	4.06	5.03	0.74
Novgorod Oblast	3.93	3.29	2.95	2.54	2.41	2.42	2.78	0.24
Komj Republic	0.88	0.53	1.01	1.05	3.78	2.18	2.37	1.32
Leningrad Oblast	2.13	1.94	2.24	2.97	1.79	1.84	1.93	-1.04
Kaliningrad Oblast	4.41	3.78	2.65	6.75	2.78	1.66	1.54	-5.21
Murmansk Oblast	0.87	0.97	0.86	2.19	1.47	1.56	1.28	-0.91
Republic of Karelia	1.01	1.49	1.08	1.13	0.74	0.77	0.73	-0.40
Arkhangelsk Oblast	0.32	0.32	0.32	0.58	0.59	0.68	0.64	0.06

Table 3. The share of export to the Republic of Belarus in GRP of NWFD regions, %

Region	2005	2006	2007	2008	2009	2010	2011	2011 to 2008, p.p.
Pskov Oblast	2.04	4.33	5.05	7.22	2.80	2.35	6.36	-0.86
Vologda Oblast	2.69	3.19	3.04	3.50	2.84	3.46	4.13	0.63
Komi Republic	0.69	0.37	0.90	0.94	3.70	2.09	2.27	1.33
Novgorod Oblast	1.73	2.09	2.01	1.52	1.47	1.43	1.22	-0.30
Leningrad Oblast	1.38	1.34	1.52	2.24	1.30	1.07	1.04	-1.20
Murmansk Oblast	0.65	0.63	0.54	1.75	1.16	1.17	0.78	-0.97
Kaliningrad Oblast	1.96	1.98	1.08	5.35	1.98	0.58	0.65	-4.70
Arkhangelsk Oblast	0.11	0.09	0.10	0.23	0.40	0.49	0.26	0.03
Republic of Karelia	0.40	0.92	0.52	0.58	0.39	0.31	0.18	-0.40

Table 4. Coefficient of regional export growth advancing GRP growth in NWFD regions

Region	2006	2007	2008	2009	2010	2011	2011 to 2008, %
Pskov Oblast	2.12	1.17	1.43	0.39	0.91	2.70	188.9
Vologda Oblast	1.18	0.95	1.15	0.81	1.32	1.20	104.0
Kaliningrad Oblast	1.01	0.54	4.96	0.37	0.32	1.11	22.5
Komi Republic	0.54	2.43	1.05	3.94	0.61	1.08	103.1
Leningrad Oblast	0.97	1.13	1.48	0.58	0.90	0.97	65.4
Novgorod Oblast	1.21	0.96	0.76	0.97	1.06	0.85	112.2
Murmansk Oblast	0.97	0.86	3.22	0.66	1.09	0.67	20.7
Republic of Karelia	2.3	0.56	1.13	0.67	0.87	0.57	50.3
Arkhangelsk Oblast	0.81	1.07	2.43	1.71	1.33	0.53	21.6

At the same time the production in NWFD regions remains highly dependent on the sales of the regions' products at the Belarusian markets *(tab. 3)*.

In 2011 the largest export potential with regard to the markets of the Republic of Belarus was observed in the Pskov (6.36%) and Vologda (4.13%) oblasts and the Komi Republic (2.27%).

Besides, the system of international division of labour in the post-crisis period involved fewer resources of regions, which is evidenced by a significant reduction of the coefficient of regional export growth advancing GRP growth in five NWFD regions *(tab. 4)*.

Comparative analysis of NWFD regions by the coefficient of regional export growth advancing GRP growth shows that the resources of the Pskov, Vologda, Kaliningrad oblasts and the Komi Republic are used more actively in the system of international division of labour than in other regions.

Despite the slowdown in integration processes within the Union State, the development of mutually beneficial trade connections between NWFD regions of the Russian Federation and the Republic of Belarus is extremely significant for the national and regional economies. In this regard, the important methodological problem is the modelling and forecasting of trade and economic activities that can be done by using gravity models [1, 2, 6, 13, 14].

The gravity models developed by Jan Tinbergen and Hans Linnemann can be used to simulate the trade turnover between the subjects of NWFD of the Russian Federation and the Republic of Belarus [2, 13, 14].

Jan Tinbergen's model appears as follows:

$$X_{ij} = \alpha_0 (Y_i)^{\alpha_1} (Y_j)^{\alpha_2} (D_{ij})^{\alpha_5} + \varepsilon, \quad (1)$$

where X_{ij} – the value of the trade flow from the country *i* to the country *j*;

Y_i, Y_j – the indicators, characterizing nominal GDP of the corresponding countries;

D_{ij} – distance between the economic centres of the countries *i* and *j*, km;

α_0 – absolute term of an equation;

ε – variable error.

H. Linnemann's model is of more general form:

$$X_{ij} = \alpha_0 (Y_i)^{\alpha_1} (Y_j)^{\alpha_2} (N_i)^{\alpha_3} (Nj)^{\alpha_4} (D_{ij})^{\alpha_5} \cdot \cdot (A_{ij})^{\alpha_6} (P_{ij})^{\alpha_7} + \varepsilon, \quad (2)$$

where N_i, and N_j – the population size in the given state;

A_{ij} –any other favourable factor or constraint to the trade (for example, the presence of borders or anti-dumping regimes in one of the countries);

P_{ij} – trade preferences among the states (in the absence of preferential agreements) $P_{ij} = 1$; otherwise $P_{ij} = 2$);

α_1, α_2, α_3, α_4, α_5, α_6, α_7 – export elasticity coefficients according to GDP of the exporting country, GDP of the importing country, population size in the country *i*, population size in the country *j*, distance between the countries, any other factor, trade preferences;

α_0 – absolute term of an equation;

ε – variable error.

The initial data on the construction of a gravity model represents time series of member variables *(tab. 5)*.

Thus, in the result of calculations, the authors obtained the Jan Tinbergen's version of the gravity model equation, describing the dynamics of eternal turnover between the regions of the Northwestern Federal District and the Republic of Belarus for 2005–2011:

$$X_{ij} = 26.919 \cdot (Y_i)^{-0.145} \cdot (Y_j)^{1.096}, \quad (3)$$

$$R^2 = 0.976$$

Note that the accuracy of the model is rather high, as the determination coefficient makes up 0.976. The economic interpretation of this model enables the authors to conclude

Table 5. Initial data on gravitation model parameters [11]

Year	Turnover between NWFD regions and the Republic of Belarus, million US dollars (*Xij*)	GDP of the Republic of Belarus, billion US dollars (*Yi*)	GRP of RF NWFD regions, billion US dollars (*Yj*)	Population size of the Republic of Belarus, million people (*Ni*)	Population size of NWFD regions, million people (*Nj*)
2005	1571	30.110	64.232	9.698	13.716
2006	1947	36.937	77.910	9.630	13.665
2007	2531	45.298	104.417	9.580	13.631
2008	3777	59.674	138.351	9.542	13.612
2009	2384	54.336	105.136	9.514	13.604
2010	2861	56.145	132.140	9.500	13.626
2011	3829	52.363	157.136	9.481	13.660

that the turnover NWFD regions will increase by 1.1%, if their GRP grows by 1%; with the 1% increase in GDP of the Republic of Belarus, however, the trade turnover between the Republic and NWFD regions will reduce by 0.15%.

According to the authors, this dependence is caused by the peculiarity of the commodity structure of exports and imports of NWFD regions of the Russian Federation and the Republic of Belarus. Raw materials (ferrous metals, mineral products and chemicals) occupy significant part in the export structure of NWFD regions. Therefore, the increase in GRP of the regions depends directly on export deliveries to the world market.

Food products, vehicles, agricultural machines and units, refrigerators and freezers, chemical and mineral fertilizers, timber and building materials, petrochemical products, synthetic fibers are imported to NWFD regions from Belarus. In other words, in the conditions of the limited capacity of the market of the given products it is possible to increase GDP of the Republic of Belarus by expanding sales geography, thus resulting in the reduction in the trade turnover between NWFD regions and the Republic.

Somewhat different result is obtained when using Hans Linnemann's gravity model:

$$X_{ij} = 1.069\text{E} - 20 \cdot (Y_i)^{0.167} \cdot (Y_j)^{1.388} \cdot \cdot (N_i)^{22.151} \cdot (N_j)^{-1.262},\ R^2 = 0.989 \quad (4)$$

The determination coefficient is higher than 0.99, as the given model considers a number of factors, affecting the turnover. However, the following conclusions can be made on the basis of the obtained equation: with the 1% increase in GDP of the Republic of Belarus, the trade turnover between the Republic and NWFD regions will rise by 0.17%; due to 1% increase in GRP of NWFD regions, the turnover will grow by 1.39%. In case the population of Belarus will increase by 1%, the trade turnover will rise by 22.2%, an increase of 1% of the population of NWFD regions will lead decline in trade turnover by 1.3%.

It is possible to forecast foreign trade turnover between NWFD regions and the Republic of Belarus based on gravity models, when constructing trends, describing the dynamics of member variables. The studied time series of the gross product and the population size of NWFD regions and Belarus are described rather accurately by power polynomial trends, as the coefficient of determination falls within 0.8–0.9 range *(fig. 2, 3)*.

The forecast values of variables, obtained on the basis of extrapolation of the trends, are likely to increase, except for the population of the Republic of Belarus *(tab. 6)*.

Thus, the forecast values of foreign trade turnover, obtained on the basis of gravity model equation of Jan Tinbergen and that of Hans Linnemann, shows strengthening of trade and economic integration of NWFD regions of the Russian Federation and the Republic of Belarus in the long view *(fig. 4)*.

A different number of factors, considered in the model, affects the indicators of foreign trade turnover, which explains the difference in the forecast values of the gravity models. In compliance with the theory of gravity models construction and their description, the gross product of the exporting country reflects production capabilities, while the gross product of the importing state determines its market capacity. In general, these two variables are directly proportional to the trade volume.

However, according to the authors, further development of trade and economic integration of NWFD regions and the Republic of Belarus both in the medium and long term can be polyvariant. Analyzing possible variants, it is possible to distinguish three possible scenarios of further development of the process at the current moment:

– 'no change' scenario, stipulating the continuation of trends and trade turnover

Figure 2. Dynamics of GDP of the Republic of Belarus and GRP of NWFD regions of th Russian Federation, billion US dollars

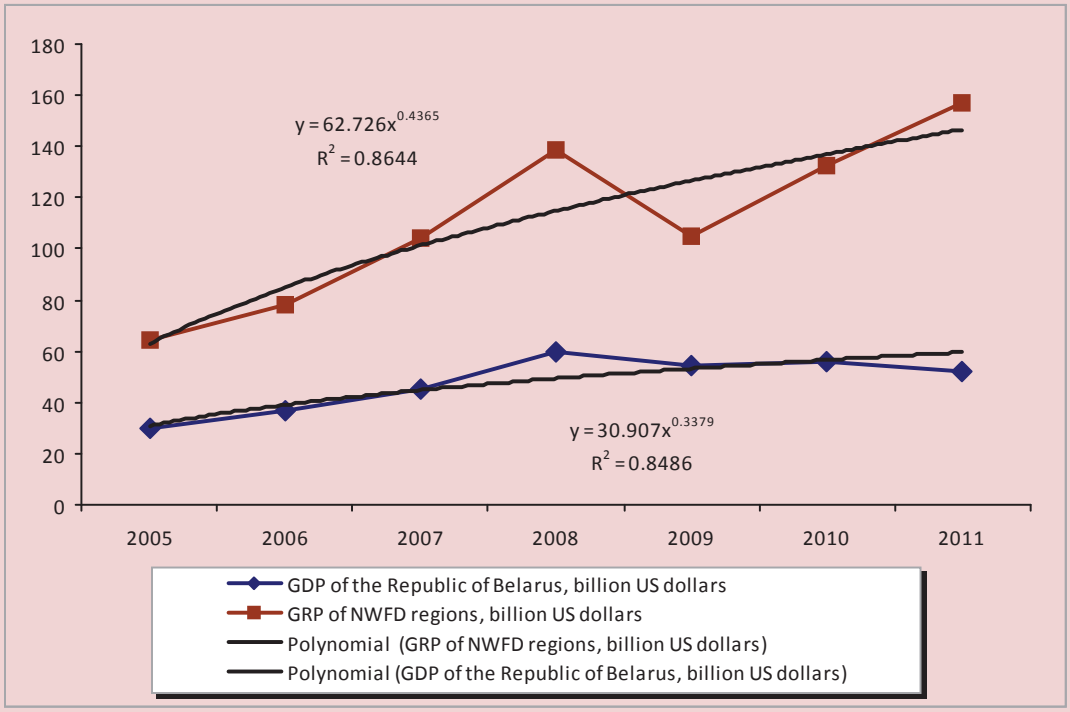


Figure 3. Dynamics of population of the Republic of Belarus and NWFD regions, million people

