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CLIMATE CHANGE IN RUSSIA: HISTORICAL DYNAMICS

Danilchenko, Sergey Leonidovych[1]

[1]Doctor of Historical Sciences, Professor, Sevastopol State University, 33, Universitetskaya Street, Sevastopol, Russia, E-mail: sldistorik@bk.ru

Abstract

The article discusses the historical aspects of climate change in Russia in the context of modern urbanization, where the degree to which this factor is taken into account in the strategic plans for the development of cities will largely depend on their sustainable development, and in addition, the security of most of humanity in the current and future centuries. In many megacities of the world, there is already a significant vulnerability of their territories, economy and population to dangerous hydrometeorological phenomena, the frequency of which increases with global warming. The adaptation of modern Russia to ongoing and predicted climate change, including in terms of reducing greenhouse gas emissions, largely depends on what measures will be taken in urban areas.

Keywords: climate, control, man, history, civilization.

I. INTRODUCTION

The climatic conditions of the European territory of Russia (ETR) are determined, first of all, by its geographical position within the continent and its great extent, both in longitude and latitude. The climate of this part of Russia is generally temperate continental (Borisov, 1967).

This area in summer is influenced by winds with a westerly component, to which it largely owes its summer rains. The absence of high mountains allows cold air masses to penetrate far to the south and warm ones from south to north.

In winter, the influence of the Atlantic is noticeable up to the Urals. This leads to the fact that the decrease in air temperatures can be traced from the southwest to the northeast.

In the south, the distribution of isotherms is close to latitudinal, since here even in winter continental air prevails, there is little cloudiness, and the role of radiation conditions and latitude is great.

The "Pole of Cold" on the European territory is located in the basin of the Pechora River (Shchugor River), where the air temperature occasionally drops to - 55°C (absolute minimum) (Borisov, 1967). The Kola Peninsula stands out, where some warming is noticeable due to the approach to the sea. Throughout the territory, the months from December to February are winter (with frost). The duration of the frost-free period in the northern regions (Komi, Kola Peninsula) is only 30-45 days.

A characteristic feature of the climate of the study area is snow cover. The duration of snow cover in the Far North of European Russia is 200-240 days, in the southern regions - 20-120 days. Due to thaws, the snow cover throughout the south of European Russia is small and unstable.

In summer, the thermal regime of a given territory is determined by the amount of incoming solar radiation; therefore, the distribution of isotherms is much closer to latitudinal than in winter. Absolute maximum temperatures reach even in the north 30°C. To the south, their value increases and reaches 40°C (Astrakhan, 43°C). The average annual amplitude of air temperature almost everywhere exceeds 23.5 °C.

Annual rainfall in most of the territory is 400-600 mm. The amount of precipitation for the warm period within the European part of the USSR is 350-500 mm. The amount of precipitation for the cold half-year is 300 mm on the Valdai Upland. In the middle zone of the European territory of the USSR, the precipitation of the cold half-year is 100-300 mm.

The entire interior of the European part is characterized by a spring or summer maximum of precipitation, which is a favorable factor for agriculture.

II. METHODOLOGY AND RESULTS

In general, the assessment of the impact of modern climate change and its consequences on sustainable development in the 21st century was carried out using a systematic approach. Observed and predicted climate changes on the territory of Russia were analyzed and evaluated on the basis of methods for processing hydrometeorological information.

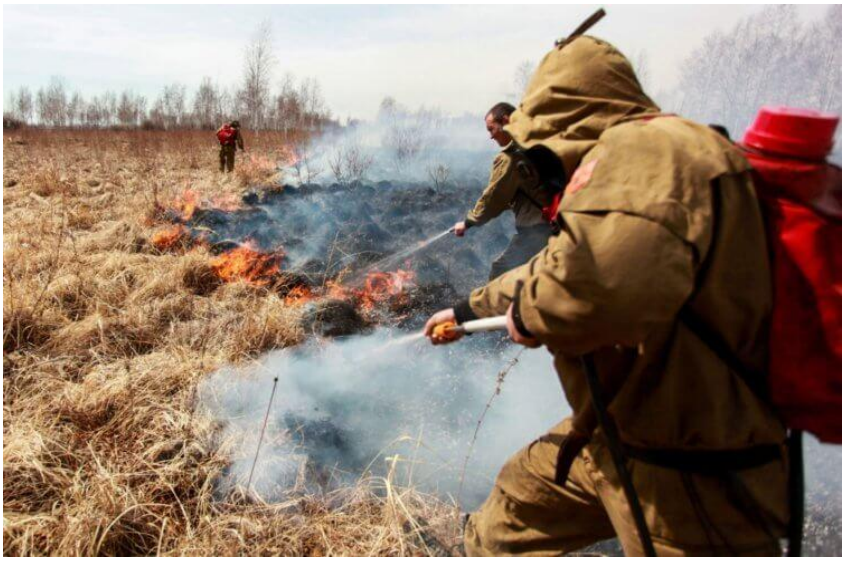
To calculate the degree of anthropogenic disturbance of the natural climate in Russia, an original method was used based on statistical processing of climatic information and methods for interpolating meteorological parameters using a complex of stations surrounding the city.

