
**CHALLENGES AND POLICY OF SPATIAL DEVELOPMENT
OF POST-SOVIET RUSSIA**

Russia in the Global Natural and Ecological Space¹

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Abstract—The evolution of the role of natural-geographical factors in the spatial organization of society is considered. It is shown that despite the high growth rates of the service sector, the distribution of mineral, water, and forest resources, as well as climatic conditions, remain the key factors in Russia’s spatial development. A brief geoecological description of Russia’s natural resource complex in the global context is presented. On the basis of intercountry comparisons for a wide range of parameters, it is shown that Russia is one of the most environmentally friendly countries in the world. Of planetary and ecological significance are: Russian forests (45% of Russia’s territory), waterlogged lands and swamps (22% of the territory), and the largest array of practically undeveloped lands (almost two-thirds of the territory). Therefore, Russia’s territory acts as a compensatory area for global pollution and natural disturbances in general, and an ecological donor of many national ecosystems. Russia stands out against the world background by the concentration of sources of potential risk and high environmental capacity. However, in general, the contribution of the Russian economy to the global transformation of the natural environment does not exceed the country’s share in Earth’s territorial resources, the population, and the global economy. The features of Russia’s ecological and geographical position are revealed: its location with respect to foreign sources of environmental hazard. In environmental terms, Russia suffers more from neighboring countries than they from it. Due to the western transfer of air masses, atmospheric pollution enters Russia’s territory from all over Europe; their main “exporters” are Ukraine, Poland, and Germany. The centers of concentration of external threats to Russia’s environmental security have been identified: the area of the Chernobyl nuclear power plant, the Seversky Donets River basin, the Kazakh Irtysh River region, and the Chinese Amur River region. The leading role of natural resources in the country’s economy determines the priority in domestic Earth sciences, including geography and geoecology.

Keywords: natural-geographical factors, natural resource complex, geoecological characteristics, spatial and ecological potential, intercountry comparisons, external threats to environmental security, Russia

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EVOLUTION OF THE ROLE OF NATURAL- GEOGRAPHICAL FACTORS IN THE SPATIAL ORGANIZATION OF SOCIETY

Natural resource factors play a crucial role in the spatial development of any state. Their dominant importance is clearly visible throughout human history. Since his inception, man has inhabited the most favorable natural conditions of the territory (among available), although with the development of mankind, the criteria for favorableness have changed significantly.

In ancient times, these criteria were related to the climate and biological productivity of the territory from the hunter-gatherer standpoint. After the Neolithic revolution, with the advent of agriculture and animal husbandry, the main feature was the natural productivity of the territory for agricultural production, a derivative of climatic characteristics. The development of hydromelioration technologies—regulation of river flow via construction of reservoirs and delivery of water to agricultural fields during dry periods—has again changed the focus: the importance of water resources has increased tremendously. The invention of metallurgy determined the need to develop territories near ore deposits and fuel resources, which were originally represented only by firewood, but over time were replaced by coal.

In the future, all the noted natural resource factors played an important role in spatial development,

¹ The article was written in 2020 based on the results of research carried out in 2009–2019 (see Glezer, O.B., Shvetsov, A.N., and Kotlyakov, V.M., *Reg. Res. Russ.*, 2023, vol. 13, no. 1, pp. 1–5) and does not reflect the impact on the subject matter considered therein from the latest events stemming from two global crises that erupted suddenly: the COVID-19 pandemic and aggravation of the military–political situation with Ukraine in 2022.

during which two opposite trends emerged. On the one hand, economic growth and technological development, particularly after the industrial revolution, demanded more and more natural resources, and their diversity constantly expanded; on the other hand, the development of transport made it possible, instead of bringing people closer to resources, to organize the delivery of resources to people's places of residence, very significantly restraining migration of the population to discoverable deposits.

The "third economic revolution" was informational; if considered in a spatial aspect, it also has two trends, but unidirectional (in terms of location of the economy and territorial distribution of the population). First, the tendencies towards greening production and resource conservation characteristic of this stage reduce the specific (per unit output) needs for natural resources (this has become an additional factor in the relative restraint of population growth in regions with raw materials). Second, the leap in information technology and communications has made it possible for the majority of those employed in the production of information to set up a workplace at their place of residence (in their house or apartment). Owing to this, the importance of a territory's climatic advantages again increased and the very significant role of its ecological quality in the choice of place of residence was determined (both of these features strongly correlate with the forest cover of the territory).

The growing shortage of fresh water, which proved a low-transportable product given the current scale of its agricultural and industrial use, can have a very significant impact on the long-term spatial development of the global economy.

Whereas industrial development in all countries that underwent the industrial revolution was marked by a decrease in the share of agriculture in GDP in favor of industry, postindustrial development is characterized by a decrease in the share of industry and agriculture in favor of the service sector. This means a decrease in the share in GDP of the primary economy sector—nature-exploiting industries: mining, agriculture, water, forestry, and fishery. However, no matter how much this share is reduced, the volume of activity in this sector, both in physical and monetary terms, is and will not decrease, at least as long as population growth continues. Moreover, population size determines a certain lower limit of the production volume in the primary sector and, in principle, it is possible to give at least rough estimates of this value (also taking into account population distribution by climatic zones). The population size also limits the volume of production in the industrial sector from below, but, although the existence of such a limit is theoretically obvious, even very rough estimates of it are hardly possible: the influence on this sector by factors determined not by population size, but by the level of its

development, ideology, culture, ethnic traditions, etc., is too strong.

The service sector is very heterogeneous in composition, and for analysis, it is necessary to structure it at least in the simplest form (Danilov-Danilyan, 2009). Services related to the material side of human life, health care, education, functioning of material production sectors, and production of business information will be attributed to the material segment of the service sector. In addition to this segment, the financial and leisure industries also remain in the service sector. The last segment will be called the entertainment segment; it is represented by all types of activities aimed at satisfying people's leisure needs, i.e. the entertainment industry in a broad sense, including not only cinema, television, radio, audio and video recordings, printed entertainment materials, and concert activities, but also tourism, all commercial sports, all kinds of Disney-related territories, fitness clubs, casinos, etc. If such services, if not entirely, but at least in their predominant part, met the minimum quality requirements, first of all, in regards to taste, would contribute to a person's harmonious development and yield real investment in human capital (in addition to education systems, health care, etc.), then we could speak about services aimed at satisfying spiritual needs. The reality is that we have to talk about the ostensible satisfaction of spiritual needs and satisfaction of professed spiritual needs; the same applies to physical development, which is hindered more than helped by commercial sports (by "freezing" people in front of their televisions).

The financial and entertainment segments of the service sector cast on the market produced or "launched" (in particular, in the case of financial derivatives) entities, a significant (possibly dominant) part of which is not intended either to satisfy the normal needs of a person, his spiritual and physical development, or management of economic processes that solve precisely these problems. On the contrary, their social role is purely negative, while at the same time they largely determine the instability of the modern economy. The same applies to the demonstration consumption of secondary sector products, etc.

Since the late 1960s, the financial and entertainment segments of the service sector proved to be the fastest growing in the US economy. They have become the locomotive of the American economy, stimulating the production of all types of products necessary for their release and launch. Other developed countries, lagging far behind the leader of the Western world, were drawn into the competition for the growth rate of these segments. It seems that the financial and entertainment segments are not accidentally found side by side. First of all, these segments have relatively recently reached significant economic positions. In addition to the fastest growth in comparison with other structural units of the economy of developed

countries (and, in many cases, developing ones), they also have other features.

Having provided the majority of its population with a high level of well-being, the developed market economy has done nothing to elevate man. On the contrary, brainwashing through advertising and other PR technologies proved beneficial in simplifying spiritual needs, reducing culture to a subculture. A 100000 seat stadium yields incomparably more income than a philharmonic hall (most symphony orchestras do not pay off at all, they exist only thanks to sponsorship), and if you build a variety stage on the football field and make the same 100000 people clap their hands to the most primitive rhythm beaten by pop group, income can be further increased. Westernization turned out to be predominantly Americanization; its main sociocultural result is the destruction of national cultural traditions and subcultural zombification of people, the number of which is measured in millions, and its economic result is the creation of a colossal leisure industry.

The volume of production in the material segment of the service sector depends on the population (in terms of services provided directly to people) and the volume of production in the primary and secondary sectors (in terms of services provided to production). Obviously, part of the products of the financial segment plays a positive role in production management processes, being an integral part of the market system. However, the other part of this segment, serving the worst in the entertainment segment, generating frankly speculative processes in the financial sector, ensuring the “self-growth” of capital from scratch, ultimately contributes to the instability of the global financial and economic system. Lastly, the entertainment segment of the service sector seems to be the focus of surplus production of the modern economy, the volume of production in it is most dependent on ideological and social factors, and the lower limit of this volume seems close to zero—in comparison to its current value, which primarily testifies to the sickness of our civilization.

Thus, the sector of the primary economy to the greatest extent depends on the most inertial parameter of human development: the population; the physical volume of production in this sector depends as strictly as possible (in comparison with other sectors) on this parameter, and the possibilities for choosing a territorial structure are determined by the distribution of natural resources and, if their global reserves are not strictly limited, by economic factors, taking into account political risks and other circumstances. Thus, no matter what volumes and growth rates are observed in the service sector (and in developed countries, its share in GDP everywhere exceeded 65%), no matter what the share of the primary economy in the GDP (in the United States, it is about 3%), the distribution of

Table 1. Russian position in world mineral resource complex, early 2000s, % of world

Type of mineral resources	Reserves	Mining
Oil	9.7	14.2
Gas	30.4	19.8
Coal	15.6	4.5
Uranium	5.5	7.0
Iron	28.0	8.0
Copper	3.5	4.9
Nickel	11.8	24.5
Gold	8.0	5.0
Silver	10.0	2.3
Platinum	12.5	15.9
Palladium	31.4	44.3
Diamonds	30.0	24.0

Compiled from: Federal State Statistics Service, http://www.gks.ru/bgd/regl/b12_39/Main.htm. Accessed July 3, 2019; (Kuzyk, 2006).

water, forest, and mineral resources, as well as climatic conditions, remain key factors in spatial development.

These factors are all the more significant for Russia’s spatial development, which currently has an industrial-raw material economy and, it seems, in the future, the primary and industrial sectors will retain a significant role in the country’s economy.

RUSSIA IN THE GLOBAL NATURAL RESOURCE SPACE

Natural resources, for which Russia’s territory has long been renowned, still ensure Russia’s survival and even development (albeit a very unstable development) in the permanent crisis conditions of recent decades. The export of mineral raw materials alone is responsible for 65–70% of the country’s foreign exchange earnings (40–54% in the USSR in the 1980s (Arbatov, 2005)) and at least half of federal budget revenues.

The high demand on the global market for Russian natural resources determines both Russia’s place as a resource-providing zone of the planet, and the paramount (strategic) importance of the natural resource complex in the country’s economy, and the priority of Earth sciences in the Russian scientific sphere, including geography and geocology.

Russia is one of the few countries that are practically “self-sufficient” in terms of natural resources, which creates all the natural prerequisites for its “sustainable development.” In Russia’s vast territory, mineral resources of global importance are concentrated (Table 1), more than 50% of the world’s chernozems, nearly 25% of its forests, 10% of its river runoff, and more than a 25% of its freshwater lake reserves.