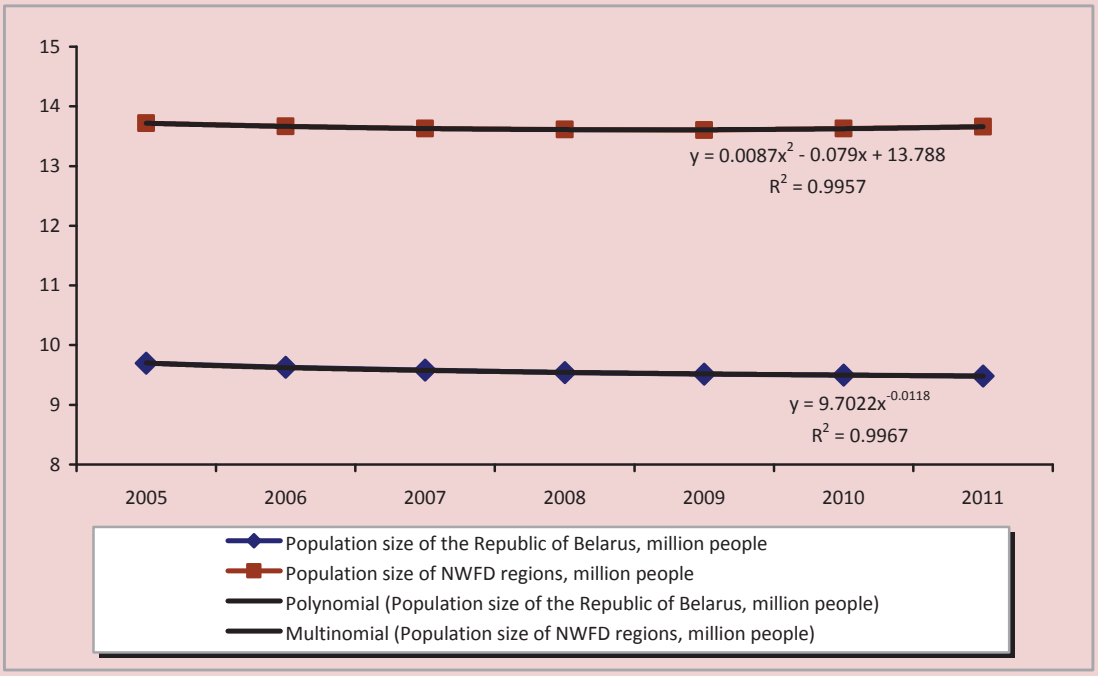
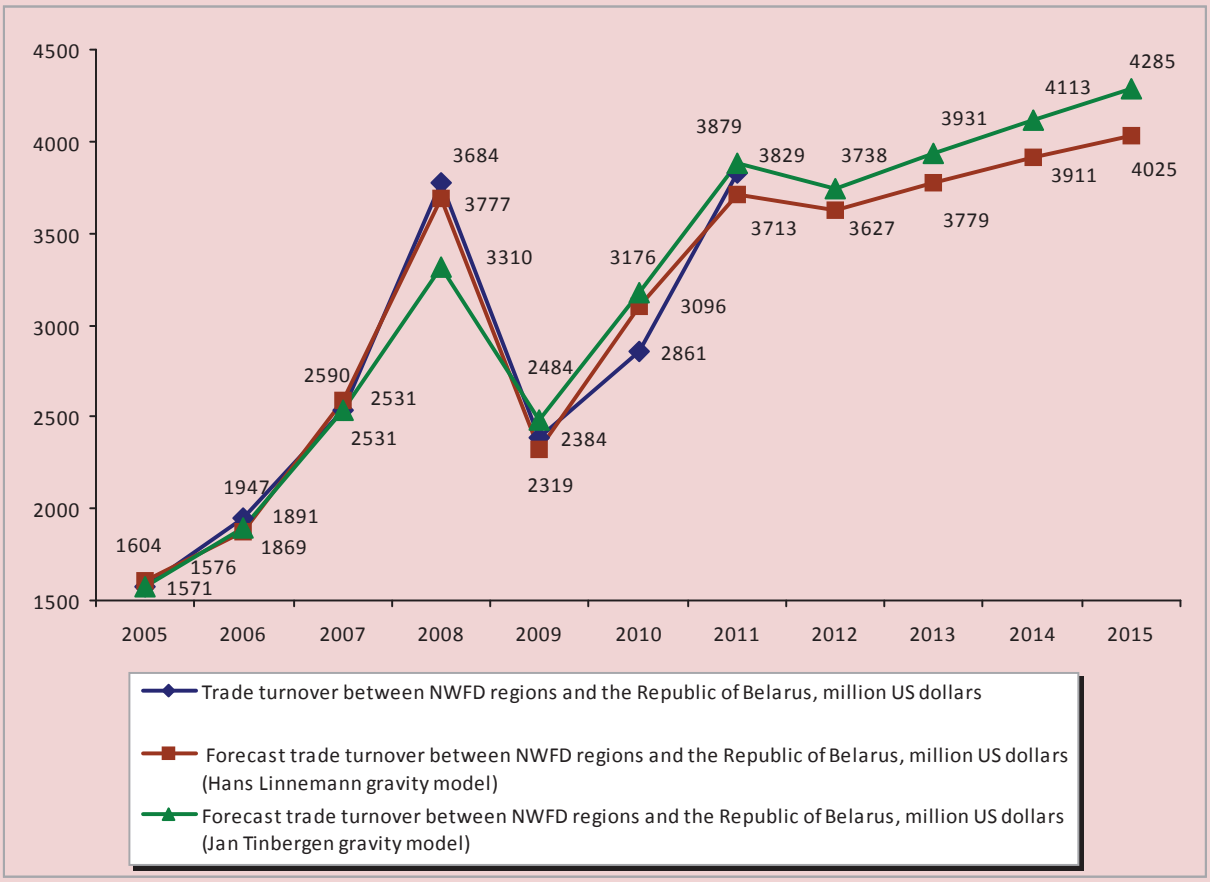


Table 6. Forecast of GDP and population growth of NWFD regions of the Russian Federation

Indicator	Forecast				Average annual growth rate, %
	2012	2013	2014	2015	
GDP of the Republic of Belarus, billion US dollars *(Yi)*	62.404	64.937	67.291	69.493	107.3
GRP of NWFD regions of the Russian Federation, billion US dollars *(Yj)*	155.470	163.672	171.375	178.655	103.3
Population size of the Republic of Belarus, million people *(Ni)*	9.467	9.454	9.442	9.432	99.9
Population size in NWFD regions, million people *(Nj)*	13.713	13.782	13.868	13.972	100.6

Figure 4. Forecast of the trade turnover between the Russian Federation and the Republic of Belarus, million US dollars



structure, existing in foreign trade relations between NWFD regions and the Republic of Belarus;

– scenario of trade and economic relations reorientation, the basic condition for implementation of which is the change of the sales markets for both NWFD regions and the Republic of Belarus;

– scenario of the further deepening of the economic integration of NWFD regions and the Republic of Belarus, stipulating the turnover increase due to the modernization of export-oriented industries and increase in volumes of competitive products with high added value.

However, at present, trade and economic integration of NWFD regions and the Republic of Belarus is aimed primarily at the efficient use of production potentials available in the regions, the development of specialization

and cooperation of enterprises, improvement of the previously existing economic ties.

Thus, in order to boost trade and economic integration in the system "country – regions of the other country", it is necessary to consider economic, political, and administrative-legal features of each party, factors affecting their development. It is possible to solve the given problem by using adequate methodological and, first of all, mathematical tools, which allow assessing the effectiveness of trade and economic relations on many factors. This will permit making timely changes to foreign trade policy and will contribute to the sustainable development of mutually beneficial cooperation.

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SOCIAL ASPECTS OF INTEGRATION IN THE FRAMEWORK OF THE UNION STATE

UDC 314.011(476+470) LBC 60.70(4Bel+2)

Demographic development of the Republic of Belarus and the Russian Federation in the context of national security *

The article considers the main features of demographic development in Russia and Belarus, and shows the similarity of demographic problems and the presence of demographic threats. It examines the state policy in the sphere of human reproduction, and for the Russian Federation it substantiates the necessity of influencing the demographic processes from the viewpoint of national security. The article proves that the Union State countries should unite their efforts for overcoming negative demographic trends.

Depopulation, reproduction of population, demographic security, demographic policy.

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Demographic security is the most important part of national security, which in the conditions of depopulation should be a priority task of the country's internal policy. Similar socio-cultural development, economic, political relations of the Russian Federation and the Republic of Belarus predetermined the creation of the Union State for joint solution of existing problems, including demographic ones.

Russia and Belarus are united by a common historic past, similar socio-political setup, they are inhabited by related peoples. In the late 1990s – early 2000s these countries faced the demographic development trends, some of which are increasingly acquiring the features of demographic threats to the sustainable development of society. Demographic security of the state is becoming the priority sphere of national security and, therefore, the major task of the country.

The main demographic threats consist in the following phenomena: depopulation, ageing and high demographic burden on the able-bodied part of the population.

Demographic development. The decrease in the population of the Republic of Belarus over the past 10 years was more pronounced than in Russia – 5% vs. 3% *(tab. 1)*.

It should be noted that in the period under review the urbanisation process in Belarus, given its lower basic indicator (in 2000 the share of urban population in the republic amounted to 70% against 73% in the Russian Federation), was more intensive, than in Russia, and by 2011 the share of urban residents has increased by 6 percentage points (up to 76% versus 74%, respectively). This was one of the reasons for the decrease in birth rate in 2000 – 2005. Total fertility rate in Belarus beginning from 2002[1] is lower than that in Russia *(fig. 1)*.

Population mortality rate in both countries remains high, despite the positive trend of reduction in the crude death rate *(fig. 2)*.

Reduction in mortality, especially infant mortality, led to the increase in the population's life expectancy. For instance, from 2000 to 2011 Russia experienced an increase in male life expectancy from 59 to 64 years, in female life expectancy – from 72.3 to 76 years, or by 8% and 5%, respectively. In the Republic of Belarus, where basic indicators were higher (63 years for men and 75 years for women in 2000), the increase was smaller – 3% for both sexes. However, life expectancy in Belarus is higher than in Russia *(tab. 2)*.

Demographic burden. Despite the fact that depopulation in Belarus has been continuing for over 20 years, the republic has not yet faced to the fullest extent those actual negative consequences that await it in the future, though until recently, the total population of Belarus has been decreasing, the number of the working-age population grew steadily, reaching in 2007 the figure of 6 million 66 thousand people. The share of working-age population in the entire population has been increasing even more rapidly, reaching its maximum in 2008 – 62.5%.

Table 1. Dynamics of the population of Russia and Belarus, million people

Country	Year								2011 to 2000, %
	2000	2005	2006	2007	2008	2009	2010	2011	
Russia	146.3	143.2	142.8	142.8	142.7	142.8	142.9	143	97.7
Belarus	10.0	9.6	9.6	9.5	9.5	9.5	9.5	9.5	95.0
Urban residents out of total population, %									
Russia	73	73	73	73	74	74	74	74	1
Belarus	70	72	73	73	74	74	75	76	6
Sources: Belarus and Russia: statistical digest. Rosstat. 2008, 2012.									

[1] Excluding 2007.

