Russia faces tough climate change challenges

Melting permafrost, dying forests, and fragile ecosystems, combined with poor resource management, means climate change could hit the Russian people especially hard

With its millions of hectares of boreal forests, vast supplies of fresh water, and rich stores of gas, oil, and other natural resources, Russia is a study in complex and fragile ecosystems. And with more than two-thirds of those ecosystems based on frozen ground, or permafrost, Russia is expected to experience some of the earliest and most dramatic effects of climate change—almost all of them bad.

Many of the changes, such as melting permafrost in Siberia and dying forests across Russia's northern tier, will be caused directly by the warming and instability of the climate. Other changes, including increasing industrial contamination of soil and water with toxins, destruction of the environment in regions with intensive gas and oil extraction, and loss of forests to encroaching grasslands, are being caused by poor resource management that will accelerate the negative impacts of climate change.

That bleak portrait comes from the research of IIASA's Environmental Services and Management (ESM) team, headed by Anatoly Shvidenko, a modeler and forestry expert who has studied Russian forests and ecosystems for decades. His concern over the future of the Russian land has grown as he and an international team of experts have studied the ecological changes expected from climate change and the increasing exploitation of Russia's natural resources.

In the past year, thanks to a collaboration with scientists from Japan's GOSAT (Greenhouse Gases Observing Satellite), the ESM team has developed a "reality-based" assessment of the carbon exchange between the land and atmosphere over Russia. This greenhouse gas accounting system, more accurate than past tools, has allowed researchers to use several models to check their results against data already gathered on the Russian environment and to assess how the future is likely to affect water supplies, agriculture, forests, and fauna across the country.

Called the Integrated Land Information System (ILIS), this information base combines data from eight satellites with a myriad of ground-based measurements. While information about Russian ecosystems has been available for years, Shvidenko says much of it, particularly official data from the Russian public administration, is obsolete or unreliable.

To create the up-to-date view of Russian ecosystems, IIASA researchers used the best current information from an array of reliable sources and can now provide accurate answers to many questions about Russia's ecosystems and their carbon budgets. But even using multiple models and several databases, understanding the dynamics and evolution of Russia's vast ecosystems under the stress of climate change is difficult.

"The complexities of a changing world cannot be understood using a simple cause and effect approach," Shvidenko says. "Integrated modeling and systems analysis remains one of the few tools able to provide answers."

East Siberia, as well as other regions in Russia's northern tier, is particularly susceptible to climate change and, according to the current scenarios of the Intergovernmental Panel on Climate Change (IPCC), is likely to experience the most dramatic climate change on the globe. While the IPCC is hoping to limit the Earth's average warming to 2 °C by mid-century, the ESM models predict a 6–10 °C increase for vast territories of Northern Eurasia, including much of Siberia, by the end of this century.

Concurrent with that increase, water supplies in vast areas of the region may decrease substantially. The ESM research shows that the climate warming will negatively impact the vitality and productivity of ecosystems and likely lead to an explosive acceleration of natural disturbances, particularly wildfires and outbreaks of insect infestation.

IIASA modeling indicates that as the permafrost melts and the already severe forest fire problem gets worse, agricultural lands in river valleys will face increased flooding. The flooding will result from rains that are more intense, but less frequent as climate warming increases the length of hot, dry periods during the summer.

Photo: Dr. L. Vaschuk

Climate change will also shift Russia's climatic zones, according to a number of models, and that, in turn, will cause a redistribution of vegetation. Some modeling shows a two-fold decrease in forested areas by the end of the century, and a significant increase in "desertified steppes."

Such changes will affect biodiversity and ecosystems productivity, including plants, forests, wild animals and—not least of all—people. The wellbeing and standards of life of local populations in the affected areas could be hit hard, particularly through the loss of stable crops in agriculture, hunting, and other means of subsistence, Shvidenko says.

The risks for terrestrial ecosystems, particularly agriculture and forestry, from climate change and anthropogenic pressure can be categorized as the following:

- Loss of soil fertility due to water erosion, soil compaction, lack of nutrients, changing water tables, and soil contamination.
- Impoverishment of soil biota causing a decline in productivity of land.
- Lack of water resources in expanding arid regions in the south.
- Increased periodic flooding of agricultural lands, particularly in river valleys.
- Outbreaks of pests, such as the Siberian silk moth, and harmful microorganisms.
- Green desertification in areas where forests are lost to unproductive grasslands.
- Increasing air pollution, as well as soil and water contamination.

What is under way in Russia in terms of ecological changes due to climate change combined with poor management of natural resources is a "crisis," Shvidenko says. ESM researchers note that the development of an advanced unified ecological management policy, especially for Russia's northern regions, is critical. Given the rapid changes anticipated because of climate change, integrated observation systems that cover the entire circumpolar boreal forest biome should be developed to provide early warning of changes, and the researchers recommend the establishment of a system of protected territories, based on their fragile and vulnerable ecology, needs to be developed for high latitude territories.