Comparing the values of natural capital and the national wealth of Russia, V.M. Simchera (1998) notes that there is no other country in the world where the gap between the value of natural resources and of accumulated property would be so large. That is, Russia still has many resources not involved in economic turnover, which have not yet been embodied a particular property. Thus, the ratio of timber harvesting to its reserves in the world as a whole is 2%, and in Russia, 0.4%.² During the years of restructuring, crises, and reforms, the role of extraction of fuel and energy resources in the country's economy has noticeably increased. However, during this time, Russia has significantly reduced its share in world production. For 1990–2017, Russia's share in global coal production decreased from 8.5 to 5.7%; oil, from 17.1 to 12.6%; and natural gas, from 31 to 19%. And Russian extraction of peat and oil shale has declined many times over.

The study of natural resources. Despite the large-scale exploration of mineral deposits in the Soviet years (based on the funds allocated for these purposes, the Soviet exploration program can be compared with nuclear and space exploration), no more than 40% of Russian territory has been studied geologically to an extent meeting modern-day requirements (Dumnov and Boriskin, 2010). The degree of subsoil exploration varies greatly across the territory: from 50–60% in the Urals to 1.2–8.4% in Eastern Siberia, the Far East, and the shelves of adjacent seas (except for Sakhalin) (Sever ..., 2005). According to the Russian Ministry of Natural Resources, the average level of exploration of the Russian shelf is 0.24 m/km². This is eight times less than the level of exploration of the American shelf of the Chukchi Sea and 16 times less than the Norwegian shelf of the North Sea.

In the post-Soviet years, the rate of devastation of Russian subsoil has outstripped the growth of its reserves. For 2000–2005, the increase in explored reserves to production is as followed (in %): uranium, 56.3; coal, 82.9; iron, 12.7; copper, 30; nickel, 20.8; gold, 54.1 (Bavlov, 2006). E.A. Kozlovskii (2007) notes that the mineral resource base of most minerals has declined over the past 15 years, despite a decrease in production volumes (in %): tin, 90; tungsten, 80; lead, 60. Deep exploration drilling in the country decreased from 5 299 000 m in 1990 to 1 155 000 m in 2017.³ The pace of development of deposits leads the pace of geological exploration. In addition, much exploration work in the country is done by foreign oil-field services companies. This poses a threat to national security. In conditions of aggravated international relations, projects for development of the shelf and hard-to-recover oil and gas reserves are particu-

larly vulnerable, since almost all of the work is carried out by or in cooperation with foreign companies.

In post-reform Russia, not only the Earth's interior, but also other natural components and complexes are deprived of researchers' attention. According to Rosreestr, the cost of cartographic service in the country is USD 7 km⁻² year⁻¹ (in the United States, 116; France, 28; Great Britain, 615; Switzerland, 1439).⁴ According to the results of an audit by the Accounts Chamber, the Federal Property Management Agency does not have reliable information on how much land is federally owned. Data on the total area of state land plots contained in different sections of the departmental GIS diverged by almost 200 mln ha (1.08 bln ha in one version and 1.27 bln ha in another).⁵

During the 1990s, meteorological and natural resource satellite constellations were completely lost; they were restored starting only in 2009. The number of hydrological posts decreased from 4481 in 1986 to 3084 in 2006, and observation points for pollution of land surface waters, from 3295 to 1815 (Vodnye ..., 2008, pp. 112, 178). The number of observation points for the marine environment has decreased by 30% (Bedritskii, 2004). For 1991–2016, the number of air pollution monitoring stations in cities decreased from 821 to 678, and the number of monitored cities, from 337 to 243.⁶ In the Far North, Siberia and the Far East, the share of reduced observation points for the natural environment is much larger. Thus, measurements of water discharges in the entire cross-border section along the Argun, Amur, and Ussuri rivers to Khabarovsk (extremely important in terms of hydroecology) have not been carried out since the late 1960s (Bolgov et al., 2015). The programs for observing water, air, and soils have also been drastically reduced. Russia's soil service has practically collapsed (Dobrovolskii and Zaidel'man, 2004). The level of forest management studies is absolutely insufficient. According to A.S. Isaev, today only 19% of the country's forests have updated information; over 95% of monitoring data for forest and other terrestrial ecosystems was obtained (including purchased) from foreign satellites.⁷ Geobotanical land surveys are very rarely carried out.

There are still no official statistical cost data on such natural wealth indicators as surface water, subsoil resources, and natural biological resources, which Rosstat includes in the list of tangible economic assets.

The introduction of the All-Russian Classification of Types of Economic Activities (OKVED) into the

⁴ *Kommersant*, February 13, 2012.

⁵ *Kommersant*, June 18, 2019.

⁶ State Report On the State and Protection of the Environment of the Russian Federation in 2016, Moscow: Ministry of Natural Resources of Russia; NIA-Priroda, 2017.

⁷ Subbotin, A., Through the eyes of others, *Poisk*, no. 18, May 2, 2014.

² www.faostat.fao.org/.

³ Russian Statistical Yearbook 2018, Federal State Statistics Service. http://www.gks.ru/bgd/regl/b18_13/Main.htm. Accessed July 3, 2019.

natural resource sector since 2005, which, according to Rosstat, meets international standards, cannot be considered completely successful. In the OKVED, according to the level of classification significance, “geological exploration, geophysical and geochemical works in field subsoil studies” (code 74.20.2) are on par with “frog and earthworm breeding” (code 01.25.8). Obviously, in this “innovative” classification scheme, the place of natural resources does not reflect their real significance in the Russian economy. A.D. Dumnov and D.A. Boriskin (2007) rightly question the expediency of breaking domestic accounting and statistical realities and their adjustment to foreign schemes (despite the fact that these schemes are also seriously criticized abroad).

Its territory is one of Russia’s most important resources. Geography proceeds from the acknowledgement of the inherent value of the territory, regardless of its how full it is of minerals, forests, and other natural resources. There are no bad, “unprofitable” places on Earth; there is only their incorrect use due to incorrect assessment. For example, an area poor in mineral resources can have extremely valuable biological diversity, recreational resources, out-of-the-way areas with pristine nature, clean water, and air; it may be an effective transit territory, a geopolitical buffer, and lastly, a spatial reserve for the future, etc. The territory is the most important element of the historical, cultural, and natural heritage, as well as a field for economic, political, military, and environmental maneuvers.

Since the concept of economic strategy was organically alien to all post-Soviet governments, their obscure regional policy led to a further strengthening of the historically established powerful regional asymmetry, the hypertrophy of the two capitals and a few other growth poles with the exposure of vast territories, to the desolation and even savagery of the periphery.

Unfortunately, even in the domestic geographical literature, there is still a nihilistic attitude towards the territory. It is declared superfluous, positive processes are acknowledged that “expose” the territories, destroy the infrastructure that has been with great difficulty created on them, putting the millions of people forced to leave habitable lands in a catastrophic situation (Kotlyakov and Tishkov, 2011).

A rational regional policy should also maintain a decent standard of living in places that seem unpromising today. Otherwise, their further desolation, mass exodus of the population, degradation of human potential with the loss of a huge development resource—millions of talented people—are inevitable. Abandoned places, wild landscapes are also a provocation for geopolitical competitors. And the reinvolvement of these lands into economic circulation will require costs comparable to those of the initial development of the territory. Respect for the territory

reflects the rationalism of the distant goal, which takes into account long-term consequences, care for descendants, and environmental factors.⁸

If the wealth of the territory and other natural resources contribute to Russia’s sustainable development, then the unfavorable physical, economic, as well as ecological and geographical, positions (Klyuev, 1995) make it difficult. The vast northern territory, by no means with a compact configuration, deprived of access to open and nonfreezing seas, requires many energy resources to overcome cold and distance. However, with a competent territorial policy, the “burden of space and the burden of nature” (so the Russian philosopher I.A. Il’in (1883–1954) defined the Russian territory) are weakened, and the economic and geographical position is improving. Thus, the shortest way from Europe to rapidly growing China and other countries of East Asia lies through Russian territory. Even more than 100 years ago, when the Trans-Siberian Railway was being built, maritime shipowners from England and the United States were in a panic, fearing a formidable competitor in the face of Russian railways. However, our low-speed railways (the speed of which is five times lower than in the United States) are still losing to maritime transport (Problemnye ..., 2002, p. 59). Meanwhile, modern technologies and methods of organizing transportation make it possible to make them fast and reliable. The current decrease in the ice coverage of the Arctic seas opens up favorable prospects for year-round navigation along the Northern Sea Route. The transfer to Russia of the main Eurasian transport artery will significantly increase the efficient use of Russian territory.

Russia has a powerful electric and oil and gas system: a dense network of power lines, main gas pipelines (over 170 000 km), oil and product pipelines (over 70 000 km). In the future, on this basis, a single integral Eurasian infrastructure can be created, uniting transport, telecommunications and energy networks, the center of which will be Russia. This will make it possible to receive income from transit, enhance the geopolitical significance of the country—its ability to influence the course of global processes.

RUSSIA IN THE GLOBAL ENVIRONMENTAL SPACE

Russia’s Ecological Image in a Global Context

In addition to colossal natural resources, Russia also possesses spatial—ecological potential, which is understood as natural mechanisms of self-purification of the environment from pollution, synthesis and breakdown of organic matter, and maintenance of the

⁸ Business pursues a short-term goal—enrichment; politicians are also more concerned about the current situation. In the religious realm, the rationalism of the long-term goal—the idea of salvation—has been around for millennia.

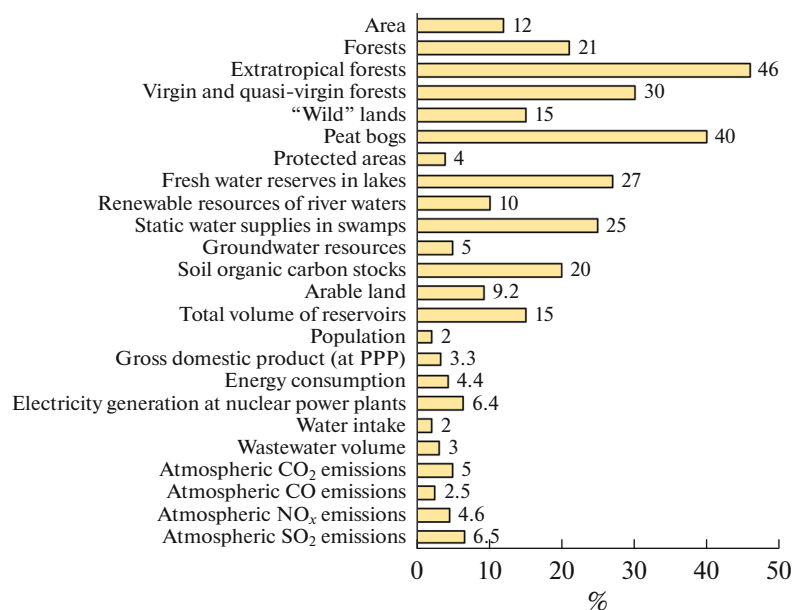


Fig. 1. Russia's ecologically significant characteristics, 2000s, % of world.

global biogeochemical cycle. These mechanisms ensure the purity of air, water, soil, and biodiversity, the importance of which in the system of vital values of society is constantly growing.

Estimates are well known, according to which the areas of acute environmental situations on Russian territory occupy an area of 2.5 mln km², or 15% of the entire territory, which corresponds to 4.5 the area of France (Kotlyakov et al., 1990). Without questioning these figures, note that here and in other sources using these estimates (and they are included in the state reports On the State and Protection of the Natural Environment of the Russian Federation, and in school and university textbooks), the relativity of the applied acuity rating scales is not mentioned. This scale is purely Russian and is not suitable for international comparisons.

This section considers the question of what the role of Russia's territory is in the biosphere and its contribution to the degradation of the planet's natural environment? Hence follows the measure of the country's responsibility and its position in international relations.

