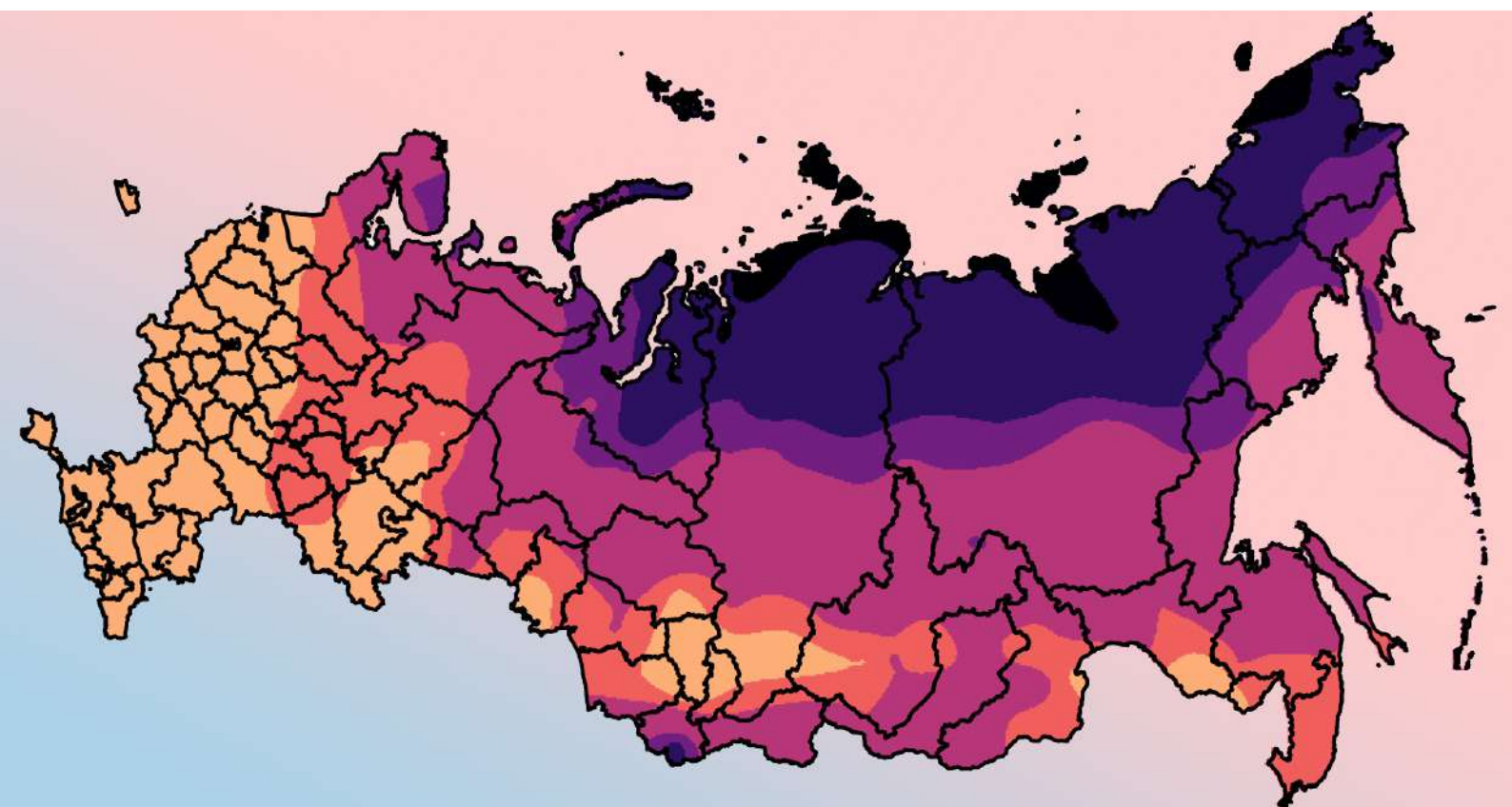


Vulnerability of Russian Population to Climate Change

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Human in the Era of Technological
Transformations

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Introduction

Global climate change impacts the human capital, economy and ecosystems of all countries, including Russia. In Russia (especially in the Arctic zone of the Russian Federation) the pace of climate warming is significantly faster than the global average. Climate change has some positive consequences – lower energy consumption for heating in winter, less discomfort from low temperatures and their negative impact on human health, more heat available to plants and better conditions for agriculture (provided there is enough moisture) and forest growth (with proper forest management).

