Moving beyond test tube studies, Verfaillie's team has made chimeric mice by injecting single mouse MAPCs into 12 mouse blastocysts, she reported at Keystone. This technique creates a mosaic animal—called a chimera—made up of cells derived from the original blastocyst as well as the progeny of the injected MAPCs. Four of the injected blastocysts grew into chimeras, and in two of the animals, Verfaillie reported, 45% of the body tissues tested expressed the MAPC genome. Moreover, these cells showed up in every organ, suggesting that they are capable of turning into all three embryonic germ layers: the mesoderm, the ectoderm, and the endoderm. Verfaillie doesn't yet know whether these cells will also contribute to germ line (egg and sperm) cells—a defining characteristic of ES cells.

In the final experiments Verfaillie reported at Keystone, the group infused MAPCs into young mice. The marked cells eventually showed up in lung, gut, and other tissues but were not seen in the skeleton, heart, or brain.

Verfaillie has yet to prove that her cells can fully function in the new roles they assume. For example, she observes, "we've shown they can fit into liver and make liver [products] but haven't [yet] shown they can rescue a mouse." In further experiments, she will see whether MAPCs spring into action in the heart or brain in response to injury.

Reaction to her reported work has been enthusiastic. She has shown that "the cells are stable and can contribute to a very broad spectrum of mature cell populations," says blood researcher John Dick of Toronto's Hospital for Sick Children. But her work still does not provide rock-solid evidence for plasticity, even she concedes. The missing piece, as Dick explains, is that "there's no way of knowing what the founder cell looks like"—that is, what cell gives rise to a MAPC. One possibility, says Gage, is that MAPCs are adult cells that really do show plasticity, "dedifferentiating" in culture to become multipotent. A less likely hypothesis, says Anderson, is that Verfaillie has hit upon a rare "highly multipotent" cell, a kind of universal stem cell, that could be hiding all over the body. But the fact that cells must be cultured at length before MAPCs appear "tends to argue" that they are an artifact of tissue culture, he says.

In a forthcoming paper in *Experimental Hematology*, Verfaillie describes cultivating MAPCs from mouse muscle and brain as well as bone marrow—a development that could fit with either theory. Verfaillie holds out hope that hers "could be the ultimate study that explains the results everybody else is getting."

Politicians are already keenly interested in Verfaillie's work—as a way to put ES cells out of business. Several members of Congress sought her out last winter, she says, after the press got wind of a patent application she had filed. She wrote back telling them it's too soon to draw any conclusions.

That might be a wise answer for the entire field, says Princeton's Lemischka. There are good evolutionary reasons for suppressing cell plasticity in the body. As yet, very little is known about how to change the rules while averting the dangers of running wild—a worry that applies to potential therapies derived from ES cells as well as adult cells.

So is plasticity biology's "cold fusion"? No, scientists say. Even some skeptics believe something is going on in these experiments, even if they don't know exactly what. "I think [therapies with transplanted stem cells] will eventually work," says Grompe. But "we've raised a lot of false hopes for quick fixes, and that's not going to happen." He and others say a closer comparison might be with gene therapy—greatly hyped 20 years ago but still without much to show for itself. James Thomson of the University of Wisconsin, Madison, who first isolated human ES cells back in 1998, agrees. "I'm not looking forward to the backlash 3 years from now when people say, 'What happened to stem cells?' " he says. What can scientists do about it? Says Thomson: "We need to educate the public that science takes a long time."