The landscape approach was used to substantiate the boundaries of the flood zone to its current position and to assess its change as a result of the development of global warming. When assessing the area of the urban territory, functional zones, an information-cartographic approach and GIS technologies were used; the number of registered land plots, capital construction projects and various structures.

Firstly, climate change in Russia is happening faster than the world average: the average annual air temperature growth rate in Russia in 1976–2019 averaged 0.47°C per ten years. This exceeds the growth rate of global temperature over the same period by more than 2.5 times. Secondly, the weather. I think it's no secret that 2020 has been the hottest year on record: Arctic ice is melting at an astonishing rate, as is permafrost. At the same time, floods and forest fires were devastating Siberia.

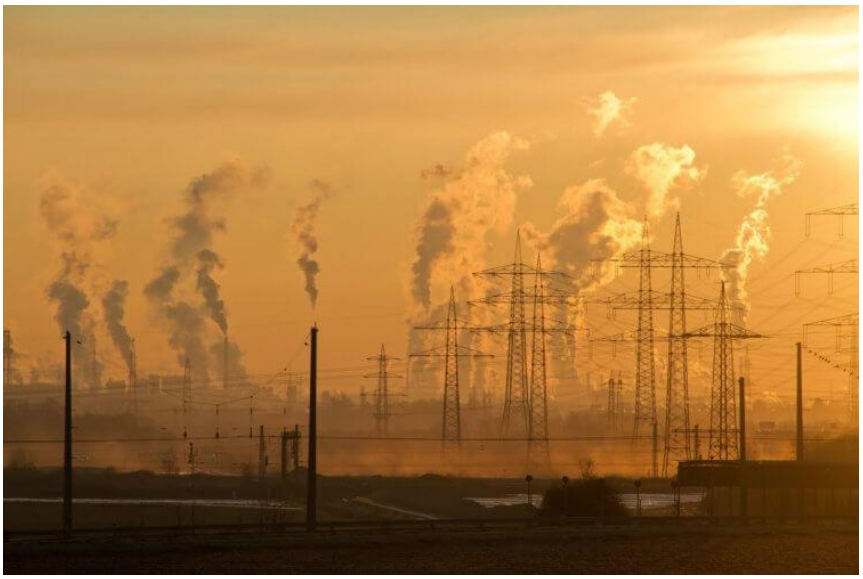
In Russia, the climate monitoring system is being developed by the Institute of Global Climate and Ecology (IGCE) of Roshydromet and the Russian Academy of Sciences, headed by Academician Yu. A. Izrael. In the monograph "Ecology and control of the state of the natural environment", published back in 1979, Yu. A. Izrael points out that "in order to understand changes and climate fluctuations, data on the state of the climate system "atmosphere - ocean - land surface - cryosphere - biota" are needed" and about the interaction of the elements of this system over a long period of time, that is, the implementation of climate monitoring. This definition singled out climate monitoring as an independent section of climatology, since it involves the study of climate change in conjunction with all other changes occurring in the natural environment, and is able to identify the limits within which its sustainable development is possible.

Observations of past decades and centuries are extremely important for assessing climate change. For the main climatic variables - air temperature and precipitation - use the data obtained by weather stations. The longest rows contain data starting from 1886, and observations were made even earlier at some stations.



Forest fires are devastating Siberia, which is extremely worrying to scientists from all over the world.