However, climate change brings with it a number of risks. In the south, the population is facing a water crisis: the lack of fresh water affects agriculture, which is important for regional economies, and makes it more difficult to access clean potable water. The European part of Russia and southern Siberia are at risk of more frequent heat waves (as well as wildfires), which cause mortality rates to rise during hot seasons, especially among the elderly, people with chronic conditions, young children and socially excluded populations¹.

Russian regions and municipalities differ dramatically in terms of their vulnerability to climate change shocks and risks. These differences stem from current natural and climatic conditions, the structure of regional and local economies, and nature management practices. The first thing to consider is the change in living conditions of the population under climate change, since human capital is a key factor in long-term development.

¹ Climate Change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Pörtner, H.O., Roberts, D.C., Adams, H., Adler, C., Aldunce, P., Ali, E., Begum, R.A., Betts, R., Kerr, R.B., Biesbroek, R. and Birkmann, J. (2022). Climate change 2022: Impacts, adaptation and vulnerability. IPCC Sixth Assessment Report.

Changes in natural and climatic conditions in Russia

The assessment of population vulnerability to climate change should take into account the spatial unevenness of both warming and its natural impact, as well as Russia's level of territorial development and population density. Large-scale macro-regional shifts in population distribution in the post-Soviet period, growing housing density in few urban areas and agglomerations occur in the context of rising frequency of natural and climatic hazards and changes in climate favorability in different parts of the country. The presented study assesses the distribution of the Russian population in the second half of the 20th – early 21st centuries by nature and climate comfort zones.

The first stage used climate data obtained using the methodology developed at the Institute of Geography of the Russian Academy of Sciences¹, to produce a comprehensive assessment of integral estimates of *comfort (discomfort) of natural and climatic living conditions* in Russia at each point of the degree grid (2.5° x 2.5°). Both zonal and azonal factors of natural and climatic comfort are considered². Each indicator is converted into a score and then the average is calculated.

Seven comfort zones regarding natural and climatic living conditions (Table 1) for average annual conditions of 1961-1990 (from the most favorable to absolutely unfavorable) are identified and their dynamics in subsequent periods is shown: 1991-2000, 2001-2010, 2011-2020.

Table 1
Area of comfort zones re. natural and climatic conditions (% of Russia's territory)

Zone #	Comfort zone	Score	1961–1990	1991–2000	2001–2010	2011–2020
1	Most favorable	< 2.00	2	0.1	3	0.4
2	Favorable	2.00–3.29	7	13	10	14
3	Conditionally favorable	3.30–3.59	6	7	6	9
4	Conditionally unfavorable	3.60–4.49	22	25	30	34
5	Unfavorable	4.50–4.89	19	14	15	12
6	Very unfavorable	4.90–5.69	21	25	21	23
7	Absolutely unfavorable	≥ 5.70	23	16	15	8

The calculations reflect two significant trends in the change of natural and climatic living conditions in Russia over the last three decades (Figure 1). The first has to do with the expansion of the favorable and conditionally favorable zone in the north of the European territory of Russia (ETR), south of Siberia and the Far East. As a result, by the 2010s the favorable zone area increased from 7% to 14% of the Russian territory as compared to 1961-1990. At the same