The nature and degree of sustainability of landscapes in Russia to anthropogenic impacts are primarily determined by climatic factors. The predominance of low temperatures determines the low rate of natural degradation of pollutants in air, water, and soil; 60% of the territory is occupied by particularly vulnerable natural complexes of the perennial permafrost zone. About half of Russia's territory consists of mountainous geosystems weakly tolerant to a wide range of economic impacts; 20% of Russia's territory belongs to seismically active regions (including 5% of the terri-

tory is subject to extremely dangerous 8–10 magnitude earthquakes), and 18% is occupied by avalanche-prone areas. Natural disasters can initiate environmental disasters and increase the severity of their consequences. Both permafrost and mountains are located in the very poorly developed East. These vulnerable landscapes are practically undisturbed by economic activity. However, in increasing the “Russian power by Siberia and the Arctic” (the Russian scientist M.V. Lomonosov in the 18th century called upon to) it is necessary to exercise great caution.

The environmentally significant characteristics of Russia are reflected in Fig. 1. Russia's ecological role in the planetary geosystem is largely determined by the size of its territory, which occupies 12% of the Earth's dry land. Russian forests are of planetary importance. In productivity, they are four times inferior to the Amazon rainforests. However, plants of temperate latitudes use 30–40% of the oxygen they emit for respiration, while tropical forests use 80–90%. As G.A. Zavarzin notes, “the idea that tropical forests serve as the ‘lungs of the planet’ has long been forgotten. This role is increasingly assigned to forests of the boreal belt with their slow and seasonally suppressed destruction” (Krugovorot ..., 1999, p. 13). In Russia, 60% of annual river runoff is meltwater, which is the most valuable part of the world's water resources (Alekseev, 2012), since the Earth's cryosphere is its most effective “dry cleaner,” where cryogenic self-purification of water occurs.

Of great ecological importance is the wide distribution of waterlogged lands and swamps in Russia (40% of the world's peat bogs), which act as geochemical barriers, or pollutant traps. The functioning strategy of

Table 2. Biodiversity in G8 ecologically dominant countries

Country	Share of plant species, % of world	Number of endangered plant species, units	Share of endangered plant species, % of number of species in country	Number of endangered animal species, units
Russia	9	127	0.56	59
United States	8	1845	9.22	281
Japan	2	704	14.08	79
Germany	1	16	0.64	11
China	12	343	1.14	153
India	6	1256	8.37	137
Indonesia	8	281	1.41	242
Brazil	22	483	0.88	167

Compiled from: State of the World, 1997, New York, 1997.

the Russian tundra and northern taiga and marsh ecosystems is aimed at removing and accumulating adsorbed pollutants from the biological cycle. With a somewhat inhibited biological cycle, the removal and transformation of pollutants proceeds slowly (Tishkov, 2005). Many researchers consider the largest array of virtually undeveloped “wild” lands concentrated in Russia as a strategic reserve of the biosphere.

A large number of biological species are concentrated in Russia. Among the “eight ecologically dominant countries,” which largely determine the ecological future of the planet, Russia is distinguished by relatively high biological diversity and degree of its conservation (Table 2).

The “material” component of the ecological situation is characterized by the amount of matter removed from nature and the volume of industrial waste. The correlation of these parameters with the scale of industrial production is reflected in Fig. 2.⁹ According to these parameters, the undisputed leaders are China and the United States. To a decisive extent, these countries form the ecological and industrial situation on the planet. Russia occupies a very modest place on this background.

From the relation of blocs, one can judge the degree of environmental friendliness, which is determined by the relative size of the production cylinder, its relationship with the amount of production and waste. The most environmentally friendly pyramids are typical of Japan, France, and Great Britain. The Russian pyramid is distinguished against the world background by its high specific natural consumption and significant “waste-producing flux.” Russian industry consumes significantly more natural resources per unit of output and generates more industrial waste than the economies of developed countries.

⁹ In the article, the borders of Russia are considered in accordance with the Constitution of the Russian Federation adopted by popular vote on December 12, 1993, with amendments approved during the All-Russian vote on July 1, 2020.

Without eliminating these defects, it is difficult for Russia to count on playing the role of an environmental leader on the planet.

At the same time, however, it should be taken into account that the relative environmental friendliness of the planet’s economic vanguard is largely based on the import of natural resources and the assimilation potential of the natural environment, in particular, from Russia.

Although the share Russia’s in the world production of certain types of industrial waste is 2–4 times higher than its share in the world’s population, it is comparable to the share of the Russian territory. Therefore, the role Russia’s in the global transformation of the environment is generally adequate to the size of the territory occupied by the country.

In terms of emissions of pollutants into the atmosphere currently, China leads the world, and among the highly developed countries, the United States stands out in terms of absolute and per capita emissions. Russia’s “gross” indicators for SO₂, NO_x, and CO₂ are several times lower than America’s. The emission parameters of European countries are lower than Russian ones, but per capita they are generally comparable (Klyuev, 2017). It is important to mention that Russia is located in a much harsher climate than the

Table 3. CO₂ balance in Russia, annual average, 1996–2002, mln t

Primary production of photosynthesis (runoff)	4730
Emission (sources), including:	3564
soil microbial respiration	2782
decomposition of debris	213
technogenic emissions and other sources	569
Balance	+1166

Source: Carbon Pools and Fluxes in Russia’s Terrestrial Ecosystems, Moscow: Nauka, 2007, p. 284.

Table 4. The largest water resources' consumers, 2000

Water consumption, total			Industrial water consumption			Agricultural water consumption		
Place in the world	Country	km ³	Place in the world	Country	km ³	Place in the world	Country	km ³
1	India	646	1	United States	220	1	India	555
2	China	630	2	China	164	2	China	429
3	United States	479	3	Russia	48	3	United States	197
4	Pakistan	169	4	India	32	4	Pakistan	163
5	Japan	88	5	Germany	32	5	Thailand	83
6	Thailand	87	6	Canada	32	6	Bangladesh	76
7	Indonesia	83	7	France	30	7	Indonesia	75
8	Bangladesh	79	8	Vietnam	17	8	Iran	66
9	Mexico	78	9	Italy	16	9	Mexico	60
10	Russia	77	10	Japan	16	10	Japan	55
	WORLD	3802		WORLD	760		WORLD	2662

Compiled from: World Resources: 1998–1999, New York: Oxford University Press, 1998; World Resources, 2005, <http://www.wri.org/pubs>. Accessed July 3, 2019.

United States and Western Europe. This also predetermines greater energy consumption (for heating, high-calorie food, heated industrial and residential premises, infrastructure, etc.), and, consequently, more atmospheric emissions and volume of water resources use. More energy is also required for Russian transport, which provides communication over a vast terri-

tory of a far from compact configuration. Russian indicators of environmental impacts per unit of territory are incomparably small compared to other countries.

The given data correlate, as a rule, with Russia's vast territory, so the Russian indicators look favorable against the global background. As for large cities, as far

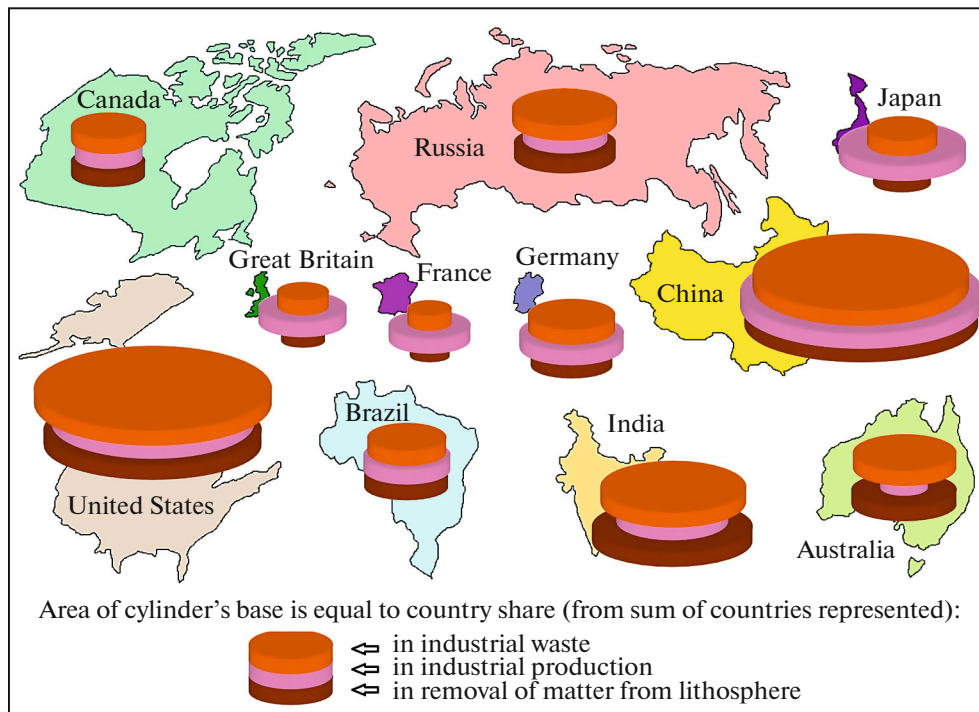


Fig. 2. Ecological and industrial pyramids of individual countries, 2000s.

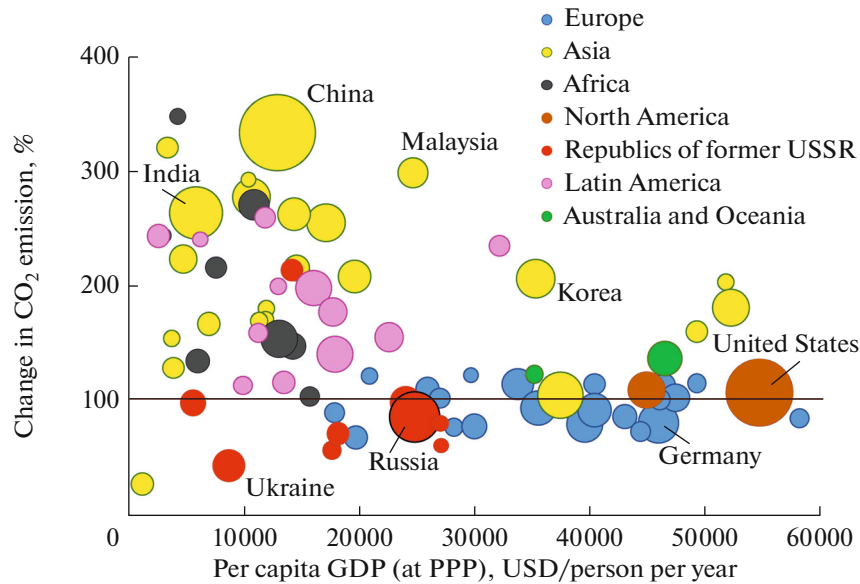


Fig. 3. GDP per capita (at PPP, USD/person per year, 2014) and dynamics of CO₂ emission (1992–2011, 1992 = 100%, %) in countries.

Note: Sign value is proportional to amount of CO₂ emission in 2011.

as one can judge from the disparate data, the levels of environmental pollution in Russian and foreign megacities are generally comparable. Thus, 65 mln people live in Russia conditions of pollutants exceeding the threshold limit value (TLV) in the air of cities versus 53 mln in the United States. However, Russian TLV are much stricter (the average daily TLV for NO₂ in Russia is 40 µg/m³ versus 100 µg/m³ in the United States) (Revich and Maleev, 2003, p. 113), which, however, makes compliance with the standards hardly realistic. The lead content in Moscow soils (in the most polluted, Eastern District of the capital) is less than in Stockholm, 1.6 times; Madrid, 2.6 times; London, 4.8 times (Nikiforova and Kosheleva, 2012).