German physicist Anders Levermann urges Russians to get involved in the fight against climate change. He notes that what is happening today in Siberia causes particular concern. “We do not understand what is currently happening in Siberia. This is something new,” says Leverman, a researcher at the Potsdam Institute for the Study of Climate Change (PIK). The physicist notes that in the summer in Siberia there is often abnormal heat, and this is no secret to anyone. What's more, we also know that global warming is happening faster in the Arctic than elsewhere. "However, the average temperature, which is 7 degrees higher than usual for the corresponding season, has been holding in the vast Siberian region for six months already! Here's what we don't understand: Why is it taking so long? This is a new climate phenomenon that needs to be studied". Given the rise in extreme weather events in the past, the Russian government has finally acknowledged that climate change poses a serious threat to Russia's future and has developed action plans accordingly. And yet, climate decisions are made reluctantly, which is not surprising. After all, the Russian economy is heavily dependent on fossil fuel exports. And this, obviously, does nothing to solve the problems caused by global warming. But what, then, needs to be done to make the fight against climate change effective?



Russia ranks fourth in the world in terms of CO2 emissions into the atmosphere.

In 2020, our country finally ratified the Paris Agreement, the main goal of which is to prevent global temperatures from rising by 2% above pre-industrial levels. However, under its nationally determined contributions, Russia is not required to reduce emissions from current levels or adopt a long-term carbon reduction strategy. "This is because, under the agreement, Moscow has pledged to cut emissions by 25-30% from 1990 levels, but it has been well below those levels since the collapse of the Soviet Union and its industrial production in 1991."

The main goal of the Paris climate agreement is to prevent the increase in the average temperature on the planet by more than 1.5 Celsius.

Plans to minimize damage from climate change should cover all areas of human activity, including health, agriculture and infrastructure.

In Russia, for example, it is necessary to change storm sewers, prepare for storm winds (recalculate the strength of structures), change the fire extinguishing system - droughts increase the fire hazard.

However, different states have different opportunities to offset the impact of climate change. So, for example, Holland and Bangladesh are experiencing the same problems: there are more storms, the sea level has risen. But Holland already has a plan of action, they know how they will strengthen the dams, where they will get the funds from. But in Bangladesh, none of this, with 10 times the coastline and 10 times the population, and in dangerous areas live 100 million people who will need to be relocated somewhere.

Thus, most of the measures required for adaptation are quite simple and straightforward, but their implementation requires funds and effective planning.

Climatologists estimate that to keep temperature rises within 2°C, countries need to halve global emissions by 2050 relative to 1990 levels, and cut to zero by the end of the 21st century.

According to PwC analysts, since 2000, Russia has reduced carbon dioxide emissions by an average of 3.6% per year, the UK - by 3.3%, France - by 2.7%, the USA - by 2.3%. The average annual reduction in carbon emissions over the past 15 years was 1.3%.

However, these efforts are not enough. To prevent irreversible climate change, the annual reduction in carbon dioxide emissions until 2100 should be at least 6.3%.

This means, on the one hand, it is necessary to introduce energy-saving technologies, on the other hand, to switch to alternative energy sources.

Several sources of energy are safe for the atmosphere in terms of emissions: hydropower, nuclear power plants and new renewable sources - the sun, wind, tides. Hydropower has physically visible limits (there are not so many rivers on Earth), wind and tides can only be used locally, so the main energy sources of the future are the Sun and the atom, says Professor Rafael Harutyunyan, Deputy Director of the Institute for the Safe Development of Nuclear Energy of the Russian Academy of Sciences.

According to the expert, based on the current level of technology development, nuclear energy looks more solid: the share of alternative renewable energy sources now accounts for 2% of world consumption, and the atom already provides 16% of the world's electricity (in developed countries - more than 70%, in the north - western Russia - 40%).

The advantage of nuclear energy is that it is a large energy industry, these are power plants for large industrial agglomerations, large cities.

The trump card of solar energy is the almost universal availability and dynamic development of technologies. In addition, solar energy is improving and can become much more economical, unlike nuclear energy, which can no longer be significantly cheaper, Aleksey Kokorin, head of the Climate and Energy Program at WWF Russia, argues with supporters of the atom.

Advisor to the President of the Russian Federation and his representative on climate issues Alexander Bedritsky believes that it is impossible to completely solve the problem of reducing greenhouse gas emissions through renewable energy sources. The expert cited solar and wind energy as an example. According to him, it is impossible to provide industry with energy using solar panels in northern countries, such as Russia, where there is sun in the north for half a year, and no sun for half a year.