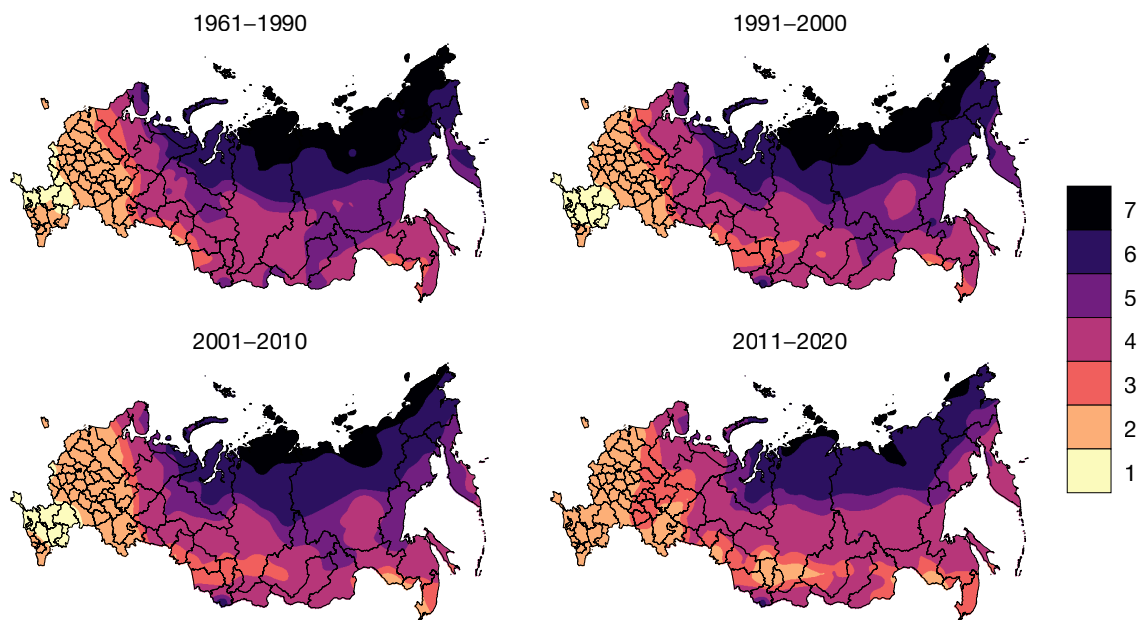
¹ A.Zolotokrylin, A.Krenke, V.Vinogradova. Zoning of Russia by natural living conditions of the population. M.: Geos, 2012. 156 c.

² Mountainous (absolute altitude of the terrain); wetlands (proportion of wetlands); natural phenomena (seismicity, floods, typhoons, tsunami).

time, unfavorable conditions zones, which previously covered significant areas in the Asian part of the country, shrank: the «absolutely unfavorable» zone area declined from 23% to 7% of the territory, «unfavorable» – from 19% to 12%. This is a positive effect of climate warming. In these areas, the temperature rise mitigates cold, – one of the key factors of discomfort in most of Russia.

However, the growing climate extremes and aridity, especially manifested in the 2010s as a series of droughts, caused deterioration of the situation in the south of European Russia and in the Volga region. By the 2010s, compared to 1961-1990, the area of the «most favorable» zone decreased from 2% to 0.4%. In these parts of Russia, which used to offer the most favorable living conditions, climate change, on the contrary, is a negative factor.

Figure 1
Natural and climate comfort zones



1 – most favorable, 2 – favorable, 3 – conditionally favorable, 4 – conditionally unfavorable, 5 – unfavorable, 6 – very unfavorable, 7 – absolutely unfavorable

Vulnerability of the Russian population to climate risks

In order to assess the scale of natural and climatic changes for the population, we compared the results of climatic calculations with demographic data. Statistical data and population projections are presented by administrative-territorial units, while climatic data are presented on a regular coordinate grid. Therefore, it is impossible to make direct comparisons of population size and the value of the climate comfort index for large northern and eastern regions with contrasting population densities that are located on the border of natural and climatic zones. To connect the data on climate and population, the potential of the settlement pattern was calculated using the data on the current settlements network (156 thousand settlements in total): at each point, the values of the potential are higher the larger and closer the settlements are within a 90 km range.