However, it is impossible not to notice that cities—these “parasites, dependents of the biosphere”—cannot exist without the landscapes surrounding them. The state of the environment in Russian cities is noticeably improved by vast sparsely populated spaces, full-flowing rivers, vast forests, and much less developed areas than abroad.

Figure 3 presents the dynamics of CO₂ emissions by countries differentiated by per capita GDP. A preliminary hypothesis, reflecting popular belief, was that rich countries reduce pressure on nature, while poor countries increase it. Indeed, an increase in emissions is clearly manifested in developing countries (primarily in Asia, but also in Latin America and Africa), which are characterized by low per capita GDP indicators. However, the hypothetical trend is violated, on the one hand, by the United States, which is increasing emissions, and, on the other hand, by the countries of Central and Eastern Europe and republics of

the former USSR, where emissions are decreasing. For 1992–2017, Russia’s share in global emissions decreased from 9.4 to 4.6%, while global emissions increased by more than 60% over this period.¹⁰ True, this reduction occurred due to a decline in production, not greening of the economy. Thus, the Russian Federation produces 4.9% of the world’s electricity, but its share in the production of alternative, progressive, relatively clean energy is only 0.5%.¹¹ Whereas in the world the latter occupies 2.8% (Germany, 11.8%; Denmark, 29.8%), in Russia it is only 0.3%.

Recent interest in CO₂ emissions is due to the so-called greenhouse theory of climate change, which, in our opinion, is still only a hypothesis. However, even if the greenhouse theory is nothing more than a hypothesis, fighting harmful atmospheric emissions is an environmentally beneficial thing. At the same time, in intercountry comparisons, it is important to take into account not only emissions, but also CO₂ sinks. Calculations show that the net production of photosynthesis on Russian territory exceeds all sources of carbon dioxide, including those of technogenic origin, by 25% (Table 3). Consequently, Russia’s territory acts as an oxygen donor and CO₂ absorber of global significance.

In Russia, the structure of the fuel balance is more environmentally friendly than in the world as a whole.

¹⁰Calculated from: Statistical Yearbook of World Energy 2018, <https://yearbook.enerdata.ru>. Accessed July 3, 2019.

¹¹This does not take into account traditional hydropower (large hydroelectric power plants), which does not release emissions into the atmosphere, but is characterized by high land intensity.

Table 5. Level of water resources' use and water-resource dependence of individual countries, 2000, %

Country	Share of country's local river runoff in global resources of river runoff	Share of country in use of global resources of river runoff	Share difference	Share of transit flow in total river runoff
Brazil	9.8	1.6	8.3	34
Russia	7.8	2.0	5.8	4
Canada	5.1	1.2	3.9	2
Colombia	3.8	0.3	3.5	1
Indonesia	5.1	2.2	3.0	0
Bangladesh	0.2	2.1	-1.9	91
Thailand	0.4	2.3	-1.9	49
Pakistan	0.1	4.5	-4.4	76
United States	5.1	12.6	-7.5	8
China	5.1	16.6	-11.5	1
India	2.3	17.0	-14.7	34

Compiled from: World Resources, 1998–1999, New York: Oxford University Press, 1998; World Resources, 2005, <http://www.wri.org/pubs>. Accessed July 3, 2019.

Natural gas accounts for 23% of global fuel consumption, and more than 50% in Russia. The share of coal in the fuel and energy balance is 20% in Japan, 40% in the United States, 45% in Germany, 60% in China, 70% in India, 90% in Poland, and only 12% in Russia. By supplying energy resources to the global market, Russia provides significant environmental assistance to foreign countries, primarily European. It is known that the most toxic emissions enter the atmosphere when coal is burned, and the least toxic, when gas is burned; oil fuel (heavy crude) occupies an intermediate position. The replacement of coal and oil products with Russian gas in European countries has greatly reduced harmful atmospheric emissions.

In Russia, the economy uses only 2% of the available river runoff resources (in the world, 8%; United States, 19%; Germany, 48%; Belgium, 108%).¹² Among the largest water consumers in the world, the “big four” stand out: India, China, the United States, and Pakistan (Table 4). Russia closes out the top ten countries in terms of total water consumption. However, it is one of the three largest industrial water consumers, although it lags greatly behind the leaders: the United States and China, where this figure is four to five times higher. On the world water management map, Russia is distinguished by high industrial water consumption, concentrated in compact urban areas. This determines the priority task of water conservation activities in Russia.

According to the ratio of shares in water resources and water consumption of the world (Table 5), Russia, along with Brazil, Canada, and Colombia, is also in

the lead. In terms of the dilution ratio of wastewater by total river runoff (this indicator reflects the likelihood of water pollution), the situation in Russia is almost ten times better than in the United States and three times better than in the world as a whole (Koronkevich et al., 2014, p. 12).

It is telling to compare the water quality of typical Central Russian and Central German rivers: the Oka and the Elbe. The concentrations of lead, copper, zinc, and chromium near the Oka River are 40% higher than the geochemical background, and near the Elbe River, they are 3–16 times higher than the background. An international research group acknowledged the following: “In general, the state of the environment in the [Volga-Caspian] basin, including water quality, is better than in Western Europe” (Videnie ..., 2004).

The most polluted sea washing Russian territory is considered to be the Sea of Azov. However, even in it, the concentrations of pesticides and polychlorinated biphenyls in the muscle tissues of fish are an order of magnitude lower than in fish from the Great Lakes (data from the Canadian Center for Great Lakes Research, the University of Illinois, and the Murmansk Marine Biological Institute) (Matishov and Il'in, 2006).

Russian agriculture is characterized by a relatively low intensity, which has a positive effect on the state of landscapes and the quality of food. Thus, the application of mineral fertilizers in 2012 was (kg per 1 ha of arable land): in France, 137; Germany, 199; the Netherlands, 310; Russia, 24¹³ (in 1999 it decreased to 15,

¹²Calculated from: World Resources, 2000–2001. // <https://www.wri.org/publication/world-resources-2000-2001>. Accessed July 12, 2019.

¹³Agriculture, Hunting and Hunting Management, and Forestry in Russia—2015. http://www.gks.ru/bgd/regl/b15_38/Main.htm. Accessed July 3, 2019.

but by 2017 it had increased to 55 kg/ha). Per hectare of crops, Russia consumes 20 times less plant protection products than Germany. In the amount of fertilizers and pesticides per unit of arable land, Russia used less than other countries until 1992. In Russian conditions, the environmental problems of agriculture were associated not with the amount of chemicals used, but primarily with the technology of their use. Our agriculture is quite competitive in terms of environmental cleanliness. The dissemination by “green” alarmists of unfounded allegations about the deplorable state of the natural environment in Russia does not contribute to the promotion of domestic food on the world agricultural market, where there is a fierce competition.

In the scale of motorization, which determines motor transport impacts on the environment, Russia, of course, is far ahead of Bangladesh (respectively, 305 and 2 personal vehicles per 1000 inhabitants, 2017), but still lags far behind Germany, Italy, and the United States (more than 700 per 1000). Due to industrial and transport underdevelopment in Russia, even in its European part, the moduli of aerial lead input into the soil are close to global ones and are an order of magnitude lower than in Western Europe and North America (Glazovskaya, 1997). The environmental friendliness of railway transport in Russia is ensured by the widespread use of electric traction, which eliminates air pollution. JSC Russian Railways transports 85% of cargo and 80% of passengers via electric traction. In the length of electrified lines, Russia ranks first in the world.

For international environmental comparisons, the integral criterion is the ratio of the load (impacts) on nature and tolerance of the natural environment to anthropogenic impacts. This ratio shows the extent to which each country has used the capacity given by nature, the stability of the environment.

One of the indirect indicators of the impact on nature can be production load—the amount of GDP created in industry and agriculture—per unit of territory.¹⁴ In Russia, the specific production load is 50–100 times less than in Western Europe, Japan, and South Korea (Fig. 4). This figure also reflects large cities: local centers of large-scale transformation of nature, and areas of “underdeveloped territory” are highlighted, the boundary of which is taken to be a population density of less than 10 people/km². The figure clearly shows that in Russia, north and east of the St. Petersburg–Novosibirsk line, development of the territory has not a frontal, but a focal character.

Another generalized indicator of anthropogenic pressure on nature is energy consumption per unit area.¹⁵ This indicator well reflects the situation in developed countries, but poorly in backward coun-

tries, where the main negative ecological processes (deforestation, aridization, and soil degradation) occur without the use of technology and, consequently, without so-called commercial energy, but statistical accounting records only this. There is a distinction between industrial energy consumption and physiological energy consumption—energy used for human nutrition. In developed countries, physiological energy consumption is a very small share of total energy consumption (according to our calculations, in the United States is 2.1%; in Russia, 2.6%), but in poor countries this share is significant (51% in Nigeria, and more than 90% in Chad, Burundi, and Lesotho). The total energy consumption indicator is introduced in order to reduce to a common denominator the parameters of impact on the environment that are difficult to compare in developed (technological pressure) and economically backward countries (demographic pressure).

The idea of summing up two types of energy consumption was implemented by A. Fedotov (1995) to determine the rent for countries for use of the biosphere. He also used the same bioconsumption power indicator for all countries. This is invalid, because the caloric content of food varies greatly: from 1600 kcal/day in Burundi up to 3800 kcal/day in Austria.

Figure 5 shows the distribution of total energy consumption (industrial and physiological) by countries. Three vast zones of destabilization of the natural environment are distinctly revealed: Western Europe, South and Southeast Asia, and North America. These zones were identified by K.S. Losev (2001) at a qualitative level; on the map they are characterized by quantitative indicators. Clearly, the European zone with high load is not limited to the west of Europe, but extends to Russia’s borders. Within the vast high load zones, Western European and Japanese-Korean areal extents are distinguished. In them, the loads are an order of magnitude higher than even those observed on average in the United States, China, and India. In Russia, energy consumption per unit of territory is lower than in South Korea or the Netherlands, by 40–50 times.

As an integral indicator of sustainability of the natural environment, it is proposed to use the natural biological productivity of landscapes. The ecological significance of biological productivity is as follows. A number of authors (Losev, 2001; etc.) consider the conservation of biota (“undisturbed by economic activity”) to be the main lever for resolving the global environmental problem. This position is disputed no less by authoritative experts (Vinogradov et al., 1994).

¹⁵Energy consumption is an indicator not only of the actual load, but also of potential threats. The world produces, transports, stores, and uses a huge amount of fuel. This mass, capable of burning and exploding, is comparable in power to the accumulated nuclear weapons arsenal in the world.

¹⁴Industry and agriculture are the main economic sectors that transform the natural environment, while the service sector is generally more inert from an environmental standpoint.