Figure 1. Crude birth rate, ‰

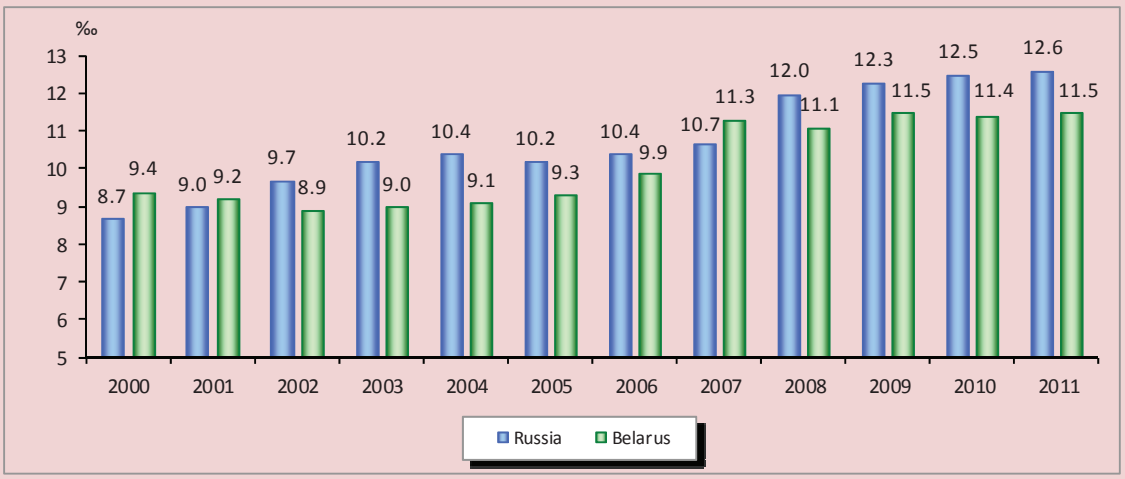

Figure 2. Crude death rate, ‰

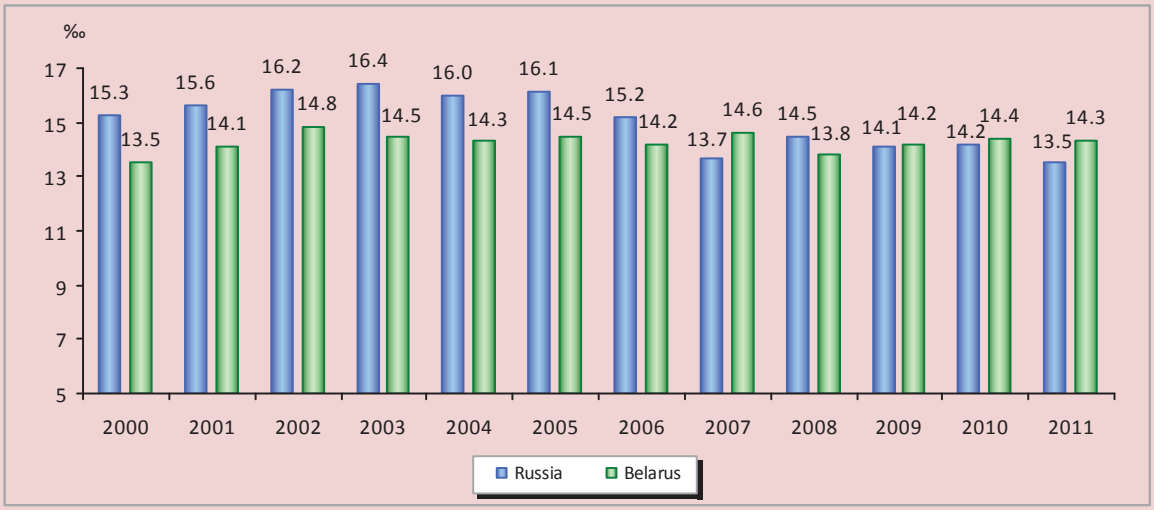

Table 2. Life expectancy, years

Territory	Sex	Year								2011 to 2000, %	2011 to 2006, %
		2000	2005	2006	2007	2008	2009	2010	2011		
Russia	Men	59.0	58.9	60.4	61.0	62.0	63.0	63.0	64.0	108.4	106.0
	Women	72.3	72.4	73.2	74.0	74.0	75.0	75.0	76.0	105.2	103.8
Belarus	Men	63.0	62.9	63.6	65.0	65.0	65.0	65.0	65.0	103.2	102.3
	Women	75.0	75.1	75.5	76.0	76.0	76.0	76.0	77.0	102.7	102.0
Vologda Oblast	Men	59.5	56.1	58.4	60.0	60.0	61.0	60.8	62.05	104.3	106.2
	Women	73.2	71.7	73.3	74.0	74.0	74.0	74.4	75.06	102.6	102.5

Sources: Belarus and Russia: statistical digest. Rosstat, 2008, 2012; Regions of Russia: statistical digest. Rosstat, 2006, 2012.

This is the highest indicator for the whole history of the country's development. The demographic burden on the able-bodied population has been constantly decreasing. Thus, according to the 2009 census, there were 624 dependent people per 1000 working-age population, while in 1970 – 894 people, and in 1989 – 785.7 people. These trends were favourable for the country's economic development, this fact alleviated the socio-economic problems, typical for the period. But in the short term the trends changed for the worse. This process has been already going on since 2008 *(fig. 3)*.

All this results in the complex socio-economic problems, which the country hasn't faced before, and which pose a real threat to its security. In at least 10 years Belarus will experience the reduction in the total population, as well as the working-age population, and the latter will decrease more rapidly.

According to the data for the beginning of 2013, the number of people entering the actual working age (aged about 22, when a person begins to work) is 134 thousand. After 10 years, those who are currently 11 years old (and at the beginning of 2013 their number was only 89 thousand, or by 45 thousand persons less) will be joining the ranks of working-age population.

125 thousand people entered the retirement age at the beginning of 2013, and in 10 years those people, the number of which is currently 147.1 thousand, i.e. by 10 thousand more, will reach this age. Moreover, these are the people who live in the country, and their number over 10 years will change slightly, almost exclusively at the expense of mortality and external migration.

The situation is similar in the Russian Federation; however, the negative trends started a little earlier – in 2007 *(fig. 4)*.

Migration attractiveness of the countries in 2000 – 2011 decreased *(tab. 3)*. Significant changes in the migration mobility of population took place after the collapse of the USSR, with the flows of refugees and immigrants from other post-Soviet states. In addition, the flow of emigrants to the other foreign countries increased, which was accompanied by brain drain, the issue of illegal migrants has become acute as well. Internal migration flows in Russia and Belarus have also changed.

Figure 3. The change in the demographic burden on the working-age population of Belarus for 2000 – 2011, people per 1000 working-age population

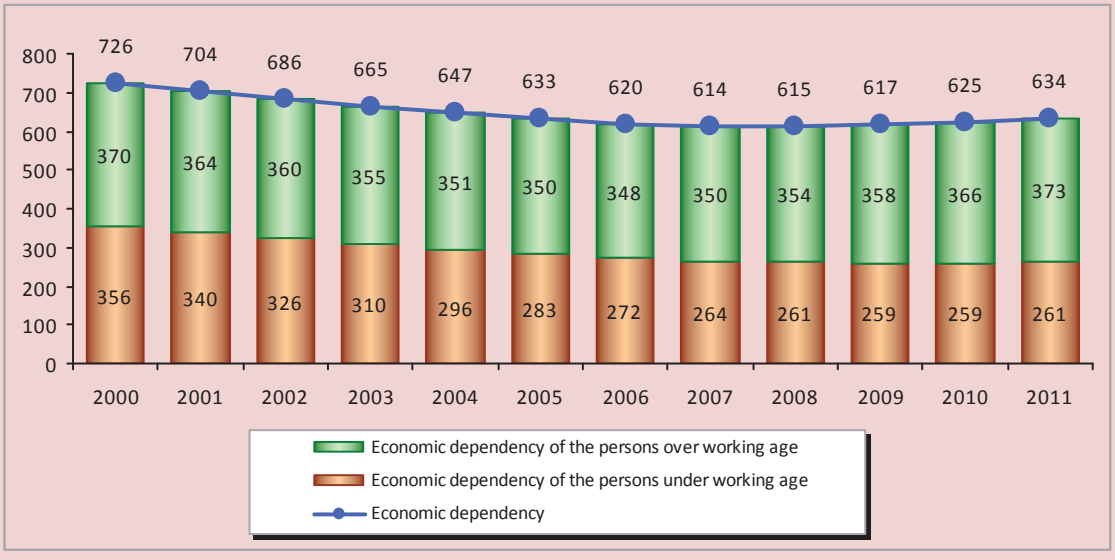

Figure 4. The change in the demographic burden on Russia's working-age population for 2000 – 2011, people per 1000 working-age population

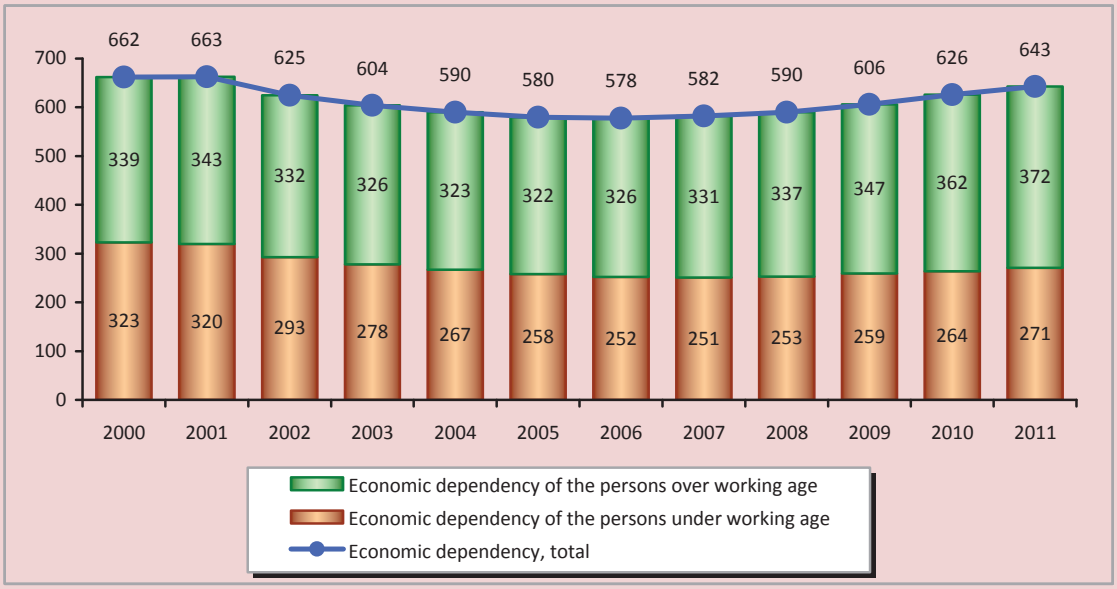

Table 3. Migration gain coefficient, ‰

Territory	Year								2012-2000, ‰	2012-2006, ‰
	2000	2005	2006	2007	2008	2009	2010	2011		
Russia	2.5	0.9	1.1	1.8	1.8	1.8	1.3	2.2	-0.3	1.1
Belarus	1.2	0.2	0.6	0.5	0.8	1.3	2.0	1.0	-0.2	0.4
Vologda Oblast	0.1	0.3	-0.03	0.4	0.5	0.1	-0.2	0.5	0.4	0.5

Sources: Regions of Russia: statistical digest. Rosstat, 2006, 2012; Russia and countries of the world: statistical digest. Rosstat, 2002, 2004, 2006, 2008, 2010, 2012; Demographic yearbook of the Vologda Oblast. Vologdastat, 2005, 2012; Demographic yearbook of the Republic of Belarus. Belstat, 2012.

So, the population is declining mainly in rural areas and small towns. In general, urban population continues to grow due to the migration inflow of rural population into big cities. As a result, the uneven population distribution throughout the country is aggravated. Rural to urban migration leads to the concentration of population in large cities and the abandonment of small towns and rural areas. 26% of the total urban population of Belarus is already concentrated in Minsk. As for Russia, 28% of its urban residents live in 12 cities with the population over one million. The demographic structure of rural population is being disturbed through the outflow of the youth, qualified specialists and young women. The process of ageing of rural population is accelerating.

Demographic policy. At the beginning of the 21st century, both countries stirred up their governmental activities to influence the natural movement of their population, which had an impact on the dynamics of demographic processes. Particularly notable results have been achieved in reducing mortality *(tab. 4)*.

The role of the state in ensuring demographic security can be efficient provided that the superior government authorities recognize the existence of the very problem and the profound socio-economic consequences it entails.

At that we should realize that solving demographic problems is a very complex task. It requires purposeful measures, time and financial resources, a concept of long-term state policy aimed at demographic security.

Table 4. Demographic coefficients, ‰

Territory	2000	2006	2011	2011 to 2000, %	2011 to 2006, %
Birth rate, ‰					
Russia	8.7	10.4	12.6	144.8	121.2
Belarus	9.4	9.9	11.5	122.3	116.2
Vologda Oblast	8.8	10.9	13.0	122.3	116.2
Death rate, ‰					
Russia	15.3	15.2	13.5	88.2	88.8
Belarus	13.5	14.2	14.3	105.9	100.7
Vologda Oblast	16.0	17.1	15.7	98.1	91.8
Sources: Belarus and Russia: statistical digest. Rosstat, 2008, 2012; Regions of Russia: statistical digest. Rosstat, 2006, 2012.					

Belarusian government recognized the complexity of the demographic situation in the country, and certain measures have been taken in this regard. Thus, October 22, 2010, the President of the Republic of Belarus A. Lukashenko held the meeting with the participants of the all-Belarusian action "A question to the President", where he noted that demographic security becomes one of the major guidelines of the government's activity [9].

The House of Representatives adopted the Law on demographic security of the Republic of Belarus, which was approved by the President on January 4, 2002. In accordance with the law, the National Demographic Security Programme of the Republic of Belarus for 2007 – 2010 was developed and approved by the Decree of the President of Belarus on March 26, 2007 [8]. The aim of the Programme was to stabilize the demographic situation and create prerequisites for demographic growth in Belarus. The implementation period of the programme document expired in 2010, and the results could be estimated *(tab. 5)*.