–CONSTANCE HOLDEN AND GRETCHEN VOGEL

CLIMATE CHANGE

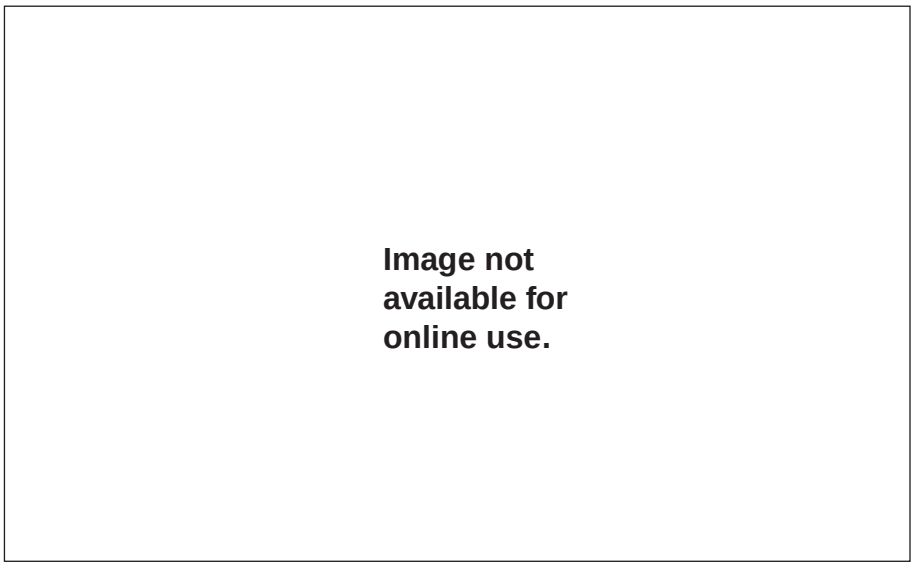
Russia Can Save Kyoto, If It Can Do the Math

Russia's ratification of the Kyoto treaty might put the pact over the top. But some take a chilly view of the reliability of its greenhouse gas emission numbers

MOSCOW—The U.S. withdrawal from international negotiations over carbon emissions last year dealt a blow to the Kyoto Protocol that many thought might be fatal. A year on, however, Russia has emerged as an unlikely savior.

To come into force, the treaty must be ratified by enough industrialized nations to account for 55% of carbon emissions in 1990, Kyoto's baseline year. The U.S. withdrawal put its leading 36% share off limits, making participation by the other major players even more important. Russia—which accounts for 17% of 1990 emissions—holds second place. Its government deliberated for more than a year before President Vladimir Putin declared in April, "We'll do it." A final review of the protocol is due for completion by midsummer, with ratification expected in the fall.

What led Russia to become an environmental champion? Its economy has traditionally relied on smokestack industries and burning fossil fuels, and until recently climate change was seen benignly as an antidote for shoveling snow. But the treaty gives



Something to hide? Russia's petroleum industry is "very shy" about revealing its emissions of greenhouse gases, including the flaring of methane from oil and gas fields.

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the cash-strapped Russian government a financial incentive to think green. Russia expects its carbon emissions to be down by 20% from 1990 levels when Kyoto comes into force in 2008, the result of an economic downturn that has shuttered factories and shrunk agriculture. The regrowth of forests has sequestered more carbon.

As a result, Russia will win huge amounts of pollution credits under Kyoto's emissions-trading system. "Russia will have a near-monopoly on emissions credits," says economist Richard Baron, an expert in the trading system at the Organisation for Economic Co-operation and Development (OECD) in Paris. Those credits can be sold to countries, in particular Europe and Japan, whose emissions have increased since 1990. The windfall could earn Russia tens of billions of dollars.

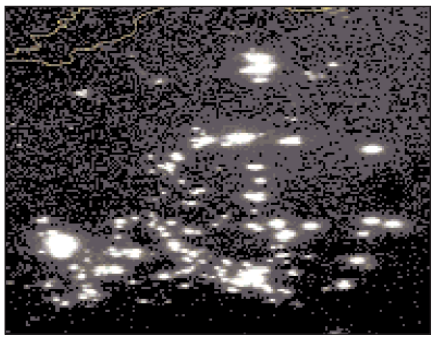
A dark cloud hangs over Russia's greenhouse bonanza, however, in the form of doubts about the accuracy of its emissions inventories. In 4 years' time, those inventories will be open to international scrutiny by the other 83 Kyoto-signatory nations. If Russia can't prove its reduction in emissions since 1990, its partners are unlikely to let it cash in. "If they can't show they have an appropriate inventory, there's no middle ground," says Baron. William Chandler, a specialist on Russian climate change policy at Pacific Northwest National Laboratory's office in Washington, D.C., agrees: "The situation is urgent."