The same, according to Bedritsky, applies to wind energy. It is suitable for individual consumption, but not for industrial production. Windmills are used in many regions, mainly in coastal areas, but there is no continuous coverage of the territory.

In Russia, adds climate adviser to the President of the Russian Federation, about a third of the energy industry is based not on mineral raw materials, but on nuclear and hydropower.

III. CONCLUSION

Modern computational climate models take into account not only temperature and precipitation, but also many additional parameters, including the content of carbon dioxide in the atmosphere (the same that is formed during the combustion of fuel and causes the greenhouse effect).

What happens if the concentration of carbon dioxide doubles? For most regions of Russia, the forecast gives a moderate average increase in precipitation (by 10-30%), but their nature will change. In the temperate latitudes of the Northern Hemisphere, heavy showers and heavy snowfalls will be more frequent, and on the planet as a whole, temperature contrasts between continents and oceans will intensify, and monsoons will become more intense in East Asia.

It must be admitted that it has not yet been possible to create a climate model that would describe well the real changes in temperature and precipitation. And this is due not only to the imperfection of algorithms and approaches or insufficient data, but also to the fact that all atmospheric processes are probabilistic in nature, and this introduces a significant amount of uncertainty into any calculations. Nevertheless, the general trend remains unchanged: the climate continues to warm up both in Russia and in the world.

That is why it is necessary to continue to conduct a thorough comparative analysis of model and empirical estimates of climate change.

REFERENCE LIST

Borisov A.A. (1967) Climatography of the Soviet Union. LSU. 309 p. (In Russ).

Easterling D.R. (2002) Recent changes in frost days and the frost-free season in the United States. Bull. Amer. Meteor. Soc. Vol. 83. Pp. 1327-1332. (In Engl).

Galin V.Y., Volodin E.M., Smyshlyaev S.P. (2003) A model of general atmospheric circulation of the IVM RAS with ozone dynamics. Meteorology and hydrology. Vol. 5. Pp.13-23. (In Russ).

Gruza G.V., Rankova E.Y., Rocheva E.V. (2007) Climatic changes in atmospheric precipitation on the territory of Russia according to instrumental observations. Use and protection of natural resources in Russia. Vol. 5. Pp. 37-42. (In Russ).

Haylock M.R., et al. (2006) Trends in Total and Extreme South American Rainfall in 1960-2000 and Links with Sea Surface Temperature. J. Climate. Vol. 19. Pp. 1490-1512. (In Engl).

Israel Y.A., Pavlov A.V., Anokhin Y.A., Ball L.T., Sherstyukov B.G. (2006) Statistical estimates of the dynamics of changes in climate elements in permafrost areas on the territory of the Russian Federation. Meteorology and Hydrology. Vol. 5. Pp. 27-38. (In Russ).

Kislov A.V. (2001) Climate in the past, present and future. M., MAIK "Science/Interperiodics". 351 p. (In Russ).

Klein Tank and Konnen G.P. (2003) Trends in indices of daily temperature and precipitation extremes in Europe, 1946-1999. J. Climate. Vol. 16. Pp. 3665-3680. (In Engl).

Mirvis V.M., Guseva I.P. (2006) Estimates of changes in the duration of the frost-free vegetation period on the territory of Russia and neighboring states in the XX century. Meteorology and Hydrology. Vol. 1. Pp. 106-113. (In Russ).

Neushkin A.I., Sanina A.T., Ivanova T.B. (2007) Cold (severe) and warm winters in the federal districts of the European part of Russia. Proceedings of VNIIGMI-MCD. Vol. 173. Pp. 260-265. (In Russ).

Plummer N, Lin Z, Torok S. (1995) Trends in the diurnal temperature range over Australia since 1951. J. Atmos Res. Vol. 37. Pp. 79-86. (In Engl).

Semenov V.G. (1961) To the question of the influence of the underlying surface on the circulation of the atmosphere. Meteorology and Hydrology. Vol. 6. Pp. 46-49. (In Russ).

Sirotenko O.D., Abashina V.V. (1994) The impact of global warming on agro-climatic resources and agricultural productivity in Russia. Meteorology and Hydrology. Vol. 4. Pp. 101-112. (In Russ).

Sochava V.B. (1978) Introduction to the doctrine of geosystems. Novosibirsk. Nauka. 319 p. (In Russ).

Torok S.J., Nicholls N. (1996) A historical annual temperature dataset for Australia. Aust Meteorol. Mag. Vol. 45. Pp. 251-260. (In Engl).