Most of the target indicators set in the National Demographic Security Programme for 2007 – 2010 were achieved, excluding the crude death rate of the population, which was 14.4 ‰ in 2010.

However, it is rather a flaw of the Programme itself, since it didn't take into account the specifics of existing age structure of the population in the country. The remarks made by demographers at the drafting stage of the programme document were not reflected in the final version.

The Russian Federation made demographic issues a priority sphere after President V.V. Putin's Address to the Federal Assembly in 2006 [11]. The Concept for Demographic Development up to 2020 was elaborated, the national projects "Health", "Education", "Affordable housing" were launched, and a new type of support for parenting: "Maternity/family capital", was introduced. The main policy document was the National Programme on the Demographic Development of Russia for the period from 2006 to 2015.

Summing up the results of the first stage of its implementation (2006 – 2010), we should point out that the planned results have been achieved only with regard to infant mortality indicator, and it is to the credit of the health care system itself rather than demographic policy in general *(tab. 6)*.

The indicators of both natural and mechanical dynamics of the population are far from the planned ones. An example can be found in the difference between the planned and actual values of the balance of migration. It was forecast to have increased almost fourfold in four years, but it actually amounted to a little less than 20%. The forecast estimations of the dynamics of Russia's population indicate its continuing reduction in the medium term [4].

Table 5. Results of implementing the National Demographic Security Programme of the Republic of Belarus for 2007 – 2010

Indicators	Reported data for 2006	Target indicators for 2010	Reported data for 2010
Crude birth rate, ‰	10.1	10–11	11.4
Total fertility rate (number of children on average per woman)	1.335	1.4 – 1.5	1.494
Infant mortality, ‰	6.1	6	4
Life expectancy, years	69.4	70-72	70.4
Crude death rate, ‰	14.4	10-11	14.4
Population growth due to external migration, thousand people	5.6	5.0	10.3
Source: Demographic yearbook of the Republic of Belarus. Belstat, 2012. P.153, 197, 302, 455.			

Table 6. Results of implementing the National Programme on the Demographic Development of Russia for the period from 2006 to 2015, according to the results of the first stage (2006 – 2010)

Indicators	Reported data for 2006	Target indicators for 2010	Reported data for 2010
Total fertility rate (number of children on average per woman)	1.3	1.65–1.7	1.4
Infant mortality, ‰	11.0	7.0-8.0	7.5
Life expectancy, years	65.3	70.0	68.9
Population growth due to external migration, thousand people	132	420	158
Sources: Regions of Russia, 2012; Russia in figures, 2011, 2012.			

In this regard, it is necessary to achieve more significant changes in demographic indicators and to enhance migration attractiveness of the country.

The weak support to the National Programme is evidenced by the fact that during its implementation period two more documents on the demographic development of Russia were elaborated: the Concept for the Long-term Socio-Economic Development of the Russian Federation for the period up to 2020 [7] and the Concept for the Demographic Policy of the Russian Federation for the period up to 2025 [6].

The main features of the demographic policy of Russia and Belarus, which need to be addressed, include the absence of targeted financially secure programmes on demographic development, uncertain migration policy and the fact that, despite official recognition of the significance of demographic issues, the very demographic security of the state is not given due attention.

Achievement of the programmes' targets and a certain improvement of the situation may create a false impression that demographic problems are easy to handle. But that is not so.

First, the success of implementing the National Programmes is not big enough to establish a simple reproduction of the population, let alone a "slightly extended" reproduction, which is most often considered the best.

The population, as before, does not reproduce itself, and its number continues to decrease. Despite some growth in the recent years, fertility in both countries remains low. They ensure the reproduction of the population only by 65 – 70%. Life expectancy indicators grew by almost two years, but they lag behind those in the developed countries by 10 – 15 years. Although the migration gain for the last 20 years has been always positive, its volume is insufficient to fully compensate for the natural decline in the population of the country.

Second, the beginning of the 21st century was characterized by favourable conditions for the positive trends in the demographic development of Russia and Belarus. There was a certain improvement in the socio-economic situation, the growth in the population's well-being, which had a positive influence on the demographic processes. Besides, special measures enhanced the welfare of families with children; in particular, they helped reduce the gap in the level of cash income between families with children and childless families. These measures also facilitated the creation of favourable conditions for education; they promoted access of the population to health services and education.

In the existing conditions, the major part of the population was able to realise their reproductive preferences. In these years the so-called "postponed children" were born, i.e. the children, the birth of which had been "postponed" by their parents due to the complicated socio-economic situation. According to calculations, the increase in the number of births in 2006 – 2010 is by more than 90% connected with the increase of birth rate in Belarus [13, p. 16] and by 78% in Russia [1, p. 82].

However, there are no grounds to speak about the increase in people's determination and willingness to have children [5, 12]. It should be noted that the existence of two, let alone three or more children in the family remains a significant factor in the risk of its falling into the category of the poor. Thus, the data from sample surveys of households shows that in Belarus the share of households with the average per capita disposable income below subsistence level was 3.4% in 2010 (4.3% in Russia). Among the households with two and more children aged under 18, this share was 12.0%, i.e. four times more.

At the same time it cannot be denied that the opportunity of receiving benefits could play a crucial role when deciding in favour of one more birth among a certain percentage of the families that had doubts concerning the number of children they would like or afford to have. The growth of well-being and enhancement of the quality of life, of course, had a positive impact on the improvement of people's health, which was facilitated by specially adopted measures undertaken to improve the work of public health sphere.

Third, the demographic processes in the first decade of the 21st century were positively affected by the following structural factors: the composition of the population by sex, age, marital status, etc. In these years in a significant part of the population reached the child-bearing age, its ratio by sex and marital status was also favourable. Age and sex structure of the population contributed to the increase in the number of births due to the rapid growth of the number of women in child-bearing age: the numerous cohorts of those born in 1983 – 1986 entered this age. According to the latest census in Belarus 1088.8 thousand women were in active child-bearing age (20 – 34 years), which is by 39.1 thousand more than in the 1999 census (1049.7 thousand) [10, p. 212]. In Russia this figure was 15903.9 thousand according to the 2002 census and 17517.6 thousand according to the census of 2010 [2, 3]. The tendency of increase in the number of women of active child-bearing age has practically exhausted itself.

Soon the situation will be the opposite. As the small cohorts of those born in the 1990s reach the active child-bearing age, their number will be declining rapidly. This will adversely affect the dynamics of the number of children who will be born in the second and third decades of the 21st century. At the beginning of the century the specifics of the age structure of the population had a positive influence on the dynamics of death rate. In these years, the small cohorts of people born in the years of World War II started to go beyond the age of 60. This reduced the population in

older age groups and, respectively, the number of deaths. As the numerous cohorts of people born in the 1950s reach the age of retirement, the number of population of pension age will increase; consequently, it would contribute to the increase in the number of deaths even given positive trends in the dynamics of indicators of age-specific mortality. Demographic forecasts have shown that if special measures for improving the demographic situation aren't undertaken at the national level, the population will continue declining more and more rapidly [4, 12, 14].

It will be possible to achieve positive trends in reproduction of the population and to curb its decline by changing the trends in the development of all the three components in the complex. The problem will not be solved by reducing mortality rate alone, even to the lowest world level. This will cause the shift in the age of death to the more advanced age, which will increase the number of senior citizens and will have almost zero impact on the population in the younger and middle age groups. The dramatic increase in immigration will have a positive impact on the number and structure of the population. However, to prevent population decline, the indicators of positive balance of migration should be very high. Belarus will not be able to receive such volumes of migration flows, because the accommodation and employment of a large number of people requires substantial material resources and organizational work. The annual intake of even 50 thousand people will not solve the problem of depopulation; but already by the middle of the century, migrants and their descendants will comprise one third of the population in Belarus, and by the end of the century – two-thirds.

In theory, the problem of depopulation in the country can be solved most comprehensively by the rapid increase in birth rate up to the level of simple reproduction, but even after that the positive effect can be achieved only by the middle of the century. In order to obtain the result earlier, it is necessary to have not less than three or four children almost in every family, capable of procreation. However, it is almost impossible to achieve in the near future. An increase in birth rate, as well as a reduction in mortality or an increase in migratory flows can't happen in no time, as it is envisaged by hypothetical scenarios. Hence, it is necessary to exert a comprehensive influence on all the components of population growth at the same time.

Russia and Belarus can solve demographic problems in cooperation within the framework of the Union State, exchanging experience, implementing common programmes including research work. An example of such cooperation can be found in the interaction between the Institute of Economics of the NAS of Belarus and the Institute of Socio-Economic Development of Territories of the Russian Academy of Sciences, with the support of the international grant of the Russian Humanitarian Science Foundation and the Belarusian Foundation for Basic Research RHSF-BFBR No. 13-22-01002/13 "Demographic security of Russia and Belarus: problems and prospects".

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Population migration as a factor in Belarus demographic security

The article presents a brief description of the demographic situation in the Republic of Belarus in the beginning of 21st century. It indicates the special role of migration in reducing negative demographic processes. The curb on natural loss of population, the impact on its gender and age structure and the rate of aging, as well as the formation of the total population increase in the administrative units of the Republic are regarded as important social aspects of the external migration of the population of Belarus.

Migration, demography, depopulation, reproduction, population ageing.

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At present, migration is the only deterrent to the decline in Belarus population, and thus, has a direct impact on the demographic security of the country. However, the social role of migration is not limited to this. The article gives the detailed analysis of the social aspects of the external migration of Belarus population.

In 1994 Belarus hit a depopulation cycle. Natural population decline in the 1994–2012 period made 780.6 thousand people. If it hadn't been for positive net migration, the population of Belarus would have reduced to 8682.7 thousand people by January 1, 2013, excluding migration processes (or 16.5% as compared with the depopulation-beginning in 1994), or to 9310 thousand people with zero migration balance. As of January 1, 2013 the factual number was 9463.3 thousand people, that is 153 thousand people more, considering the positive migration balance of 9.3 thousand people in 2012 (the amount of positive balance for 1994–2012). As can be observed, the difference is quite significant; this value reflects the positive impact of migration on the population of Belarus. Its compensating role amounted to 15.4% for 1994–2012 in general, and was equal to 83.7% in 2012. The maximum value of the external migration in Belarus reached 66.9 thousand people in 1992, which made it possible to increase significantly the population growth, which had been positive in any case (+11.3 thousand people) [1; 2].

In 1994 the population growth of Belarus became negative (-3.3 thousand people) and laid over the natural decrease of the time (-19.4 thousand people). Then the migration growth became positive and of wavy character. There have been two waves in the 1994–2012 period. The first wave started in 1996 and reached its peak in 1998: the highest balance of external migration in the last decade of the 20th century (an inflow from the CIS and Baltic countries plus a slight outflow to foreign countries), and, as a consequence, the compensatory role of external migration, accounting for 44.6% of natural decline.

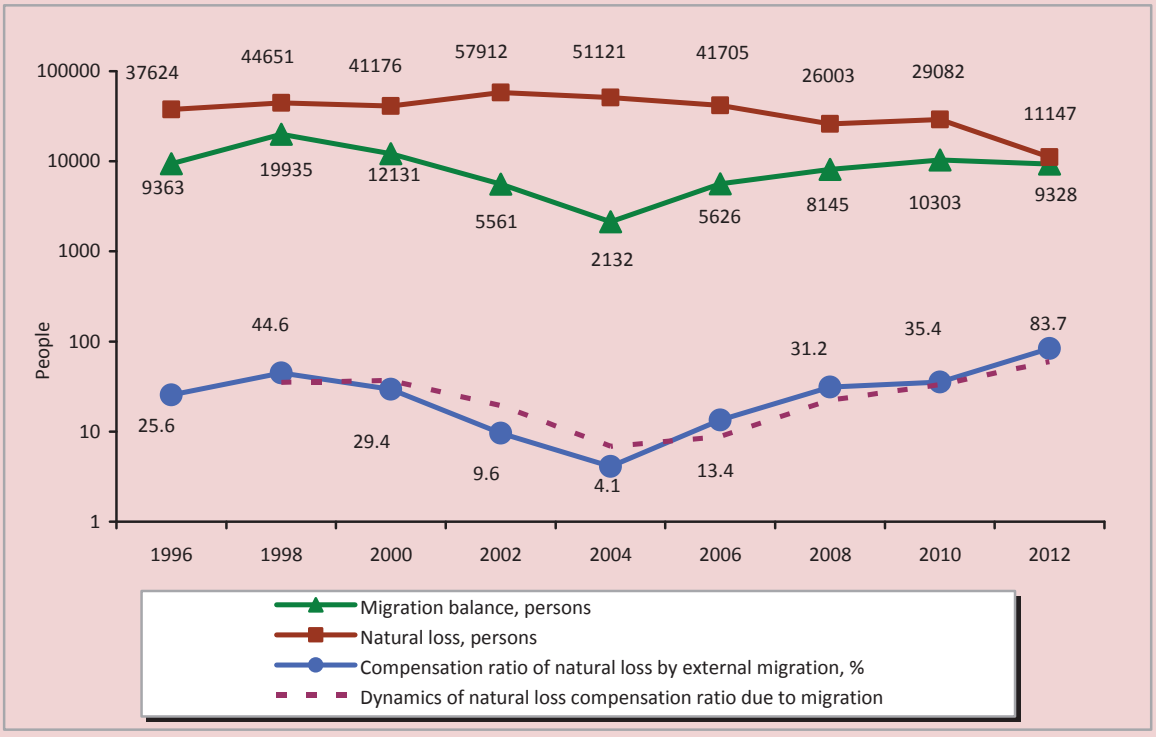
Then the stage of the wave decay comes. The minimum fell for 2004: positive migration balance amounted to 2.1 thousand people and the rate of natural decline was one of the highest in the past two decades (-57912 people in 2002). As a result, in 2004 the compensatory role of migration was the lowest for the two decades (4.1%, except for 1994, when she was absent at all) *(fig. 1)*.