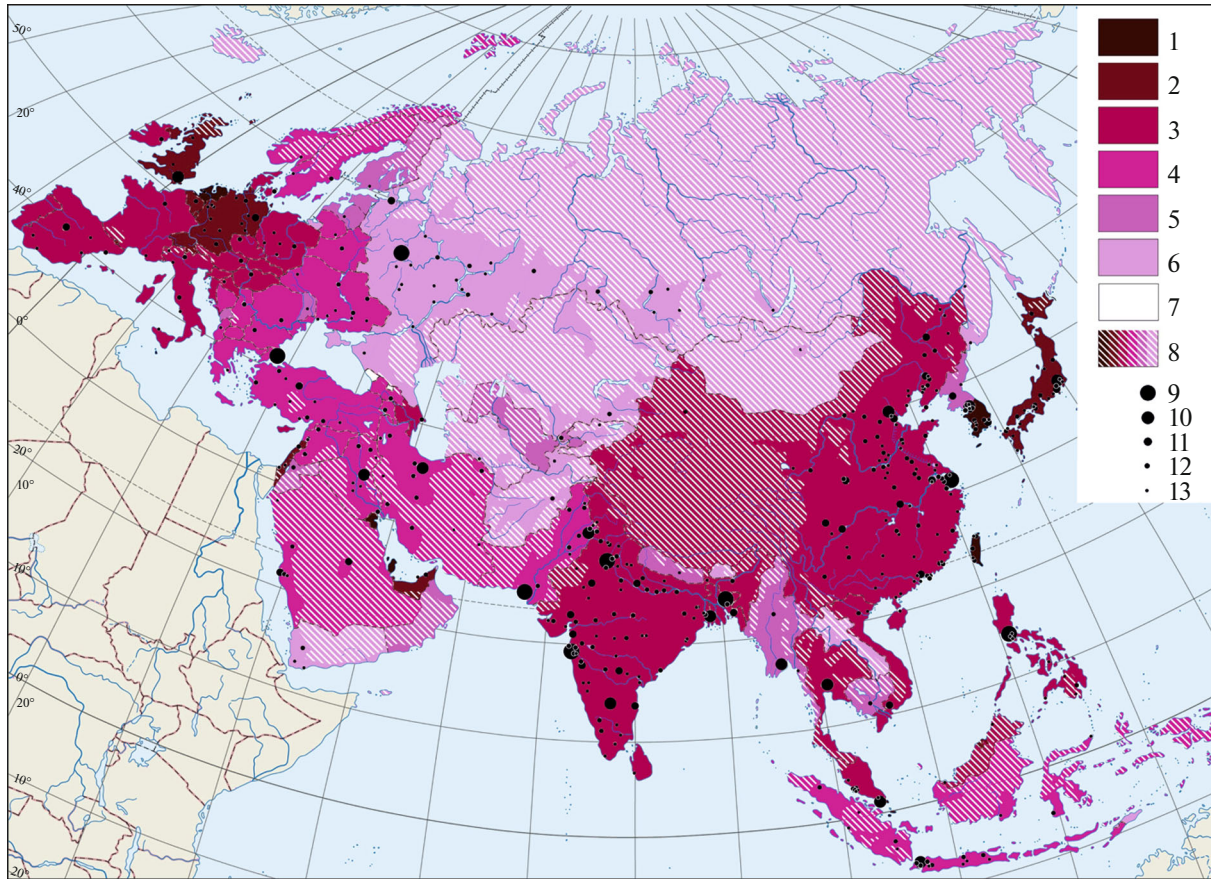


Fig. 4. Production load on territory in countries of Eurasia, 2000s. GDP (at PPP) per unit of territory (USD 1000/km²): 1, >3600; 2, 1500–3300; 3, 500–1400; 4, 200–450; 5, 100–190; 6, 5–70; 7, no data; 8, areas with population density <10 people/km²; largest cities (mln people): 9, more than 10; 10, 5–10; 11, 3–5; 12, 1–3; 13, 0.5–1.

Note: map made by A.N. Vasiltsova.

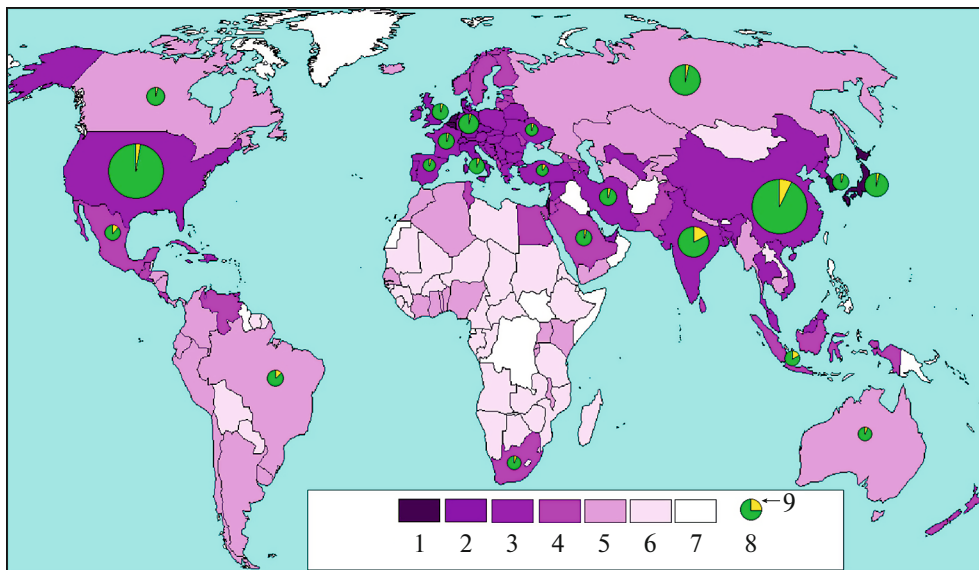


Fig. 5. Energy consumption per unit area by country, 10¹² J/km², 2000s: 1, >40; 2, 15–35; 3, 5–14; 4, 2–4; 5, 0.5–2; 6, <0.5; 7, no data; 8, total energy consumption in country (area of circle is proportional to energy consumption; for countries with consumption >4 × 10¹⁸ J); 9, share of physiological consumption in total energy consumption.

Compiled from: <http://unstats.un.org/unsd/syb/>.

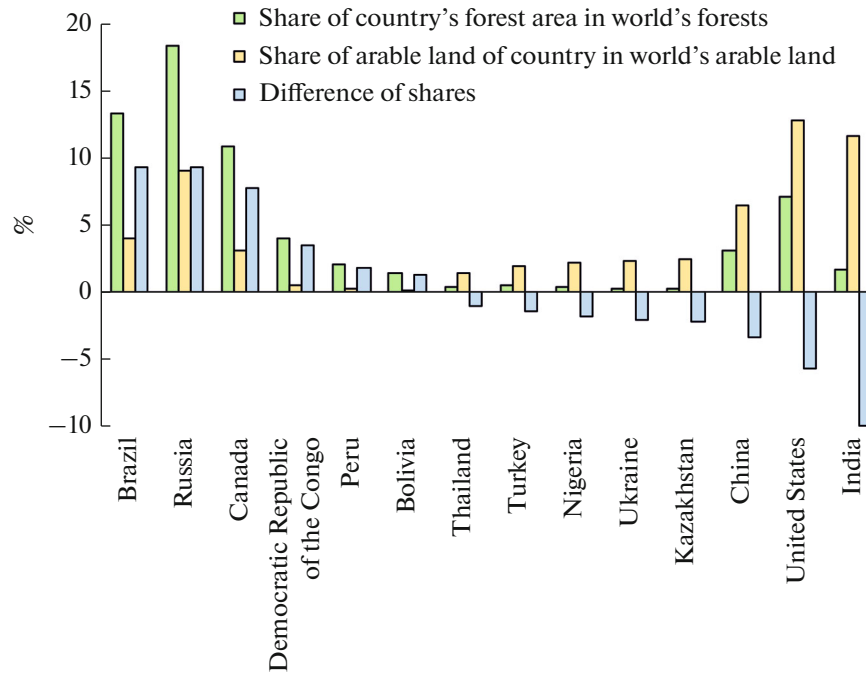


Fig. 6. Share of individual countries in annual increase in biological production and energy consumption of the world, 2000s.

Apparently, this lever cannot be a panacea for all environmental ills, if only because the currently preserved “undisturbed” biota is distributed extremely unevenly over the surface of the Earth. The necessary conservation of this part of the biota must certainly be combined with resuscitation of the disturbed biota, which implies the widespread use of technical means of environmental protection: resource saving, improvement of technologies, including treatment, etc. However, it is obvious that the biota (primarily vegetation), even disturbed, is the most important “purification plant” of the planet. Usually, the importance of vegetation cover for reproduction of oxygen and absorption of carbon dioxide is singled out, although, naturally, these important functions are only part of its role on Earth.

The annual increase in biological production serves as an important indicator of the intensity of the biological cycle, which also corresponds to the intensity of self-purification of the environment and its ability to process anthropogenic waste. Vegetation is a factor of moisture circulation, source of soil nutrition, and replenishment of its fertility. “The developed vegetation cover is the most important condition for stability of the landscape to anthropogenic impacts. It tolerates destructive influences: solifluction, erosion, deflation, mudflows, and landslides” (Isachenko, 2001). In addition to the environment-forming biota, it also performs important resource-reproducing functions, being the main source of food for humans. In the age of fossil fuels, the energy value of vegetation has decreased markedly (with the exception of under-

developed countries). However, the global environmental crisis could change the situation drastically. If mankind exhausts fossil fuels before it ensures the unconditional purity of nuclear energy or economic efficiency of renewable energy, vegetation will remain the only real promising source of fuel and energy resources.

Environmental donor and dependent countries are clearly distinguished, on the one hand, by the difference in the contribution to the production of biological products and, on the other, their role in global energy consumption (Fig. 6). Thus, in environmental and energy indicators, Russia is among the most prosperous countries on the planet.

The considered ratios of water resources and water intake, energy consumption and production of products by vegetation, the removal of matter from nature, and the introduction of waste into it characterize the matter–energy component of natural resource management. To characterize another side of it, land use, i.e., use of a natural area as land or landscape, such an indicator as the “environmental friendliness of land use” ratio can be used: the ratio of the area of arable land (i.e., land that is certainly environmentally harmful) to the area of forests (land that is environmentally beneficial). Note that for the countries of the arid belt, deprived of natural forests, where man-made oases based on irrigated agriculture serve as centers of life, this situation is invalid. Figure 7 shows the strong overplowing of India, United States, China, Kazakhstan, and Ukraine. Russia, along with Brazil and Canada,

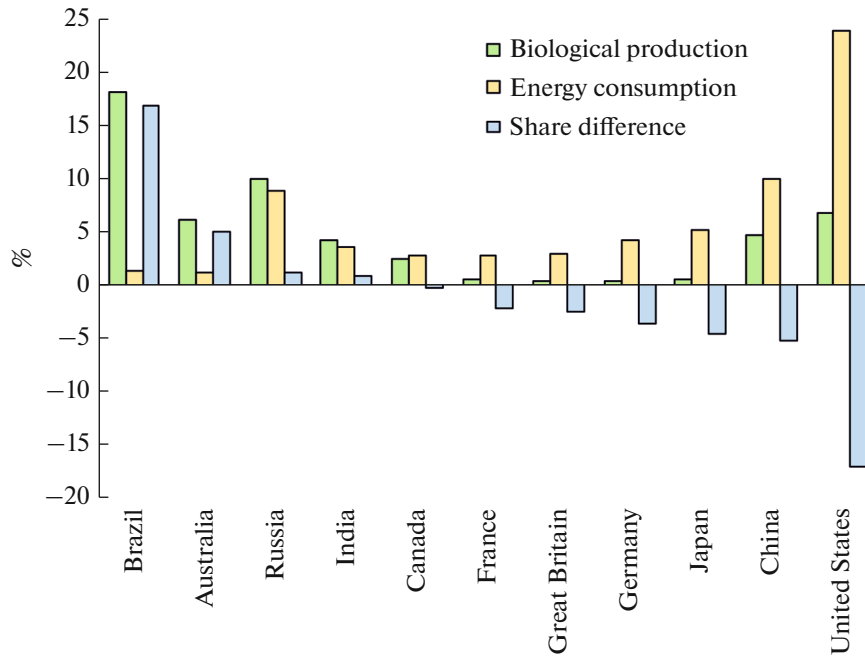


Fig. 7. Ratio of forest and arable land for individual countries, %.

are characterized by favorable ratios of forest and arable land.