Vincent L.A. (2005) Observed trends in indices of daily temperature extremes in South America 1960-2000. J. Climate. Vol. 18. Pp. 5011-5023. (In Engl).

ИЗМЕНЕНИЯ КЛИМАТА В РОССИИ: ИСТОРИЧЕСКАЯ ДИНАМИКА

Данильченко Сергей Леонидович[1]

[1]Доктор исторических наук, профессор, Севастопольский государственный университет, ул. Университетская, 33, Севастополь, Россия, E-mail: sldistorik@bk.ru

Аннотация

В статье рассматриваются исторические аспекты изменения климата в России в контексте современной урбанизации, где степень учета этого фактора в стратегических планах развития городов во многом будет зависеть от их устойчивого развития, а кроме того, безопасность большей части человечества в нынешнем и будущем веках. Во многих мегаполисах мира уже наблюдается значительная уязвимость территорий, экономики и населения к опасным гидрометеорологическим явлениям, повторяемость которых увеличивается с глобальным потеплением. Адаптация современной России к происходящим и прогнозируемым изменениям климата, в том числе в части снижения выбросов парниковых газов, во многом зависит от того, какие меры будут приняты в городах.

Ключевые слова: климат, контроль, человек, история, цивилизация.

СПИСОК ЛИТЕРАТУРЫ

Borisov A.A. (1967) Climatography of the Soviet Union. LSU. 309 p. (In Russ).

Easterling D.R. (2002) Recent changes in frost days and the frost-free season in the United States. Bull. Amer. Meteor. Soc. Vol. 83. Pp. 1327-1332. (In Engl).

Galin V.Y., Volodin E.M., Smyshlyaev S.P. (2003) A model of general atmospheric circulation of the IVM RAS with ozone dynamics. Meteorology and hydrology. Vol. 5. Pp.13-23. (In Russ).

Gruza G.V., Rankova E.Y., Rocheva E.V. (2007) Climatic changes in atmospheric precipitation on the territory of Russia according to instrumental observations. Use and protection of natural resources in Russia. Vol. 5. Pp. 37-42. (In Russ).

Haylock M.R., et al. (2006) Trends in Total and Extreme South American Rainfall in 1960-2000 and Links with Sea Surface Temperature. J. Climate. Vol. 19. Pp. 1490-1512. (In Engl).

Israel Y.A., Pavlov A.V., Anokhin Y.A., Ball L.T., Sherstyukov B.G. (2006) Statistical estimates of the dynamics of changes in climate elements in permafrost areas on the territory of the Russian Federation. Meteorology and Hydrology. Vol. 5. Pp. 27-38. (In Russ).

Kislov A.V. (2001) Climate in the past, present and future. M., MAIK "Science/Interperiodics". 351 p. (In Russ).

Klein Tank and Konnen G.P. (2003) Trends in indices of daily temperature and precipitation extremes in Europe, 1946-1999. J. Climate. Vol. 16. Pp. 3665-3680. (In Engl).

Mirvis V.M., Guseva I.P. (2006) Estimates of changes in the duration of the frost-free vegetation period on the territory of Russia and neighboring states in the XX century. Meteorology and Hydrology. Vol. 1. Pp. 106-113. (In Russ).

Neushkin A.I., Sanina A.T., Ivanova T.B. (2007) Cold (severe) and warm winters in the federal districts of the European part of Russia. Proceedings of VNIIGMI-MCD. Vol. 173. Pp. 260-265. (In Russ).

Plummer N, Lin Z, Torok S. (1995) Trends in the diurnal temperature range over Australia since 1951. J. Atmos Res. Vol. 37. Pp. 79-86. (In Engl).

Semenov V.G. (1961) To the question of the influence of the underlying surface on the circulation of the atmosphere. Meteorology and Hydrology. Vol. 6. Pp. 46-49. (In Russ).

Sirotenko O.D., Abashina V.V. (1994) The impact of global warming on agro-climatic resources and agricultural productivity in Russia. Meteorology and Hydrology. Vol. 4. Pp. 101-112. (In Russ).

Sochava V.B. (1978) Introduction to the doctrine of geosystems. Novosibirsk. Nauka. 319 p. (In Russ).

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Vincent L.A. (2005) Observed trends in indices of daily temperature extremes in South America 1960-2000. J. Climate. Vol. 18. Pp. 5011-5023. (In Engl).