But the migration inflow, as well as migration balance was declining. The absence of a comprehensive national migration policy was the main reason for the reduction in the inflow in the second half of the 1990s.

The second wave of the migration impact on the demographic processes occurred in other conditions. The Programme on the Socio-economic Development of the Republic of Belarus for 2001–2005, the National Demographic Security Programme of the Republic of Belarus for 2007–2010, the National Demographic Security Programme of the Republic of Belarus for 2011–2015 had been adopted. But the main thing is that the generation of the demographic rise of the late 1980s reached the reproductive age. This led to a significant reduction in natural losses (up to 11147 people in 2012). The number of departures from the Republic reduced (up to 9328 people in 2012 against 13812 in 2000) [3-6, 12].

In 2012, the natural loss of Belarus population amounted to 11147 people, the positive balance of migration was 9328 people, compensatory role of migration reached 83.7%. However, considering that the second wave of migration growth is approaching its peak, the wave decay is likely to begin soon, as the prerequisites for this exist. According to the Belarusian demographer L.P. Shakhotko, in the first decade of the 21st century the sex-age structure of Belarus population contributed

Figure 1. Compensation ratio dynamics of the natural loss of Belarus population due to external migration in 1996–2012, with the use of logarithmic scale. [comp. 2, 3, 4, 5, 6, 12]



to the increase in the number of births and the reduction in the number of deaths. But as thin cohorts of those, born in the 1990s, will be reaching the active reproductive age, their number will start declining rapidly. It will adversely affect the dynamics of children born in the country in the second and third decades of the 21st century. As the people born after the war will reach the retirement age, the number of deaths will increase [2].

It should be acknowledged that the state authorities got an understanding of the migration role in the ensuring of the demographic security of the Republic. Upon the implementation of the economic growth and migration attractiveness, 33 thousand of foreign citizens were temporarily employed in the country and 13 thousand were attracted to Belarus as full-time residents in 2010. More than 3.5 thousand ethnic Belarusians have acquired the citizenship [7]. The National Demographic Security Programme of the Republic of Belarus for 2011–2015 have been adopted. It stipulates the increase in the positive migration balance within 60 thousand people in 5 years up to 2015, including 10 thousand people in 2011, 11 thousand people in 2012, 12 thousand people in 2013, 13 thousand people in 2014, 14 thousand people in 2015 [8].

According to the authors, such migration volume is insufficient to overcome the depopulation of Belarus. The National Demographic Security Programme of the Republic of Belarus for 2011–2015 points out the necessity to reduce population decline up to 18.5 thousand people in 2011, up to 15 thousand people in 2012, up to 9 thousand people in 2013, up to 4 thousand people in 2014, and to ensure minimum positive natural growth in 2015. In order to stabilize the demographic situation, large-scale compensatory immigration, based on a differentiated approach to various categories of migrants, with regard to national interests, is necessary on the one hand, and the preservation and enhancement of its own population (reduced mortality and increased birth rate), on the other hand. To stop population decline, it is necessary to ensure the so-called 'zero option', assuming the full coverage of natural loss by migration growth. The 'zero option' in the context of Belarus implies the positive migration balance of about 28–30 thousand people per year (the real rate of natural loss amounted to 25.7 thousand in 2011 and decreased to 11.2 thousand only in 2012) or 140–150 thousand people in total for 5 years, i.e., in fact, the entire volume of net migration for the 1994–2010 period. It is difficult to achieve these numbers in such a short period taking into account the existing demographic trends, since the total real indicator for 2006–2010 amounted to 40999 people, and 23887 people for 2001–2005 [2, 3, 4, 5, 6].

During 1996–2000 the indicator made 73.6 thousand people, but migration policies have not yet been developed then, therefore the opportunity to keep the pace was missed out. Obviously, it is impossible to increase the inflow from 10.3 thousand in 2010 up to 30 thousand people per year, this can be only achieved gradually, as the socio-economic conditions in Belarus will be improving, which is rather problematic in the conditions of global financial and economic crisis. However, there are objective prerequisites for improving the quantitative indicators of the total inflows. A significant migration potential of Belarus in the CIS countries and abroad still remains.

Thus, according to 2009 data, 814.7 thousand Belarusians live in Russia, 600 thousand in the USA, 275.8 thousand in Ukraine, 200 thousand in Canada, 130 thousand in Israel, 96 thousand in Latvia, 95 thousand in Kazakhstan, 55 thousand in Lithuania, 50 thousand in Poland, 21 thousand in Estonia, 20 thousand in Moldova, 20 thousand in Australia, 7 thousand in Argentina, 7 thousand in Great Britain, 2 thousand in Belgium [9]. Mixed families, one or more members of which are

ethnic Belarusians, as well as migrants who have relatives in the Republic of Belarus fall into the category of potential migrants in the first place.

Currently, there are two major factors contributing to the return migration of the Belarusians to the Republic of Belarus from the former Soviet republics: a) stable political situation; b) the status of the Russian language as the state language alongside with the Belarusian language. The mobility of the indigenous ethnic groups of the CIS and Baltic States is quite low, however, due to the considerable number of Russian citizens (about 140 million people); the migration potential is quite significant and can be oriented at the Republic of Belarus.

The realization of the migration potential of the Belarusian diaspora and the indigenous population of the CIS and Baltic States depends on the socio-political and economic situation prevailing in these states, as well as the current migration policy. An adequate national migration policy can contribute to the return of a sufficient number of compatriots from the CIS and countries outside the former Soviet Union back to Belarus. Belarus may, to some extent, resolve the problem of shrinking population in the midterm, as well as obtain qualified labour resources by attracting migrants from the CIS countries. The migration of the population from the CIS countries can address at least two tasks: gradual levelling of depopulation; the provision of the stability of the population and the transition to a zero growth.

The influx of migrants from the CIS countries should not be considered as a threat to the titular nation for three reasons: firstly, the number of immigrants is relatively smaller than the number of Belarusians (7 957 252 people according to 2009 population census); secondly, the demographic situation will gradually stabilize, and in the long term the Belarusian population will be able to reproduce on an extended basis; thirdly, Belarus has never been a purely mononational country, such as Japan, the traditions of different peoples, living together on the same territory, are strong and still remain.

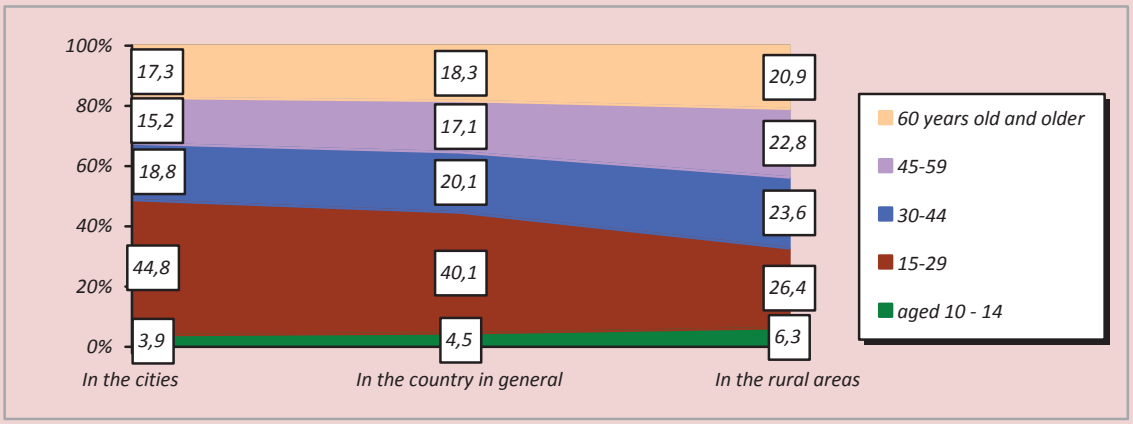
However, migration is not only partially levels population natural loss, but also has a positive effect on its age structure. At present, it is important for Belarus to slow down the ageing of the population. Clearly, if the senior citizens prevail in the immigrant structure, it will reinforce the deformation of the age pyramid of Belarus population, i.e. aggravate the current situation. Vice versa, the prevalence of young persons in the immigrant structure contributes to the increase in labour resources of the Republic, as well as working-age people in general and plays an important role in the adjustment of the population age structure.

The last population census of the Republic of Belarus, conducted in 2009, allowed identifying the age structure of the migrants, who arrived in the country in the 2005–2009 period *(fig. 2)*.

The situation is the following: individuals aged 15–29 years made up 40.1% of the migrants who arrived in the Republic in the 2005–2009 period. It is a very positive and advisable fact for replenishing demoreproductive potential of Belarus and to adjust the age structure of its population, however it is nonhomogeneous. As follows from fig. 2, the major share in this process is played by the migrants, arriving to the city (people aged 15–29 years made up 44.8% of the arrived) constitute the major share in the process.

The bulletin column 'working-age population' [10] shows that the working age population prevails both in the flow of migrants, who have arrived in 2005–2009 in the cities (75.4%), and in the flow of migrants, who have arrived in 2005–2009 in the rural areas of Belarus (67.9%). At the same time, 43.7% of those, who arrived in 2005–2009 in the rural areas, were people aged 45 and older, on the verge or exceeding both the working and reproductive ages.

Figure 2. Age structure of migrants, arrived in the Republic of Belarus in 2005–2009 [comp. by 10]



Thus, the external migration most thoroughly ensures the decrease in the pace of aging only of Belarus urban population, and practically has no effect on the decline in the pace of ageing and on the adjustment of the sex and age pyramid in the rural areas.

The latter determines the goal of improving the state immigration policy, which cannot be limited only to the solution of the displaced persons issue and the creation of an emigration control system, and should be aimed at the regulation of migration flows, in order to improve the demographic and socio-economic situation in Belarus. The programme on the attraction and resettlement of labour migrants and their resettlement is to be coordinated at national and regional levels. Regions may initiate targeted programmes to draw migrants, particularly labour migrants. Moreover, local budgets are also to be involved in the implementation of these programmes.

Given the fact that the migration policy of Belarus must contribute to the current and future economic and demographic needs of the country, the measures on selective immigration policy (the attraction of young people and highly skilled work force to solve problems of innovation development of the country and regions) should be elaborated starting from now.

Thus, based on the conducted research, it can be concluded that external migration plays an important role in the development of Belarus as a factor: 1) containing natural loss of the population of the Republic; 2) changing the age and sex structure and rates of aging of both urban and rural population; 3) forming the total increase of the population of the administrative units of the Republic of Belarus.

In general external migration acts for the Republic as a factor stabilizing the population and contributing to the creation of conditions for its further growth. Following 2011, one can expect some reduction in mortality, and, probably, a certain rise in birth rates but only in case of economic recovery and improving health service. It is advisable to facilitate the increase in migration volumes. Under such condition, the prerequisites will be created for the growth of Belarus population as a key factor in achieving socio-economic development and enhancing national security.

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Health saving activity as a health-promoting factor: the gender aspect *

The article analyses health-saving behaviour of population in the two countries – the Republic of Belarus and the Russian Federation (the case study of the Vologda Oblast) in the context of the gender aspect. The aim of the article is to highlight the specifics of behaviour of men and women in their choice of strategies of health-saving activity, which, in turn, influence their health condition.

The results of an international multidisciplinary research testify that gender determines the choice of health-saving behaviour strategy.

Health, health-saving activity, gender, self-assessment of health, men, women, population of the Vologda Oblast, population of Belarus.

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Health is an important factor in preserving the number and quality of population. It largely determines the level of mortality and quality of the future generation, thereby predetermining the country's demographic development.