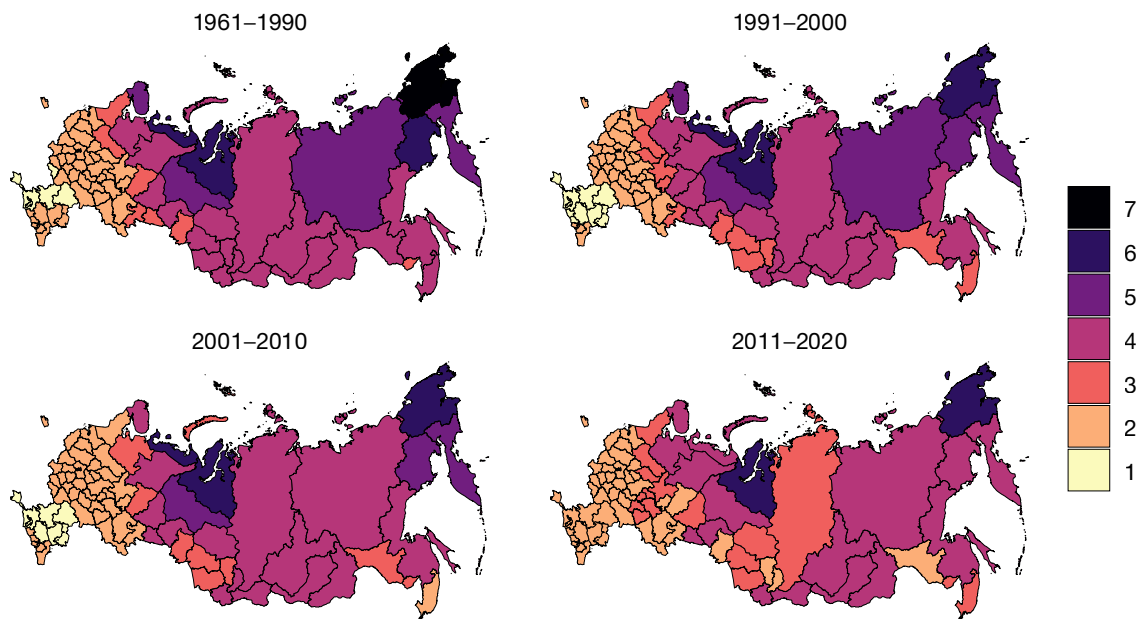
When calculating the average climate comfort index for the region, the values in each point were weighted by the potential of the settlement pattern and averaged. Thus, the final assessment of climate comfort in the region for different time periods takes into account densely populated areas to a greater extent, and sparsely populated areas to a lesser extent. The resulting distribution of the population by zones of natural and climatic comfort (Table 2) permits assessing the scale and trends in the change of climatic living conditions taking into account shifts in settlement patterns as a result of natural population increase/decline and migration. Changes in natural and climatic conditions during the post-Soviet period have affected tens of millions of people (Figure 2): for the better – primarily in the Urals, the south of Western Siberia and the Far East (a total of 19 regions), for the worse – in the south of European Russia and the Volga region (a total of 15 regions).

On the one hand, the population in the most unfavorable zones has noticeably shrank, both due to climate change and the transition of regions to more favorable zones, and due to the migration outflow as part of the «western drift» phenomenon described in detail in research¹ with regard to intra-Russian migration in the post-Soviet period and outmigration from northern regions (Yamalo-Nenets Autonomous Okrug is an exception due to the ongoing expansion of natural gas production and high wages that attract migrants). In the Urals, the south of Western Siberia and the Far East, a number of regions (with a total population of 14.4 million people) moved from «conditionally unfavorable» to «conditionally favorable» zone. On the other hand, densely populated regions of the south of European Russia with a total population of 14.0 million people moved from the «most favorable» to «favorable» zone.

¹ Migration in Russia: western drift. <https://polit.ru/article/2005/01/17/demoscope185/>
N.Mkrtchyan. Cities in the East of Russia "Under Pressure" from Population Squeeze and Western Drift // Demoscope Weekly. 2015. № 631-632. <http://www.demoscope.ru/weekly/2015/0631/analit03.php>

Figure 2

Assessments of natural and climate comfort of living conditions by region taking into account uneven settlement patterns



1 – most favorable, 2 – favorable, 3 – conditionally favorable, 4 – conditionally unfavorable, 5 – unfavorable, 6 – very unfavorable, 7 – absolutely unfavorable.