Other indicators of the environmental friendliness of land use can be (a) the coefficient of naturalness of land—the share of particularly ecologically valuable landscapes in the country, which should include virtually undeveloped, “wild” lands; (b) the share of contaminated land. These indicators in different aspects characterize the degree of preservation of the “primordial” nature of the country’s territory. Virtually undeveloped lands in Russia occupy two-thirds of its terri-

Table 6. Undeveloped lands by individual countries, % of country’s territory

Country	Area of virtually undeveloped land
Russia	67
Canada	70
Australia	33
Brazil	32
China	20
United States	4
India	0
Japan	0
Germany	0
France	0
Great Britain	0
Land surface	36

Compiled from: (Losev, 2001).

tory, which without exaggeration can be considered a unique global environmental asset and of great significance for the country (Table 6). In countries such as India, Japan, France, Germany, and Great Britain, no such lands have been identified. On the other hand, in Western European countries there are large shares of heavily polluted lands, which is clearly seen in Fig. 8, compiled after (Prokacheva and Usachev, 2004).

Clearly, Russia is one of the most environmentally friendly countries on the planet, far (by an order of magnitude) ahead of the demographic and economic giants of the world: China, India, the United States, Japan. The indicators of the leading European countries already differ from Russia’s by two orders of magnitude. These countries, therefore, are Russia’s major “environmental dependents.”

In Russia, there is no unbridled consumerism (although, unfortunately, it has begun to take shape rapidly), which is characteristic of economically developed countries,—one of the most important environmental threats. Russia’s cultural traditions have never associated happiness with acquisitiveness and excessive accumulation of material wealth. There is also no overpopulation from which the nature of many economically backward countries suffers severely. At the same time, the worldview is characterized by disregard for the law, wastefulness towards resources, and a rudimentary state of ecological consciousness (Losev, 2001).

Russia as a whole stands out against the world background by sources of potential risk: nuclear weapons, the aerospace sector, military-industrial complex

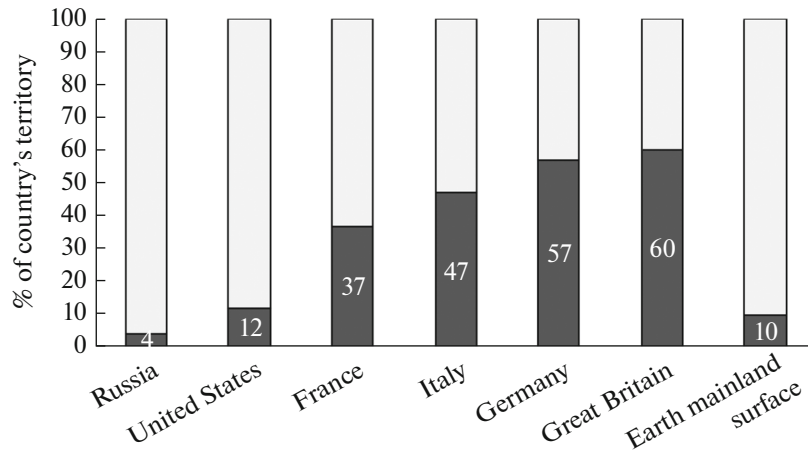


Fig. 8. Share of land subjected to chronic industrial pollution in selected countries.

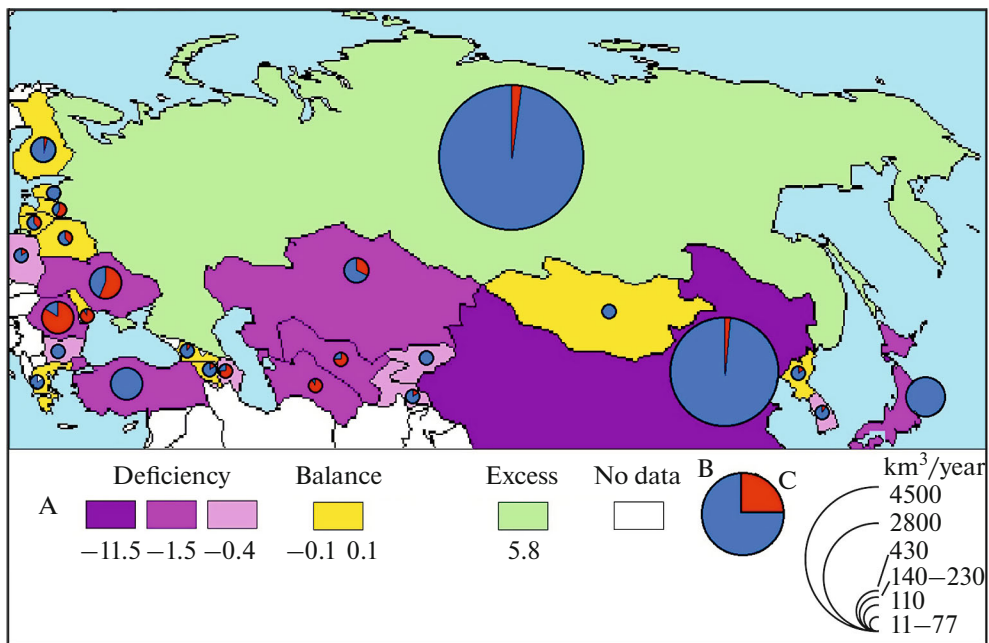


Fig. 9. Level of water resources' use and water-resource dependence of Russia and neighboring countries: A, difference between country's share in water resources and its share in world's water consumption, %, 2000s; B, total annual river runoff, km³/year; C, share of foreign inflow.

enterprises, pipelines, gas storage facilities, nuclear and hydroelectric power plants, chemical industries, etc. Thus, according to estimates, about half the enriched uranium accumulated in the world and, accordingly, about half its enrichment waste is concentrated in the Russian Federation. Russia is responsible for 50% of space debris. In Russia there are very large, on a global scale, radioactive contamination zones and local centers of extremely strong chemical contamination (Karabash, Dzerzhinsk, etc.). However, in general, the contribution of the Russian economy to global transformation of the natural environment does not exceed the country's share in Earth's territorial resources, in population, and the global

economy. Russia's territory is the main natural treatment plant of the planet, one of the main areas for compensation of global pollution and natural disturbances in general, and an ecological donor of many national ecosystems. The world is actively developing (note, free of charge) Russia's ecological potential.

The analysis shows that, provided that a fair international ecological order is established, Russia can expect to receive significant environmental rent.

Russia's Ecological and Geographical Position

The exposure of the country's territory to external environmental threats is determined by its geographi-

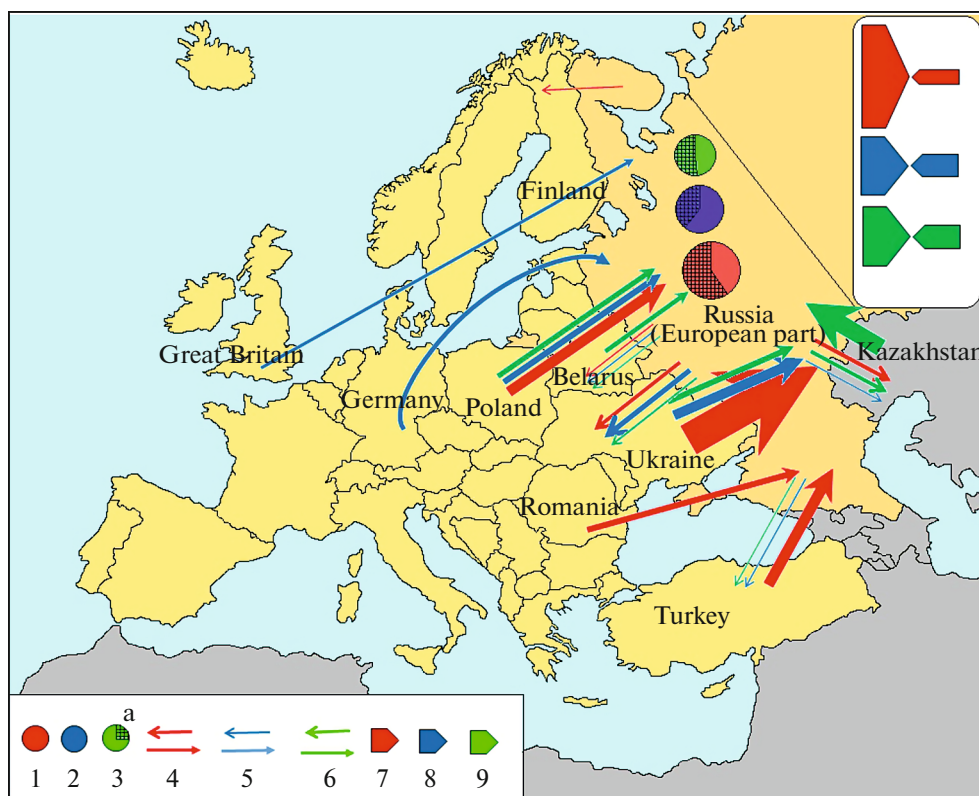


Fig. 10. Cross-border air pollution in European Russia, 2010. Total deposition of oxidized sulfur (1), oxidized nitrogen (2), and reduced nitrogen (3) on European Russia; (a) share of foreign sources: area of circle is proportional to value of total deposition of pollutants on European Russia. Main cross-border fluxes of oxidized sulfur (4), oxidized nitrogen (5), and reduced nitrogen (6): thickness of arrow is proportional to cross-border fluxes of pollutants from individual countries. Ratio of import and export of pollutants in European Russia: oxidized sulfur (7), oxidized nitrogen (8), and reduced nitrogen (9): thickness of arrow is proportional to cross-border fluxes of pollutants.

cal position—its location with respect to foreign sources of environmental hazard, channels, and “distribution barriers” (Klyuev, 1995). The specific features of Russia’s ecological and geographical position are as follows.

Russia is characterized by relative natural and geographical isolation from other states, expressed in the significant distance from them to Russia’s main coastline, a high (over 95%) share of local runoff in the amount of water resources, and extended orographic barriers on the southeastern borders. A significant part of the country’s territory, particularly on the East European Plain, is occupied by geosystems closed to inland waterbodies, making it difficult to export environmental threats outside the country. Due to the deep continental location of the country, Russian sources of environmental risk threaten primarily their own, and not foreign territories and water areas.

Despite this, Russia has close environmental ties with its neighbors (Table 7), due to Russia’s huge size; proximity to all the major areas of economic activity on Earth (Western Europe, China, Japan, South Korea, the United States), which therefore act as zones of concentration of environmental threats; non-

coincidence of its state borders with watersheds; western transport of air masses.

On more than half of its land border, Russia neighbors former Soviet republics, which, like it, are undergoing socioeconomic transformation. The politics of Russia’s closest neighbors is per force nonenvironmental. Poor countries cannot afford to care for a clean environment. Meanwhile, poverty is no less hazardous to the environment than wasteful Western consumerism. This, of course, is a negative externality on Russia’s external environmental security. The long borders of the Russian Federation, 13 500 km of which are new, with the former Soviet republics, often permeable, create wide opportunities for smuggling, including the illegal export of natural resources and waste transportation. The problem of border security thus acquires an ecological dimension.

The former unified ecological space of the USSR is now fragmented into 15. Coordinated efforts are difficult. As an example, let us mention the aggravated contradictions between Russia and other Caspian states in the developing oil fields on the Caspian shelf, which may be associated with negative environmental consequences. Russia and Iran are mainly interested

in preserving the bioresources of the Caspian Sea. Other countries, in particular, Kazakhstan (the leader in oil reserves and production in the water area), are focusing on hydrocarbon resource development.