Russia and Belarus are former Soviet states that have common trends in demographic development and population's health. The analysis of the general regularities of demographic development, health and behaviour strategies of the population of these states helps to work out more efficient measures for handling the existing demographic problems.

The World Health Organization recognizes that there are differences in the factors determining health and diseases among women and men and emphasizes the special importance of studying the dynamics of gender aspects of health, which has been neglected for a long time [2].

The concept *gender* came into Russian from the English language and is translated into Russian as "род"; the adjective *gender* is used to describe those characteristics of women and men that are socially acquired, while the word *sex* is used for the description of biologically predetermined characteristics. Behavioural traits and attitudes that boys and girls acquire in the process of socialization form their gender identity and define the gender roles [2].

At the same time, most of the research on the population's health in the two countries does not often take into account gender differences in the choice of the behavioural strategies with regard to health, when developing the recommendations to the authorities and social structures concerning the improvement of mechanisms for reducing mortality and enhancing the quality of human potential.

One of the indicators of demographic development is life expectancy (LE). Health of Belarus and Russia's population is characterized by a low level of life expectancy: the difference between these countries and the countries leading in LE indicators is 6 – 8 years for women, 12 – 14 years for men *(tab. 1)*. In Belarus in 2011 the indicator of life expectancy at birth amounted to 70.6 years (64.7 years for men, 76.7 years for women), in Russia – 70 years (64 years for men, 76 years for women). For more than 10 years, a significant gap in the life expectancy between women and men (12 years) is maintained in Belarus [3] and Russia [5].

Mortality rate from external causes at working age in men ranks 1st in Russia and 2nd in Belarus. This indicator decreased significantly in Belarus and in Russia in the 2009–2011 period (from 146.2 to 142.5 in the Republic of Belarus and from 329.3 to 291.8 in the Russian Federation). At the same time the given indicator differs considerably for men and women. For example, in 2011 in Russia mortality rate from external causes amounted

Table 1. Life expectancy in the context of gender in 2011 (number of years)

Territories	All population	Men	Women	Difference W/M
Life expectancy at birth				
Russian Federation	70.0	64.0	76.0	12
Republic of Belarus	70.6	64.7	76.7	12
European Union	80.1	77.2	83.0	5.8
Life expectancy at the age of 65				
Russian Federation	14.8	12.1	16.7	4.6
Republic of Belarus	14.9	11.8	17.1	5.3
European Union	19.5	17.6	21.2	3.6

Sources: Belarus and Russia, 2012: statistical digest. The Permanent Committee of the Union State; National Statistical Committee of the Republic of Belarus; Federal State Statistics Service. Editorial board: Kostevich I.A. et al. Moscow: Rosstat, 2012; European Health for All Database. WHO, 2012 Available at: http://data.euro.who.int/hfadb/shell_ru.html

to 273 cases per 100 thousand people among men, and to 59.6 cases among women. The similar indicator in Belarus made up 241.6 cases per 100 thousand people among men, and 56.4 among women; gender difference is even more pronounced at working-age, with the indicator amounting to 274.8 among men, and 47.9 among women [3].

Many reasons determining the gap between the health indicators in the post-Soviet states and the Western European countries have been understudied yet. However, leading analysts agree that about 30% of the lag is caused by the well-being differences, 50% is related to the factors specified by the way of life, 10% is connected with pollution and the risk of occupational diseases, 10% is due to the lack of preventive and therapeutic medical services [11].

At this stage it is important to know to what extent people strive for the preservation of health, whether they pay attention to nutrition and physical education issues, seek timely treatment; whether women and men take care of their health differently.

This paper presents some results of the analysis of population health-saving behaviour on the basis of an international multi-disciplinary health study of the residents of the two countries, held in 2011 in Belarus[1] and on the territory of the Vologda Oblast[2] (one of the biggest regions of the Russian Federation). The aim of the article is to reveal the peculiarities in behaviour of men and women, when choosing the behaviour strategies, affecting their health.

The empirical indicators of the population attitude to health are the following: 1) health self-assessment as the main source of information about micro-level changes; 2) health care motives, indicating the true reasons for choosing health-saving behaviour; 3) population health-saving activity (passivity), reflecting the real choice of an individual with regard to health preservation issues[3].

The application of sociological indicators along with statistical ones, such as life expectancy, mortality, morbidity, raises the correctness of the overall health status assessment at population level. Sociological methodologies allow investigating the health self-assessment of different population groups, in order to reveal the most secured of them, taking into account behaviour strategies and risk groups, aimed at the elaboration of targeted offers and recommendations for improving the situation. The method of health self-assessments (despite certain limitations) is considered sufficiently reliable and is recommended by WHO for health monitoring within individual countries and for cross-country comparisons. Health self-assessment as an integral indicator involves the assessment of not only the presence or absence of disease symptoms, but also general psychological well-being.

[1] A national survey of Belarus population was held by the Institute of Sociology of the NAS of Belarus in 2011. Sample volume is 2101 people. The sampling is random and route, controlling the quotas of the population aged 16 and older in compliance with the area of residence, sex, age and education. Representativeness of the sample is ensured by compliance to the following conditions: the sample proportionally represents the population of the Minsk Voblast (distinguishing Minsk), the Mogilev, Vitebsk, Grodno, Gomel and Brest voblasts; urban and rural population; the population of six 'zones' is proportionally represented within the regions (1 – Minsk and regional centers, 2 – cities with the population of 100 – 250 thousand people, 3 – cities with the population of 50 – 100 thousand people; 4 – cities with the population of 10 – 50 thousand people; 5 – urban-type settlements with the population of less than 10 thousand people; 6 – rural population); in each 'zone' the population is proportionally represented in accordance with such characteristics as: sex, age, education.

[2] The public opinion poll on the state of population health was carried out by ISEDT RAS in 2011 in Vologda, Cherepovets and eight districts of the Vologda Oblast. The sample volume – 1500 respondents. The sample is purposive and quota. Representativeness of the sample is ensured by compliance to the following conditions: the proportions between urban and rural residents, between residents of different settlement types (rural settlements, towns and medium-sized cities), the proportions of the sex-age structure of the oblast adult population. Sampling error does not exceed 3%.

[3] Data for comparative analysis was obtained in the course of the survey, conducted on the territory of Belarus and the Vologda Oblast, on the basis of the authorings of V.R. Shukhatovich.

Significant gender differences in health self-assessments of population are observed in Belarus, and in Russia *(tab. 2)*. They are much better for men than for women: the share of 'good' or 'rather good' assessments is almost twice higher, while the proportion of 'rather poor' and 'poor' assessments is almost twice lower; men noted that their health has deteriorated over the last year by 1.5 times less.

37% of the population of the Republic of Belarus with chronic diseases comprise 29% of men and 43% of women. The disproportion is similar for the Vologda Oblast: 18% of men and 29% women.

The disparity between the statistical indicators (average life expectancy, mortality) and health self-assessments by gender is observed in both countries: according to self-assessments the women's health is worse than men's, while according to the statistical indicators the situation is reverse: men's health is significantly worse than that of women.

This phenomenon, revealing itself in the fact that the average life expectancy is 12 years less for men, and individual capacity of women's health is on the average 10% lower, is defined by famous Russian scientist and social politician N.M. Rimashevskaya as 'the gender paradox in health'. She accounts this phenomenon for objective and subjective, biological and social factors: greater responsibility for the well-being of children and higher inborn endurance of women; lower tendency of men to the vital (health-saving) behaviour and higher inclination to risk; men have greater energy, but are more vulnerable to stress: a male body is a sprinter, a woman's body is a stayer [8]. N.M. Rimashevskaya associates the social factors affecting health, with a double burden of women and high risks, taken by men.

When studying the behaviour strategies aimed at health preservation and the extension of life, it was revealed that women pay attention to healthy lifestyle and try to follow it to a greater extent than men.

Lifestyle is considered to be the determining factor affecting human health [9]. In general social category of 'healthy lifestyle' describes: a) the degree of the implementation of the capabilities of a particular society (individual, social group) to secure health; b) the degree of social welfare as the wholeness of the standard

Table 2. Health self-assessments of the population of Belarus and the Vologda Oblast, 2011, by gender (% of respondents)

Answers	Republic of Belarus			Vologda Oblast		
	Men	Women	Total	Men	Women	Total
What is the current state of your health?						
Good and rather good	36.7	20.9	28.1	48.7	37.5	42.5
Satisfactory	46.2	52.2	49.4	36.2	42.6	39.8
Rather poor and poor	12.6	22.1	17.7	12.0	18.7	15.7
Don't know	4.6	4.4	4.3	3.0	1.2	2.0
Has the state of your health changed over the past year?						
Improved	5.5	4.6	5.1	9.2	7.5	8.3
Remained the same	63.5	51.8	57.1	64.1	56.3	59.7
Worsened	22.2	36.1	29.7	20.5	30.1	25.8
Don't know	8.9	7.3	7.8	6.3	6.1	6.2
Do you suffer from chronic disease?						
Yes	28.9	43.4	36.8	18.2	29.3	24.4
Do you suffer from aftereffects of a serious illness, injury, limiting your ability to work?						
Yes	7.2	6.3	6.7	10.7	8.7	9.6
Are you qualified as disabled?						
Yes	4.4	5.6	5.1	6.6	7.9	7.3

and quality of living; c) the efficiency degree of the social organization functioning in its correlation with the value of health.

The authors consider the health-saving activity as a social activity, characterized by consciousness, goal-setting, and result anticipation. A healthy lifestyle requires an active ability to cope with difficulties and to withstand health risks.

In the presented analysis the following indicators of the population's attitude to health have been selected: 1) the motives of health care, developing and predicting the activity directions of an individual; 2) population health-saving activity (passivity), reflecting the real choice of an individual with regard to health preservation.

The results of the study confirmed the hypothesis that the prevalence of the indicators of health-saving activity is higher among the respondent groups with the highest health self-assessments, than among those with low self-assessments *(tab. 3)*. Among the respondents, who gave the answer 'I do not undertake special efforts to preserve and improve my health', the share of individuals, assessing their health as poor, is 2 times higher than of those, rating their health as 'good' or 'rather good'.

Active workouts, strengthening of the body, weight control, the improvement of health in sanatoria and health resorts, steam baths, controlled drinking, walks, optimal combination of work and leisure activities, organization of free time with the advantage to health, control

Table 3. Prevalence of the indicators of health-saving activity in population groups with various health self-assessments (% of respondents)

What do you personally do to preserve and to improve your health?	Subject	How do you assess your health?					Total population
		Good	Rather good	Satisfactory	Rather poor	Poor	
Work out actively, strengthen my body	BR	29.5	22.4	10.8	4.4	4.8	13.5
	VO	34.1	13.1	5.7	4.8	4.3	12.3
Use household appliances for water purification, buy bottled water, use water from special sources	BR	21.2	24.6	23.9	17.5	13.0	21.7
	VO	25.3	34.3	30.2	27.5	20.3	29.3
Control my weight	BR	33.9	27.4	27.3	18.7	17.8	26.2
	VO	22.9	24.2	18.4	14.4	13.0	19.8
Do not smoke	BR	59.3	54.7	58.0	56.1	56.1	57.0
	VO	43.4	42.8	43.2	43.1	40.6	42.7
When possible, improve my health in a sanatorium, health resort, etc.	BR	14.6	15.9	13.7	12.6	8.8	13.7
	VO	8.8	9.0	10.6	15.0	13.0	10.3
Take saunas, steam baths	BR	31.7	37.6	31.1	22.4	18.6	30.4
	VO	32.9	38.7	32.5	23.4	15.9	32.3
Control alcohol drinking	BR	49.7	49.2	52.4	43.7	31.6	49.0
	VO	25.7	25.5	27.5	26.9	13.0	25.9
Try to walk more, take walks in recreation areas	BR	41.5	28.8	36.1	32.6	23.2	34.4
	VO	21.7	22.2	30.8	28.1	21.7	26.2
Try to control my mental state	BR	33.8	25.4	27.2	20.3	14.8	26.3
	VO	15.7	13.7	12.7	9.6	8.7	13.0
Try to optimally combine work and leisure activities	BR	32.8	29.4	29.1	26.2	23.1	28.9
	VO	20.9	16.2	20.6	20.4	5.8	18.7
Try to use my free time with the advantage to health, self-development, self-realization	BR	29.8	22.5	20.5	10.2	8.2	19.9
	VO	20.5	16.8	13.1	10.2	14.5	14.9
Do not undertake special efforts	BR	13.5	18.1	21.1	21.9	31.0	20.5
	VO	14.9	18.6	26.3	28.7	39.1	23.4

BR – Republic of Belarus; VO – Vologda Oblast

over the mental state are more frequently stated by the groups with the highest health self-assessments, and more seldom in groups with the lowest self-assessments.