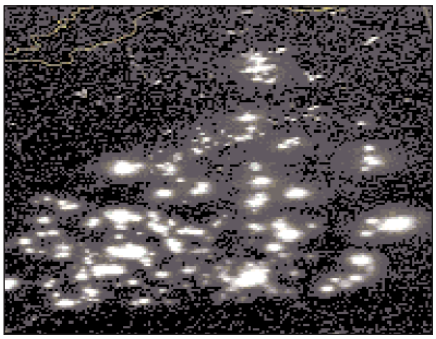
In 1997 a panel of scientists convened by the United Nations to review data compiled by the Russian Federal Service for Hydrometrology and Environmental Monitoring (Roshydromet) revealed glaring methodological problems and striking data gaps. The U.N. review team labeled Roshydromet's approach "insufficient" and highlighted its poor presentation of data and its lack of uncertainty levels and information on data-collection methods. Methane emission figures, the U.N. team said, were "highly unreliable since they were based upon hypothetical assumptions." Estimates for emissions from the oil and coal industries and the carbon consumption of Russian forests and peatlands were similarly criticized.

Three years later, a second U.N. review team evaluating a second set of data from Roshydromet reported some progress but pointed to many lingering problems. One is a complete absence of figures from important industries including pulp and paper, asphalt, glass, iron and steel, and nonferrous metal production. The team concluded that the new data were "of average or low quality." According to review team member Raisa Mäkipää of the Finnish Forest Research Institute, "We were not satisfied."

The current government review prior to ratification is based partly on a third set of data from Roshydromet that have not yet been made public. But Alexei Kokorin, a campaigner with the Worldwide Fund for Nature in Moscow who says he has seen the latest Roshydromet data, believes that it still "doesn't conform to international norms."

Climatologist Yuri Izrael, Roshydromet's principal greenhouse gas inventory investigator, agrees that the data quality in the first two inventories was "variable" and that "we still need better information." He insists, however, that Russian greenhouse gas data quality has improved steadily since Roshydromet began work in 1994. "Our latest inventory is much better than the previous inventories were," he says.





On the slide? Despite official figures, natural gas flaring seems to have increased in these satellite images of Siberia in 1992 (*left*) and 2002.

One of the biggest obstacles to a more accurate accounting of greenhouse gas emissions is the Russian petroleum industry—now the world's largest producer. Kokorin says that the industry is "very shy" about its emissions data and that the latest Roshydromet inventory doesn't include them. Russian oil companies say such tallies are provided in confidence to the government. A recent World Bank report highlighted one sore spot: the widespread industry practice of burning off byproduct gases in giant torchlike flares.

According to the World Bank, Russian government estimates based on industry data indicated that 2.6 billion cubic meters of gas were flared in 2000. But an alternative assessment commissioned later by the World Bank in collaboration with the Russian government estimated 10.25 billion cubic meters of flaring. According to Bent Svensson, head of the World Bank's international flaring project, obtaining reliable Russian data for the petroleum sector has been "very difficult."

At the other end of the carbon chain, the contribution of Russia's forests in reducing emissions is also very uncertain. Finland's Mäkipää, who helped review Roshydromet's 2000 inventory, found the official inventories unreliable after a more thorough study of Russian forest data. The data depend on highly uncertain estimates of tree age, she says, and are simply not usable for Kyoto requirements: "The quality of the data don't allow objective evaluation of the size of the forest carbon sink."

A lone bright spot in Russia's emission inventories is the data produced by Russia's mammoth electrical utility, United Energy System of Russia (UES), which produces an estimated 25% of all Russian carbon emissions. According to Ludmilla Khoudogarova of the Russian Academy of Sciences' Energy Research Institute, UES produced a reasonable account of emissions from its 370 power plants for Roshydromet in 1995, and that account has improved with each review. "It's possible groups could buy [emission] credits directly from Russian companies like UES that can actually prove their numbers," says OECD's Baron.

Apart from the opacity of Russian industry, the basic competence of Russian climate change researchers is also causing concern. A 1999 review of the research by Nina Poussenkova of the Russian Academy of Sciences' Institute of World Economy and International Relations revealed plenty of well-trained scientists. But their isolation from the mainstream, combined with a Soviet-era fear of challenging official information, makes them uneasy in the highly internationalized and politicized climate change field. Lack of funding is also a problem. The U.N. team that reviewed Roshydromet's data in 2000 declared that Russia's financial commitment to climate change research was "marginal."

As Russian officials sharpen their pencils for a final review of the Kyoto accord, Russian climate change researchers hope the government will boost its investment in climate change research to meet the protocol's scientific requirements. In the absence of better data, Pacific Northwest's Chandler says that Russia is ill equipped to participate in an international system built first on trust, then verification. "Without accurate data, the system crashes," Chandler warns. "It just won't work."

–PAUL WEBSTER

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