The inflow of river waters into Russia is three times greater than their outflow. The main suppliers of river water to Russia are China, Finland, and Mongolia; the consumers are Mongolia, Belarus, Ukraine, and Kazakhstan. The last three countries also “consume” the main share of polluted wastewater exported by Russia through the river network. For Russia as a whole, the inflow plus outflow of river runoff is very small compared to Russia’s own water resources. However, in some regions, this share is significant. In Omsk oblast, only 16% of water resources are local; the rest come from abroad.

From the ratio of water resources to water consumption in the world (see Fig. 2), it can be seen that in Russia, this ratio is favorable, while its southern and southwestern neighbors noticeably “overspend” their share in the global water resources. Such a particularly strong imbalance is observed in China, but it is also significant in Uzbekistan, Ukraine, and Kazakhstan. Water-poor neighbors are a potential source of instability (Danilov-Danilyan and Losev, 2006). The map also shows the degree of water dependence of countries. The high degree of such dependence in Turkmenistan, Moldova, Uzbekistan, Azerbaijan, and Ukraine draws attention. Russia is self-sufficient in water-resource and water-environmental relations.

An acute shortage of fresh water has arisen in the Chinese part of the Amur River basin. Within China’s program Revival of the Industrial Bases of the Northeast, about 20 large water management facilities are being built and designed: reservoirs, waterworks, and hydroelectric power stations. The total siphoning of runoff from the upper reaches of the Amur River can be up to 70% of the river’s flow (Sovremennye ..., 2013, p. 67). In Dauria, the Hailaer River–Lake Dalai Nor canal has already been built (in 2009), which violated the Ramsar Convention, since it altered internationally important wetlands. The possible negative environmental externalities of this canal’s construction are the degraded floodplain habitats of bird populations, including endangered species listed in the Red Book, aridization, and increased pollution of the Argun River. The Great China Water Leap Forward ignores Russia’s national environmental interests.

A similar situation is developing in the Irtysh River basin. In China, transfer of runoff through the Black Irtysh–Karamay Canal was begun, which provides siphoning from the Irtysh River basin of more than 1.5 km³ of water per year. The implementation of this project threatens navigation, water supply, and ecosystems of the Irtysh, which comes to Russia from China via Kazakhstan. The latter, in turn, plans to increase water supply to the Kanysh Satpaev (formerly, the Irtysh–Karaganda) Canal. Thus, in Omsk oblast in

2011, construction of a reservoir commenced to prevent a possible water shortage. It should be added that even now, the Irtysh and its tributaries are the most polluted waterbodies in Kazakhstan. In addition, China refuses to include Russia in trilateral (China–Kazakhstan–Russian Federation) negotiations on water allocation of the Irtysh River (Ekologicheskie ..., 2014, p. 138). Although a government agreement on cooperation in the protection of cross-border rivers was signed between Kazakhstan and China (2001), issues of the legal status of rivers remain unresolved between these countries. Water-resource and water-environmental problems in the basin remain tense and institutionally unresolved.

Judging from Table 7, cross-border wastewater exchange is dominated by its export from Russia. However, this table does not contain data on polluted wastewater from non-CIS countries. Accounting for these waters, particularly Chinese ones, will undoubtedly change the shares of wastewater exchange that do not favor Russia.

Almost a third of Russia’s land (not sea) borders pass along rivers and lakes (meaning waterbodies that mark the border but do not cross it) (see Table 7). More than half the river frontier is along China. Border watercourses and reservoirs are interesting as objects of joint interstate natural resource management, the water quality in which depends on the specifics of the economic use of the territory in the catchment areas on both sides of the border.

According to our calculations, the area of the watersheds, where Russia’s “imported” river flow is formed, is more than 2 mln km² (roughly the area of Mexico). The Russia’s zone of hydroecological interests abroad covers the Seversky Donets River basin, all of northern Kazakhstan east of 60° N, almost a third of the area of Mongolia, vast territories of northeastern China, and the Neman River basin bordering the Kaliningrad exclave. More than 100 mln people abroad live in this zone. The Russian parts of international river basins are less developed than the foreign. For example, the production and demographic load on the territory of interstate river basins in China is 10–20 times higher than in Russia (Gorbatenko, 2016).

Russia’s poorly developed Far Eastern areas are directly adjacent to a continuous, highly developed Chinese areas. Currently, China is not only a first-rank demographic power, but also a country with the highest growth rates of economic potential: it consumes a quarter of global energy resources. Although China has recently made efforts to green the economy, its intensive economic growth poses a serious environmental threat, including to its neighbors. Due to the high share of coal in the fuel mix, China ranks first in the world in atmospheric greenhouse gas and sulfur compound emissions. The high growth rate of living standards in China stimulates mass motorization of

Table 7. Ecological Relationships between Russia and Neighboring Countries

Country	River runoff, km ³ /year		Polluted wastewater, mln m ³ /year		Share of lake–river border, % of border length	Total volume of overlying reservoirs*, km ³ that threaten territory:	
	inflow to Russia	outflow from Russia	inflow to Russia	outflow from Russia		Russia	other countries
Norway	–	–	–	–	65	–	8.9
Finland	28	–	...	–	5	7.4	4.9
Estonia	–	2.2	–	10	75	1	3
Latvia	–	–	–	–	28	–	–
Lithuania	0.8	–	5	–	75	1	–
Poland	1.6	–	...	–	–	–	–
Belarus	0.5	15.4	10	150	16	–	3
Ukraine	5	11.1	450	300	13	2	2
Georgia	3.1	–	–	–	–	–	–
Azerbaijan	–	2.2	–	–	20	–	–
Kazakhstan	31.9	10.3	140	400	15	57.6	3.3
Mongolia	24.9	20.6	...	–	15	–	–
China	95.5	–	...	–	85	17.2	90.9
North Korea	–	–	...	–	100	–	–
TOTAL	191.3	61.8			30	86.2	116

Compiled from: (Rossiya ..., 2001) and authors' calculations.

Note. (...), no data; (–), no phenomenon or small value. * Reservoirs are objects of high potential hazard to underlying regions. Primarily, we are talking about the danger of dams breaking due to accidents, sabotage, deterioration of hydroelectric facilities, and other causes, followed by flooding of the territory. The main damaging factor of such a break—a destructive pressure wave—can be added to the polluting effect of bottom sediments accumulated in reservoirs, as well as erosion of chemical warehouses or waste dumps. Reservoirs with volume >0.1 km³ are taken into account. Most significant relationships of each type are highlighted. There are no data for Abkhazia and South Ossetia.

this country, which entails negative environmental consequences. In connection with the reform of agriculture, erosion, pollution of soils and waterbodies, and aridization are expanding.

At Russia's southern borders are concentrated countries distinguished by high demographic growth rates and, consequently, an increase in demographic pressure on the environment. In terms of demographic pressure on the natural environment, the ecological and geographical position Russia's has noticeably deteriorated in the postwar period. The close proximity of the least developed and most vulnerable of Russia's territory with countries with huge demographic potential and highest economic growth rates creates potential political and environmental tensions in the Far East.

Russia's contribution to the use and transformation of the basins of inland interstate seas is significant only for the Caspian and Azov seas. Russia's share in the load on these basins, according to our rough estimates, ranges from 60 to 80% of the total. Russia's contribution to the anthropogenic change in the basins of other inland seas surrounding its territory does not exceed 10%.

For marginal seas, the main pathways for the spread of environmental risk to Russia are associated with the Norwegian–North Cape Current, which carries pollutants into the Barents Sea from the North and Norwegian seas, where one of Eurasia's largest economic activity centers is located. The Barents Sea is the largest shelf waterbody in Russia, surpassing in fish productivity the Baltic, White, Black, Azov, and Caspian seas together. The most developed European countries have used the North Sea as a large-scale waste dump for over 150 years. In the postwar years, nuclear energy was used in active development of this sea (France dumped radioactive waste into it, while Great Britain dumped waste into the Irish Sea) and offshore oil and gas fields. Owing to the Gulf Stream, a wide range of pollutants—from household waste to radionuclides—have made their way to the Kara Sea.

Western environmentalists, politicians, and the media are showing increased concern about the nuclear and radiation hazard in the Barents Sea region. Russia has indeed concentrated here a cluster of hazardous objects: nuclear power plants, bases for nuclear icebreaker and submarine fleets, a nuclear submarine production plant, ship repair facilities,

Table 8. Nuclear pollution of seas

Water area	Cesium-137 concentration (nCu/m ³) in surface water layer	Cesium-137 content (nCu/kg) in fish muscles	Plutonium-239 and plutonium-240 (nCu/m ³) concentration in surface water layer
Baltic Sea	6.8	800	no data
Atlantic Ocean	1.6	20	no data
Barents Sea	0.2	20	<0.027
Kara Sea	1.6	no data	no data
Irish sea	no data	800	0.27
North Sea	no data	30	0.007

Compiled from: (Ogorodnikov, 1996).

graveyards for decommissioned nuclear ships, storage facilities for spent nuclear fuel, purification plants and a marine repository for radioactive waste, and the former Novaya Zemlya nuclear test site. A Russian–Norwegian expedition found that the background radioactive contamination of the Barents and Kara seas is significantly (by an order of magnitude) lower than that of the Irish and Baltic seas (Table 8). It is estimated that discharges from radiochemical plants—the English Sellafield and French La Hague—responsible for 30% of the Kara Sea’s pollution with strontium-90 and about 60% with cesium-137. Clearly, in this area, domestic potential environmental threats are combined with imported realistic dangers.

In the Far East, the Tsushima Current siphons water from the Yellow Sea, and partly from the northern East China Sea, creating a threat to Primorye from Chinese, Korean, and Japanese sources of environmental risk. Japan is noted for large-scale nuclear power; it ranks third in the world after the United States and France in total nuclear plant capacity. The Alaska Current affects the formation of Bering Sea water masses, which may contribute to pollution of the coasts of Chukotka and Kamchatka from oil fields of the Alaskan shelf.

The cyclonic circulation of Caspian Sea currents causes inflow of pollution in Russia’s direction with the possible development of oil in the Kazakhstan sector of the sea.

Due to the “openness” of Russia’s borders to the west and western transfer of air masses, Russia’s zone of atmospheric and environmental interests extends all the way to the Iberian Peninsula. Sixty percent of anthropogenic sulfur and nitrogen fallout in European Russia comes from Western and Central Europe, but even in Asian Russia, this value is about 10%. The impact of these pollutants from Europe can be traced

all the way to Lake Baikal. The main exporters of atmospheric pollution to Russia are Ukraine, Poland, and Germany (Fig. 10).

Since western transport of air masses prevails in the mid-latitudes of the Northern Hemisphere, when Europe consumes Russian oil and gas products, part of the atmospheric pollutants released are carried by air flows to Russian territory. Thus, the two main environmental problems of where to obtain natural resources and what to do with industrial waste are resolved at Russia’s expense in this case. Its “environmental assistance,” unfortunately, is not yet taken into account in foreign economic calculations and is therefore free of charge.

Southeast Russia is bordered by mountains and mountain ranges with a sublatitudinal distribution, which act as barriers to the free spread of air pollutants from abroad. In the region, stable anticyclonic conditions predominate in winter, also serving as a climatic barrier. Therefore, in particular, only 1.2% of sulfur emitted by Chinese sources enter Russian territory, but even this accounts for 4.2% of the total sulfur fallout in Asian Russia (Bashkin, 2005, p. 134).