The cross-country analysis revealed that the Belarusians are more inclined to lead a healthy life, in comparison with the Russians: for example, they much more often try not to smoke (57% vs. 42%), optimally combine work and leisure activities (29% vs. 19%), control their alcohol drinking (49% vs. 26%), as well as control their mental state (26% vs. 13%; tab. 3).

According to the authors, differences in the life expectancy of the main socio-demographic groups (men and women) can be explained by the substantial differences in attitudes towards health. Let us consider the prevalence of indicators characterizing the attitude to health, in the studied groups of men and women.

The results showed that Belarus and Russian women take greater health care than men: when answering the questions concerning nutrition, self-development and self-realization, organization of their free time, they more frequently stated controlled alcohol drinking, and less often – moderate smoking *(tab. 4)*.

In general, women take greater care of their health.

In both countries under review, men stated more frequently than women that they work out actively, strengthen their bodies, take steam baths, saunas. At the same time the share of smokers among men is 1.5 times higher; the percentage of men paying attention to nutrition is almost twice as low. The analysis of the table data shows that health behaviour provokes the risks of cardiovascular diseases, cancer, and diseases of the digestive system, i.e. the leading causes of mortality among working-age males, in men more frequently than in women.

According to the study, the feeling of well-being is the main motive for taking care of health for both men and women in Belarus and the Vologda Oblast *(tab. 5)*. Women are motivated by the desire to look good, to be liked by others.

In both countries, the share of women, by almost all the motives for health protection stated in the survey, exceeds the share of men, except by the answers 'Desire to achieve important goals in life' and 'Desire to have healthy offspring'.

Table 4. Health-saving activity of population, by gender (% of respondents)

What do you personally do to preserve and to improve your health?	Republic of Belarus			Vologda Oblast		
	Men	Women	Total population	Men	Women	Total population
Work out actively, strengthen my body	17.3	10.4	13.5	17.1	8.4	12.3
Control my weight	16.0	34.8	26.2	11.4	26.5	19.8
Do not smoke	45.3	66.9	57.0	33.5	50.1	42.7
Seek medical attention at the first signs of illness, regularly undergo full medical examination	20.6	29.4	25.4	12.6	22.2	17.9
When possible, improve my health in a sanatorium, health resort, etc.	12.8	14.4	13.7	7.4	12.7	10.3
Take saunas, steam baths	34.0	27.3	30.4	33.5	31.3	32.3
Control alcohol drinking	45.7	51.7	49.0	23.3	28.0	25.9
Try to walk more, take walks in recreation areas	29.0	38.9	34.4	20.5	30.8	26.2
Try to control my mental state	22.4	29.6	26.3	11.6	14.1	13.0
Try to optimally combine work and leisure activities	27.9	29.8	28.9	16.1	20.7	18.7
Try to use my free time with the advantage to health, self-development, self-realization	17.4	22.0	19.9	12.6	16.6	14.9
Do not undertake special efforts	23.9	17.6	20.5	30.2	18.0	23.4

Table 5. Motives for taking care of health, by gender (% of respondents)

What impels you to take care of your health?	Republic of Belarus			Vologda Oblast		
	Men	Women	Total population	Men	Women	Total population
Desire to have healthy offspring	23.1	20.5	21.7	22.7	19.6	21.0
Desire to enhance (maintain) working efficiency	28.7	25.5	27.0	22.0	22.2	22.1
Reluctance to give troubles, to be a burden on the relatives	33.1	40.1	36.9	20.8	30.5	26.2
Need to feel good	46.1	55.4	51.2	32.9	45.4	39.9
Fear of diseases	17.1	27.0	22.4	17.1	17.7	17.5
Set the example for my children, relatives	16.9	20.6	18.9	13.4	18.0	15.9
Desire to achieve important goals in life (at work, school)	13.9	9.3	11.4	13.1	9.6	11.1
Striving for longevity	17.6	21.2	19.5	21.2	24.0	22.7
Desire to look good, to be liked by others	23.8	40.9	33.1	19.7	29.5	25.1
Health deterioration, disease	16.2	21.3	19.0	13.2	14.9	14.1
Do not take care of my health	11.2	4.0	7.3	20.5	8.5	13.8

The intersex comparison of two countries shows that Belarus women are motivated by 'Need to feel good' (55% vs. 45%),'Desire to look good, to be liked by others' (41% vs. 30%), 'Reluctance to give troubles, to be a burden on the relatives' (40% vs. 31%).

The conducted analysis showed that the population of both countries in general has the same motives for health protection. At the same time for the Belarusians, contrary to Vologda residents, 'Reluctance to give troubles, to be a burden on the relatives', (37% vs. 26%), 'Need for good health' (51% vs. 40%), 'Desire to look good, to be liked by others' (33% vs. 25%) are more important. In turn, the share of those, who mentioned such motives as 'striving for longevity' (23% vs. 20%) among the population of the Vologda Oblast is by 4% higher, however the share of those, who are not motivated to take care of their health, is 2 times higher, as they 'do not take care of health' (14% vs. 7%).

Timely use of qualified medical care is known to be an important way of health preservation. According to the results of the survey, the population of the Vologda Oblast seeking medical attention at the early signs of the disease is divided the following way: 11.5% of the population seek medical advice always, 35% – not always, but in most cases. More than 40% of the oblast residents prefer self-treatment and consult a physician only when their state worsens significantly.

Proper health behaviour also comprises disease prevention, along with seeking qualified medical care, when being ill. Special attention was given to the aim of the respondents' visit to medical institutions in the year preceding the year of the survey. Based on the results, the groups with similar behaviour strategies with regard to health have been formed. It turned out that 17% of the oblast respondents go to a doctor for preventive purposes, 14% for periodic medical examination. One can assume that this group comprises active and relatively active citizens, taking care of their health themselves or with the assistance from the state and the employer. Mostly these are working age individuals, with good or satisfactory health assessment. Women go to a doctor for preventive purposes more frequently than men.

Another group is those, who maintain their health (46%), and consult a doctor, when they feel sick. It consists primarily of individuals,

self-assessing their health as poor (73% vs. 33% of those, assessing their health as good); persons belonging to the 20% of the well-to-do group (53% vs. 32% among 20% of the poorest); individuals over the working age (60% vs. 36% under the age of 30). The study showed that men seek qualified medical care, when being ill, less frequently than women (41% vs. 51%).

The third group includes passive residents of the region, neglecting their health. They either did not consult a doctor, opting for self-treatment (11%), do not recall the purpose of their visit to hospital (4% assumed not to undergo treatment at hospital), or did not go to a doctor, as they hadn't fallen ill (8%). The group mostly comprises young people. Self-medication is more typical for representatives of the 20% of the poorest (15% vs.10% among the 20% of the well-to-do group). The vast majority of those, who do not go to a doctor, assess their health as good (23% vs. 4% with poor health). Men do not visit a doctor twice more often, as they do not fall ill (10% vs. 6%).

Similar results were obtained in other studies: for example, according to REMEZ data, during the last three months about 20% of the population attended medical institutions or underwent medical examination. Well-to-do people are more active in that respect: Among the individuals visiting a doctor, 19% get income above the median, 14% are with income lower than the median.

The analysis of in-depth interviews, conducted in accordance with the EQ-5D methodology, confirms the quantitative data and allows determining the main characteristics of the individuals seeking medical help in health institutions, i.e. relatively high income level; serious health problems (health deterioration, exacerbation); high level of health care [6, 7].

Thus, the study showed that health-preserving behaviour and medical activity of the population of the two countries have similar characteristics (positions). In general, the health-saving activity of the population of Belarus and the Vologda Oblast can be characterized as insufficient: low prevalence of physical education and lack of preventive medical activity, high prevalence of smoking and alcohol drinking. The choice of the health-preserving behaviour strategy is mostly determined by gender characteristics. Health-saving activity is more characteristic of women, while men tend to choose risky behaviour. The conducted analysis shows that 'quite good' health and the preconditions for longevity are inherent in men, but they make little efforts to maintain it.

This fact is proved by high mortality rate from external causes among working age males. It largely determines the gender difference in life expectancy at birth. Another evidence is that the difference in life expectancy at the age of 65 between men and women is significantly lower than in life expectancy at birth (5-year difference, not 12; see tab. 1).

Many health preservation traditions, formed over the centuries, have been gradually lost due to global changes (urbanization, migration). The norms and values of self-preservation behaviour that are relevant to the modern lifestyle of both Belarus and Vologda Oblast residents, are only being formed and have not yet been sufficiently integrated in the culture of everyday life.

According to the authors, it is necessary to inform the population of the longevity factors, determining the lifestyle, including biological and social characteristics of people (gender, age, complexion, type of work, etc.). The scale and complexity of health-related problems associated with lifestyle go beyond medical knowledge and require the involvement of specialists of different scientific fields that are part of the study of human nature.

When elaborating measures and mechanisms concerning health-saving activity, due attention should be given to the issue of formation of health-saving culture among the population with regard to gender characteristics; that will promote the changes in the negative trends of public health and will serve as the basis for economic growth, strengthening of social stability and demographic security of the country and a separate region.

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Lifelong education in the context of innovation development of Russia and Belarus

The article presents the results of indicators analysis characterizing lifelong education in the context of transition to innovation-based development in Russia and Belarus. Problems of developing lifelong education and main directions of integrated educational space formation in both countries are defined.

Lifelong education, formal education, innovative development.

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Innovation development of the society is directly connected with the educational system. Scientists proved that in the first two decades after World War II the USA and several European countries managed to achieve significant rate of economic growth due to the high level of investments in education [Aghion et al., 2005]. As an example, the following countries called "Asian tigers" can be mentioned: Hong Kong, Taiwan, Korea and Singapore, where investments into elementary and vocational secondary education allowed increasing economic growth, which is called "miracle effect" [13, p. 3].

The role of education especially increases during the time of social and economic reforms. Such situation was observed in a post-war, quite unstable period, at the stage of market reforms, during the demise of the Soviet Union. In the last case, the countries that became independent due to the opening of borders (organization of international cooperation, activities of international funds in the educational sphere) met with the necessity of modernizing the whole educational system including education of adults. Organization of such changes was accompanied by development of new training methods and practices, enhancement of

opportunities for personal qualities development, introduction of practice-oriented approach to education, which makes it possible to respond to labour market changes flexibly.

However, despite the changes happened in the CIS countries and the obtained positive results, some problems, which are general for these countries (partly it is connected with unified historical roots and unified principles of educational systems formation) can be mentioned. In the first place the following problems can be marked: lack of system approach in implementing reforms, slow response of the "former motion path", and absence of modern technologies, which considerably hinder transition to new principles of education, appropriate to innovation challenges. In particular it concerns lifelong education, so called learning of life.

So, in Russia, for instance, system of lifelong education is not formed (only single elements of it are present), erratic accesses to education during the whole life, cost increase of educational services, reduction of economic returns from education with age (demotivating factor of investment in education) are observed.

The same situation is in Belarus – there is no unified educational system for adults. Besides, slow response of motion within the Soviet tradition (adaptation of the existing forms to new challenges, neglecting of world tendencies and needs of population), particular provisions of lifelong education are not codified. So, in the new Educational Code of Belarus, admitted in 2011, not only some notional aspects (the term "non-formal education of adults" is not codified), but also the legal and regulatory framework of activities of particular organizations, which along with public structures can provide educational services, are missing.

These and many other problems hinder participation of population in lifelong education that reduces opportunities for rise of professional level and in the long run for innovation reforms of territories.

All the problems mentioned above considerably actualize the necessity of studying indicators of lifelong education in the context of transition of post-Soviet countries (Belarus, Russia, etc.) to the innovation development.

One of the indicators characterizing innovation development of territories is the global innovation index. It comprises such blocks of indicators as institutes and politics, human capital, infrastructure, technological indicators, business environment, etc. The key sub-index of the global innovation index is the human capital, while calculating it the following indicators are taken into consideration: investments in education, quality of educational institutes, and innovation potential of population.

Analysis of integrated indicators and their components characterizes not only the opportunities of the country's economic growth, but the degree of educational system's development, opportunities for development of lifelong education and implementation of accumulated human capital.

Comparing the figures of global innovation index and sub-index "human capital", we revealed that the highest figures of the last one provide the highest positions of integrated indicator. All in all, it is noteworthy that in spite of the common historical past of the former CIS member-states, the level of their innovation development is different *(tab. 1)*. Higher figures among the countries under consideration are shown by Russia; however, even Russia is in the middle of the list of countries ranking in descending order of the global innovation index. Belarus is 27 positions down than Russia, Tajikistan – almost twofold.

Apart from integrated indicators, which allow estimating the general level of innovation development, particular indicators characterizing the level of innovation activity of organizations, the share of expenditure on research and development in the GDP structure, etc. are also used in investigations.