The scale of the climate change impact on population distribution by zones of natural and climatic comfort is much greater than the shifts in settlement patterns. Climate change over 30 years has led to changes in the living conditions of more than 30 million people, and the impact of shifts in population distribution (primarily migration) is manifested mainly in the growth of the population of the favorable zone by 7.3 million people. It is in this zone that the largest regions attracting migrants are located – metropolitan agglomerations (Moscow and the Moscow Region, St. Petersburg and the Leningrad Region) and the southwestern regions of European Russia – the Belgorod and Rostov Regions, the Krasnodar Territory and Adygea, as well as Crimea. But ultimately both factors work in the same direction – towards concentration of population in areas with favorable conditions, therefore two zones (2 and 3) accounted for almost 90% of Russia's population in 2011-2020 (Table 2).

Table 2
Population estimates, by natural and climatic comfort zone

Zone	Comfort zone	Average annual* population (mln people)				Change (mln people) from 1961- 1990 to 2011-2020, including due to:	
		1961–1990	1991–2000	2001–2010	2011–2020	Shifts in settlement patterns	Climate change
1	Most favorable	14.0	19.9	19.0	0.0	0.0	–14.0
2	Favorable	76.9	7.,8	88.7	101.0	+7.3	+16.8
3	Conditionally favorable	11.5	2.,3	15.1	29.4	–0.25	+18.2
4	Conditionally unfavorable	29.5	2.,9	21.0	15.0	–0.1	–14.4
5	Unfavorable	2.5	4.1	2.0	0	0.0	–2.5
6	Very unfavorable	0.5	0.7	0.6	0.6	+0.3	–0.3
7	Absolutely unfavorable	0.1	0.0	0.0	0.0	0	–0.1

* Census data on population of RSFSR/RF regions for 1959, 1970, 1979, 1989, 2002, 2010, and current Rosstat estimates for 2020.

Conclusion

The retrospective trend analysis of changes in natural and climatic conditions and settlement patterns over the last 30 years allows suggesting the future trajectory of these processes (additional forecast studies are needed, however, and these are planned by the Center).

In the future, by 2050, natural and climatic conditions will become more favorable in most parts of Russia due to climate warming. But this trend primarily concerns the sparsely populated regions of the north and east of the country, where the population is small and continues to decline. In addition, the vulnerability of the population, infrastructure and sectors of the economy to extreme natural and climatic phenomena will generally increase. One of the most significant climatic risks in the north of the country is permafrost melting, which threatens to destroy the infrastructure located on it. In Siberia, wildfires are becoming more of a problem: they not only reduce forest cover and destroy infrastructure, but also pose a threat to human life.

Yet, the vulnerability of the population to unfavorable climatic conditions will decrease in the future due to climate warming and the population moving from the northern and eastern regions with unfavorable living conditions to the southern and western regions. However, the southern regions of the European part of Russia with the most favorable natural conditions and high concentration of population and economy (including agriculture) will see a deterioration of natural and climatic conditions.

It is ironic that throughout the post-Soviet period, the main trend in Russia's spatial development has been the shift of population and economy to the south and west (as well as to the largest urban agglomerations) – and it is these regions that have been most exposed to the negative effects of climate change, – while in the northern and eastern regions the natural and climatic living conditions are rather improving, but this does not stop out-migration.

Climate change has already become irreversible, therefore, the policies aimed to reduce GHG emissions notwithstanding, adaptation to global climate change by key sectors of the economy, cities, and infrastructure is necessary. On December 25, 2019, the Russian Government approved the national action plan to support the first stage of climate change adaptation for the period until 2022. Adaptation plans are developed at both federal, corporate and regional levels, relevant Recommendations¹, have been adopted, but this work is at the initial stage. Most regions have not produced adaptation plans, while existing plans are formal and lack detail; besides, the current methodologies are not without limitations, too. It is essential that spatially differentiated climate change vulnerability assessments are effectively integrated into federal, regional and city strategic planning systems.

¹ Ordinance of the Ministry of Economic Development of Russia No. 267 dated May 13, 2021 «On Approval of Methodological Recommendations and Indicators Regarding Climate Change Adaptation».