The areas of concentration of external threats to Russia’s environmental security are:

The Chernobyl NPP area—a zone of substantial radioactive contamination with a potentially hazardous sarcophagus, where the spread of radionuclides by animals, people, cars, and forest fires is possible.

The Ukrainian part of the Seversky Donets River Basin—Kharkiv urban agglomeration and Ukrainian Donbass—in a highly urbanized region (with a population density of over 100 people/km²), which specializes in coal mining, metallurgy, electric power, and the chemical and petrochemical industries. The Ukrainian contribution to pollution of the Seversky Donets River is at least 70%. Right at Russia’s borders,

Table 9. Structure of land use in Amur River basin, %

Land type	Russia	Mongolia	China
Woodlands	73	3	24
Burned-out forests	97	2	1
Reclaimed land	9	0	91
Unreclaimed agricultural land	23	1	76
Population centers	37	1	63
Unused land	93	not determined	7
Wasteland	84	not determined	16

Source: (Ganzei et al., 2007).

from the side of the prevailing winds, the most serious center of industrial emissions in the post-Soviet space is concentrated in the Donetsk–Dnieper region of Ukraine. Within this area, almost 40% of emissions came from near-border Donetsk oblast.

The environmental situation in the Donbass is of particular concern in connection with the current acute political crisis in Ukraine, which has resulted in a serious military conflict. Hazardous, technically complex objects and territorial concentration of huge masses of substances capable of burning and exploding are the privilege of countries with highly organized political systems and prosperous economies. Such objects are incompatible with the economic chaos and barbarization of governance and social mores masked in modern Ukraine by the declarative cry “a return to European civilization.”

In *Kazakhstan's Irtysh River region* are the Pavlodar–Ekibastuz and Ust-Kamenogorsk industrial regions with specialization in coal mining, electric power, non-ferrous metallurgy. The region is home to the Ulba Metallurgical Plant, which produces fuel for nuclear power plants, four large reservoirs on the Irtysh, the former Semipalatinsk nuclear test site, and the Pavlodar source of mercury contamination of soils.

The Chinese Amur River region comprises the province of Heilongjiang and most of the province of Jilin. In the latter, the population density reaches 300 people/km². The region specializes in “dirty” sectors of heavy industry, based on the local raw materials and fuel base (coal mining, nonferrous metals, oil, oil refining, petrochemistry, electric power, chemical industry). There are several million-plus cities here, and agriculture is highly intensive. Thus, in Jilin, more than 700 kg of mineral fertilizers are applied per 1 ha of agricultural crops (Baklanov and Ganzei, 2008, p. 111). This is 12 times more than in Russia.

The volume of water consumption in the Chinese part of the Amur River basin is 39 km³, and in the Rus-

sian part, 1.1 km³ (Geosistemy ..., 2010, p. 478). According to approximate data (data on polluted wastewater in China are closed), China's share in total wastewater discharge is as follows: in the Argun River basin, 87%; in the Amur River from the mouth of the Argun River to that of the Songhua River, 75%; from the mouth of the Songhua River to the mouth of the Ussuri River, 98%; in the Ussuri River, 97% (On Russian-Chinese ..., 2005).

According to Chinese data, the Songhua River is more polluted than the Yangtze River (Ganzei, 2004, p. 171). Since the 1970s, Chinese sources of pollution have made a decisive contribution to degradation of the Amur ecosystem. A major accident at a chemical plant in the city of Kirin in 2005, when benzene, nitrobenzene, and aniline were exported by the Songhua River to Russian territory, which posed a threat to the water supply of Khabarovsk krai, only highlighted the problem of cross-border pollution of the Amur River, which has existed for a long time. It should also be noted that pathogens responsible for cholera, dysentery, hepatitis A, etc., enter the Amur River with Songhua River waters (Voronov, 2006).

In the Russian–Chinese border area, such properties of cross-border natural resource management as asymmetry and asynchrony are clearly manifested (Baklanov and Hanzey, 2008). On Chinese territory, anthropogenic pressure on nature is much stronger and continues to increase, while on the border periphery of Russia's Far Eastern regions, signs of demographic devastation, economic desertification, and even savagery arises: deserted taiga, abandoned villages, and collapsed fish farms and timber industry enterprises. The level and nature of development of the cross-border Amur region is reflected in Table 9. Clearly, the Chinese territory is characterized by high development, while the Russian territory is dominated by unused lands, burned areas, and wastelands. In the wild landscapes of the Russian borderlands, where there is no monitoring or control, fires are frequent, which sometimes cross into Chinese territory.

At present, China's economic policy is becoming more and more ecologically oriented. Commercial logging has been banned in many regions of the country. Paradoxically, the greening of forest management in China is causing serious harm to Russia's forest resources. Increased Chinese demand for Russian timber (as well as unemployment in remote Russian villages) is spurring illegal logging in the Russian Far East, which, by some estimates, exceeds legal harvesting. Due to weak control and corruption in the forest industry, a large shadow sector has formed, causing environmental and economic damage (Prigranichnye ..., 2010, p. 180). Large-scale illegal logging is often carried out in water protection zones, without compliance with forestry regulations. To mask illegal activities, arsonists set forest areas ablaze. A distinct illegal logging gradient has been revealed, the share of which is higher, the more timber is available for export to China. In western Primorsky krai and southern Khabarovsk krai, the amount of illegal logging is 50–70% that of legal logging, and in territories remote from China, 20–30% (Prirodopol'zovanie ..., 2005, p. 188).

Illegal harvesting and subsequent smuggling to China affects not only forest, but also other biological resources. Oriental medicine's high demand for derivatives of Amur tiger, musk deer, bear, as well as pine nuts, mollusks, and medicinal herbs (eleutherococcus, ginseng) has caused an increase in poaching in Russia. In the authors' opinion, it is impossible to reduce this as long as there is a social basis: chronic poverty, unemployment, and, consequently, the populations high dependence on the use of biological resources in border peripheral regions.

The environmentally friendly decision of the Chinese authorities to ban coal generation (the most environmentally unfavorable practice) from the 1000 km zone around Beijing and incentivize construction of power plants in the north areas of the country bring environmental threats closer to Russia's borders.

In recent decades, China has been systematically working to strengthen the banks of the Amur River and its tributaries. Russian countermeasures have been discussed but not carried out. As a result, in some sections, the fairway of the river along which the state border passes is shifting towards the Russian coast. Chinese coastal protection measures also play a negative role from an environmental standpoint. Free meandering of rivers is a key functional element of the floodplain ecosystem, disruption of which leads to degradation of spawning grounds and loss of biodiversity. We emphasize that on the Amur River (the right, washed-out bank is Chinese), the Coriolis effect "works" for Russia, but Chinese reclamation engineers neutralize and overcome the natural process. In the case of the Ussuri River (the right bank is Russian), the Coriolis effect aids in China's "hydroengineering war." Therefore, a proposal by Moscow State

University hydrologists is noteworthy: to establish new rules for demarcation of the Russian–Chinese border by fixing it on land based on geodetic features, which will eliminate the dependence on natural and hydro-engineering displacements of the riverbed (Sovremennye ..., 2013).

A potential area of external environmental threats to Russia is located in the *Mongolian part of the Selenga River basin*. The Selenga River is the biggest river running into Lake Baikal, a natural World Heritage site. In the lower, Russian part of the basin, a special environmental regime of economic activity has been established. In the Mongolian part of the basin, there are no restrictions on natural resource management, and here two-thirds of the population, four-fifths of industry, and 90% of the irrigated lands of Mongolia are concentrated, i.e., the lion's share of the country's economy. Its planned economic growth is associated with the development of new coal, copper, and gold deposits. To provide them with water and electricity, it is planned to build a hydroelectric power station on the Selenga River; there are also projects to transfer part of the flow of the Orkhon, Selenga, Kerulen, and Onon rivers to the south, to the Gobi; hence the potential contradictions between the economic development of Mongolian regions and preservation of the Baikal ecosystem, recognized by UNESCO as an area of exceptional natural beauty.

The world's longest land borders between Russia and Kazakhstan passing in the steppe and forest-steppe zones are characterized by specific environmental problems. Due to a significant reduction of economic activity in vast areas on both sides of the border, unused former agrocenoses are overgrown with thickets of weeds and act as breeding grounds for pests and agricultural crop diseases. Saratov oblast, Altai krai, and other regions along the border with Kazakhstan are suffering a locust invasion. An effective measure to combat locusts is to plow up of their larval nesting sites, which has not been done in these vast wastelands for many years. Due to a manifold reduction in livestock, the load on pasture landscapes has sharply decreased. Thus, steppe mat began to accumulate almost everywhere. However, its formation, combined with the spread of tall-weedy overgrowth, sharply increased the fire hazard. Every year, steppe fires span up to a third of the territory in Orenburg oblast and the Trans-Volga regions of Saratov and Volgograd oblasts (Chibilev, 2004). Natural and man-made fires easily cross the state border.

In general, with normal (nonemergency) functioning of the economy, Russia poses less of a danger to its neighbors than the other way around. For example, fluxes of anthropogenic sulfur and nitrogen entering the Russian Plain from Western Europe are three to eight times higher than those going the other way. In reality, Russia suffers more (environmentally) from its

neighbors than vice versa. This should be taken into account and used in foreign policy activities.

Not all external environmental threats are determined by the country's ecological and geographical position. Some of these threats are generated by the mechanisms of international division of labor. A striking example is the export of platinum group metals by Norilsk Nickel to Japan and the United States, where they are used in catalytic converter to combat automobile emissions. The more stringent the requirements on the cleanliness of exhaust, the greater the demand for these products. The struggle for clean air abroad intensifies air pollution in Russia. Note that Norilsk Nickel is the largest air polluter in Eurasia in terms of sulfur oxides.

CONCLUSIONS

Russia's natural-resource and natural-ecological self-sufficiency favors its sustainable development. The unfavorable features of the country's geographical position—the burdens of space and nature—make it difficult for its “frontal” inclusion in the international division of labor. A science-based territorial policy can and should fortify Russia's advantages of location and mitigate its shortcomings. This can be facilitated by the organization on Russian territory and water areas of railway and sea superhighways and the central link of a single integrated Eurasian infrastructure.

Russia's natural conditions are not fated to lag behind the economic vanguard of the planet. This geographic optimism is related to the targeted search for promising sectors of specialization with which Russia could successfully enter the global market, as well as with the development of its own technologies, its own methods for organizing production, and the territorial organization of society.

Fixing the severity of domestic environmental problems, it is important to understand that in a wide range of parameters, Russia is among the world's prosperous countries and is a major environmental power (Klyuev, 2015). Because of this, important sectors of Russia's specialization in the global market are production of pure agricultural products and provision of recreational and environmental services.

Russia's extrapure, “virgin” territories are concentrated in its northern regions. This implies the importance of agricultural development of the North: development of northern agriculture, pasture—nomadic animal husbandry: reindeer, herd-horse, maral, and yak breeding. In addition to obtaining environmentally acceptable products, the agrarian development of the North will help support its indigenous peoples, as well as improve the extremely unfavorable spatial situation in which Russia now finds itself. Agriculture is the industry that primarily develops the country's territory. Such development has geopolitical significance that is not measured by economic criteria.

Russia's natural potential makes it possible with its own resources to compensate for internal disruption of environmental conditions. Moreover, it can withstand negative externalities on nature. The country's environmental defects are high resource intensity and specific waste output, and concentration of sources of potential risk. Without eliminating these defects, it is difficult for Russia to take on the role of an environmental leader of the planet.

Russia's role as the world's main treatment plant should be used to strengthen its positions in international relations, particularly since the weight of environmental factors in global politics is steadily increasing.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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