The ESM assessment shows that wild fires burned an average of 8.23 million hectares of Russian land and released 121 million tons of carbon to the atmosphere annually during the past 12 years, and the problem is expected to worsen over the next few decades. The Russian government needs to develop policies that have a clear emphasis on protecting the natural landscapes, particularly forests. The exploitation of forests and other natural resources in environmentally sensitive regions of Russia must be brought under control through a policy-based approach that recognizes the challenges caused by climate change.

Finally, the assessment notes, although there is widespread scientific agreement on the overall impacts of climate change, the uncertainties of estimates and predictions are high. Those uncertainties must be dealt with through better observation and data gathering, continued in-depth analyses, and recognition by policymakers that, despite the uncertainties, the need to set policies for biophysical, ecological, social, and economic issues arising out of climate change is urgent. ■

Further information Shvidenko A (2009). Terrestrial ecosystems in Northern Asia, global change and post Kyoto developments. In: *Resource Economics, Environmental Economics and Climate Change—2009*. Proceedings of International Conference, 1–7 July 2009, Siberian Federal University, Krasnoyarsk, Russia, pp. 665–678. Available at www.iiasa.ac.at/Research/FOR/forest_cdrom/Articles/Shvidenko_2009_Kyoto.pdf.

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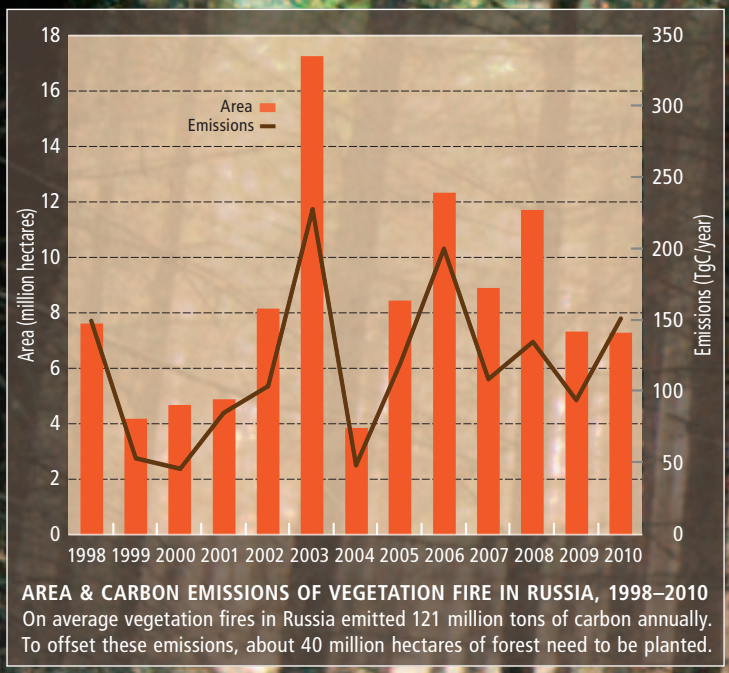
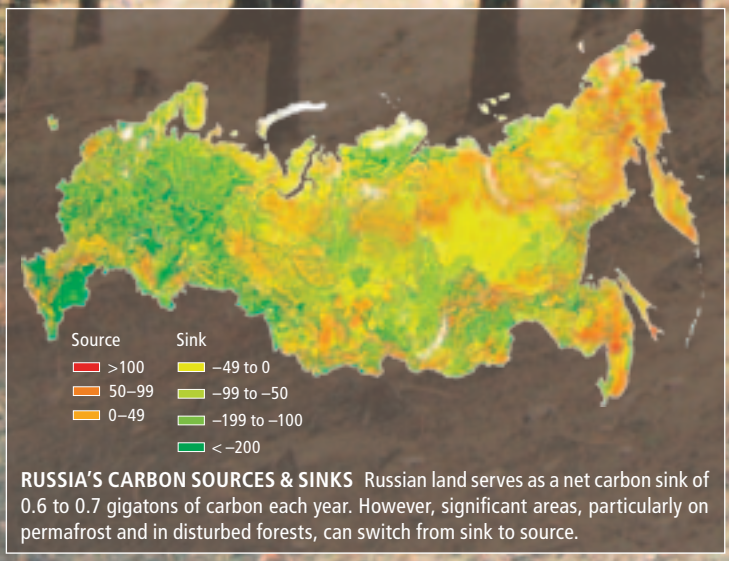


AREA & CARBON EMISSIONS OF VEGETATION FIRE IN RUSSIA, 1998–2010 On average vegetation fires in Russia emitted 121 million tons of carbon annually. To offset these emissions, about 40 million hectares of forest need to be planted.



RUSSIA'S CARBON SOURCES & SINKS Russian land serves as a net carbon sink of 0.6 to 0.7 gigatons of carbon each year. However, significant areas, particularly on permafrost and in disturbed forests, can switch from sink to source.