Their analysis completes "the general picture" and allows revealing obstacles for innovation development of territories more reasonably.

Activeness in the sphere of technological innovations is one of the key indicators of innovation activity determining potential of technological modernization. The level of innovation activity among the industrial and service sector organizations in Belarus exceed the figures in the RF (industrial enterprises – 23% in Belarus, 9% in the RF). But figures of both countries are considerably lower than utterly critical points – 40% [4] and the average level of the EU countries (52%), which gives evidence about limitation of development and competitiveness of their economic systems *(tab. 2)*. According to the level of innovation development, Russian economy considerably concedes not only leading industrial countries (Germany – 70%, Belgium – 60%), but also the majority of countries from the Central and Eastern Europe.

Resources provision of innovation development is characterized by expenditure volume on carrying out different kinds of innovation activity. Volume of expenses on R&D in Russia after 20 times downfall in the beginning of 1990s somehow rose and hardened at the level a little bit more than 1% of GDP. Such situation does not provide reproduction of scientific and technological potential of the country [4]. Besides, the Republic of Belarus concedes this indicator to Russia twofold. The share of expenditure on research and development activities in GDP of both countries considerably falls behind the utterly critical level (3% in GDP; *tab. 3*).

Russia and Belarus considerably fall behind not only leading European countries accor-ding to the amount of financing, but in the structure of their expenditure on technological innovations significant disproportions are observed *(tab. 4)*. In both countries half of assets allocated to technological innovations is spent on acquisition of machines and equipment, while

Table 1. Global innovation index*

Country	Global innovation index			Human capital**		
	2008	2010	2012 ***	2008	2010	2012
Russia	2.60 (54)	3.03 (64)	37.9 (51)	–	3.86 (46)	43.8 (43)
Ukraine	2.24 (75)	3.06 (61)	36.1 (63)	–	4.04 (36)	42.2 (48)
Armenia	2.07 (86)	2.84 (82)	34.5 (69)	–	2.98 (107)	32.5 (76)
Belarus	–	–	32.9 (78)	–	–	42.7 (45)
Kazakhstan	2.45 (61)	3.05 (63)	31.9 (83)	–	3.48 (66)	31.2 (85)
Tajikistan	1.95 (94)	2.59 (115)	26.4 (108)	–	2.90 (112)	29.1 (96)

* CIS countries, which have higher figure of integrated indicator as well as countries with a lower one, are presented.
** Human capital as the structural component of the global innovation index.
Source: Global innovation index(2007, 2008, 2010, 2012)
[Electronic source]. – Available at: http://www.globalinnovationindex.org/
*** Ranking by the global innovation index data in 2012. When calculating the scale from 0 to 100 points was used, not unit fractions as before.

Table 2. Level of innovation activity of organizations in 2011, %

Country	Ratio of organizations realizing technological innovations in the total number of industrial organizations	Ratio of organizations realizing technological innovations in the total number of service sector organizations
Russia	9.4	11.2
Belarus	22.7	12.1

Source: Science and innovation activity in the Republic of Belarus: statistical digest. Minsk: National statistical committee of the Republic of Belarus, 2012. P. 148.

Table 3. Internal expenditure on R&D, % in GDP

Country	2005	2011
Russia	1.07	1.16
Belarus	0.68	0.76

Source: Science and innovation activity in the Republic of Belarus: statistical digest. Minsk: National statistical committee of the Republic of Belarus, 2012. P. 139.

Table 4. The structure of expenditure on technological innovations of industrial organizations in 2011, %

Country	Total	Types of expenditure				
		Investigations and researches made by themselves	Investigations and researches made by external organizations	Acquisition of machines, equipment and software tools	Acquisition of new technologies	Sundry expenditures on technological innovations
Russia	100.0	16.3	10.9	52.5	1.5	18.7
Belarus	100.0	25.4	10.9	65.6	0.1	2.0

Source: Science and innovation activity in the Republic of Belarus: statistical digest. Minsk: National statistical committee of the Republic of Belarus, 2012. P. 139.

considerably less funding goes to the investment of investigations and researches directly.

However, it is noteworthy that significant changes in the structure of investing probably will not occur in the near future. The situation in Russia can be an example of this case, where this type of expenses was predominant during the last decade *(tab. 5)*. The same can give evidence to the fact that the leading strategy is "technological borrowing", not the "creation of innovations" by activation of investigations in the native country and by organization of cooperation with other countries in the innovation sphere[1].

In spite of all existing problems, modern economy of post-Soviet countries is characterized by the development of new types of activity and modernization of technologies. Due to this fact, the demands of employers to the quality of human capital are increasing (in particular to professional skills and innovation abilities of population), what considerably actualizes the necessity of organizing lifelong educational process. One of the main characteristics of human capital is the educational level of population, which can be evaluated only by the average number of cumulative years of study.

The results of analysis reveal that duration of training within the decade increased almost in all the countries under consideration. The largest duration of training was in Russia, the smallest one was in Tajikistan. Speaking about Belarus, in comparison with other European countries and former CIS states, there is no data about the number of cumulative years of study in the database "Educational Attainment for Total Population, 1950–2010".

Taking into account the fact that the key element of lifelong education is the formal education, let us dwell on the analysis of some of its indicators. One of the tendencies, characteristic both for Russia and Belarus is the rise in number of students in higher education institutions per 10 000 people during 2000 – 2011 (in Russia – 1.3 times, in Belarus – 1.7 times). However, according to the number of students of secondary education institutions of these countries, multidirectional trends are revealed: while in Belarus the rise was observed, in Russia there was a reduction of the figure *(tab. 7)*.

[1] According to the data of the National Research University Higher School of Economics, 34.3% of innovation companies in the country hold the strategy of "technological borrowings", 29.2% – "imitators on the national (local) level", 20.5% – "imitators on the international level", 8.6% – "innovators on the national (local) level", 7.4% – "innovators on the international level".

Table 5. Ratio of expenditure on certain kinds of innovation activity in the whole volume of expenditures on technological innovations in Russia, %

Figures	2000	2005	2010	2011
Investigations and researches	14.3	15.7	20.6	14.9
Acquisition of machines and equipment	57.4	60.3	54.5	60.9
Acquisition of new technologies	7.7	1.4	1.3	0.7
Acquisition of patent rights and patent licenses	1.8	0.8	0.5	0.2
Acquisition of software tools	2.1	2.1	1.2	0.9
Training and preparation of personnel	1.3	0.4	0.2	0.4
Marketing investigations	1.6	0.6	0.6	0.3

Source: Indicators of innovation activity: 2013: statistical digest. Moscow: NRU HSE, 2013. P. 43.

Table 6. Number of cumulative years of study*

Country	Population 15 years and older			Population 25 years and older		
	2000	2005	2010**	2000	2005	2010
Russia	11.1	11.3	11.5	11.3	11.6	11.7
Ukraine	10.4	10.9	11.1	10.7	11.1	11.3
Armenia	10.4	10.4	10.4	10.8	10.8	10.8
Kazakhstan	9.9	10.1	10.4	9.9	10.2	10.4
Tajikistan	9.5	9.3	9.3	9.9	10.0	9.8

* Data on the Republic of Belarus is missing in the database "Educational Attainment for Total Population, 1950–2010".
** Ranking of the data, 2010
Sources: Barro R., Lee J.W. Educational Attainment for Total Population, 1950–2010. Available at: http://www.barrolee.com/; Barro R., Lee J.W. A new data set of educational attainment in the world, 1950–2010: working paper No. 15902. Cambridge, 2010. P. 32.

Table 7. Number of students of secondary and higher educational institutions in Russia and Belarus per 10 000 people at the beginning of school year

Territory	2000/01	2005/06	2009/10	2010/11	2011/12
Number of students of secondary educational institutions in Russia and Belarus per 10 000 people at the beginning of school year					
Russia	158	173	144	142	139
Belarus	145	144	153	154	153
Number of students of higher educational institutions in Russia and Belarus per 10 000 people at the beginning of school year					
Russia	292	416	430	409	381
Belarus	246	337	392	404	409

Source: Belarus and Russia. 2012.: statistical digest. Rosstat; Belstat; Permanent Committee of the Union State. Moscow: Rosstat, 2012. P. 61.

Although, there is a significant demand in higher education among people, some researchers [5] forecast changing of the tendency in future. One of the reasons for such situation, reduction of benefit from higher education due to transition of holders of higher education institution's diplomas to semi-skilled work places and increase of unemployment among this group of people according to inconsistence of demand on labour force and its supply can be named [5]. That is why it can be supposed that secondary education would be more requested in comparison with higher education.

Postgraduate study is also requested among people except for higher education. Acceptance of education can not only contribute to professional level growth, but create opportunities for accumulation of innovation potential of population. However, in spite of population's readiness to study in postgraduate school, it should be marked that the ratio of those

who graduated from it including those who defended their dissertations remains rather low. In Russia only one third of those who graduated from postgraduate school defend their dissertations, in Belarus their number is even less *(tab. 8)*.

Among Russian and Belorussian postgraduate students (more than 60% of population in both countries) the most requested branches of science are technical fields. However, in Russia the ratio of postgraduate students in this direction decreases, while in Belarus, in contrast, increases *(tab. 9)*.

Comparing structures of researchers according to branches of science, considerable differences in Russia and Belarus are not revealed. However, in Belarus due to the fact that in the technical branch the number of employed researchers is almost 10% less than in Russia, more requested branches are social sciences and humanities.

The key indicator, characterizing involvement in educational process of population, is the share of participants in programmes of formal and non-formal education. According to the data of the Organization for Economic Cooperation and Development, in 2011 40% of adults on average in its member-states took part in such programmes, 27% looked for information about different educational programmes [12].

Cross-country analysis of involvement of population into the system of lifelong education revealed the leading countries (Austria, Slovenia, Luxemburg, Denmark, Finland, Sweden), where 70 – 80% of population get education during whole life; countries taking intermediate place (France, Ireland, Italy, Latvia, Portugal, Belgium, Germany), where the level of population's involvement into lifelong education is comparable to the average one among the OECD member-states; countries with low level of population's participation in lifelong education.

The last group comprises Estonia, Lithuania and some CIS-countries including Russia, where almost one third of population takes part in lifelong education. In Belarus the level of

Table 8. Main figures of postgraduate school activities

Figures	2000		2005		2011	
	Russia	Belarus	Russia	Belarus	Russia	Belarus
The share of postgraduate students graduated from postgraduate school, in the total number of postgraduate students, %	21.1	19.4	23.5	25.7	21.2	19.0
The share of postgraduate students graduated from postgraduate school and defended their dissertations, in the total number of postgraduate students, %	6.4	1.4	7.5	1.5	6.2	0.9
Source: Belarus and Russia. 2012: statistical digest. Rosstat; Belstat; Permanent Committee of the Union State. Moscow: Rosstat, 2012. P. 61.						

Table 9. Structure of researchers according to the branches of science in Russia and Belarus

Country	Year	Branches of Science					
		Natural sciences	Technical sciences	Medical sciences	Agricultural sciences	Social sciences	Humanities
Russia	2000	23.4	64.6	3.6	3.4	3.1	1.9
	2011	24.0	60.4	4.5	3.5	4.5	3.1
Belarus	2000	23.8	54.4	6.3	5.7	7.0	2.8
	2011	18.3	61.3	5.3	6.0	6.8	2.3
Source: Belarus and Russia. 2012: statistical digest. Rosstat; Belstat; Permanent Committee of the Union State. Moscow: Rosstat, 2012. P. 137.							

population's participation in lifelong education is comparable to the level in Romania and Hungary, moreover, during 2000 – 2010 a certain reduction of the figure was observed (from 13% to 10%). Low level of population's participation in lifelong education and in professional improvement can be considered as one of the indicators impeding innovation transformations.

According to the experts from the Institute of Contemporary Development, the transition to innovation economy will be connected not only with modernization of national economies of countries under consideration, but partly with integration processes. The reason for this lies in common history and problems in the sphere of education. Therefore, using deeper forms of cooperation is more efficient, which will suppose agreement of national priorities in the sphere of science and technology, creation of institutional and financial mechanisms in the form of international funds for researches and innovation projects support on a multilateral basis [3, p. 35-37].

Strategy of the CIS economic growth for the period until 2020 supposes the formation of intergovernmental innovation space on the basis of national innovation system, which contributes to the promotion of research, development and innovation. Considerable part of this process will be allocated to education. Among the main directions of cooperation in the educational sphere of allied states the following directions can be mentioned: improvement of content, forms and methods of education on all the stages of education process, development of agreed parameters for monitoring the quality of education, "harmonization of educational programmes (it will make it possible to simplify the procedure of mutual recognition of documents on education)", joint preparation, organization of on-the-job training and professional development of personnel, implementation of joint research activities, implementation of mutual examination of research, scientific-methodological and teaching works and regulatory documents in the sphere of education [9].

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