HARVARD UNIVERSITY
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Capitalizing on Russia's Forest Sequestration Potential: Opportunities and Challenges

Noune Sekhpossian and Karen Filipovich

Environment and Natural Resources Program
Belfer Center for Science and International Affairs

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Environment and Natural Resources Program (ENRP)
Belfer Center for Science and International Affairs (BCSIA)
John F. Kennedy School of Government
Harvard University
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Executive Summary

Terrestrial carbon sequestration is advocated as an inexpensive mitigation option to the problem of global climate change. The country with the largest forest resource in the world is Russia, and is perceived to have the potential to store vast amounts of carbon. In a world constrained by the threat of climate change, this capacity could be enormously valuable.

Russia has millions of acres of standing forests, some 22 percent of the world total.[1] The potential to store carbon in newly planted forests has been estimated at 140–240 million tons of carbon in the 2008–12 commitment period under the Kyoto Protocol, at a price of approximately $30/ton of Carbon (tC).[2] If this potential were realized, it would offset more than all of the EU obligated target under Kyoto.[3]

While these numbers are encouraging, they are offset by three factors that will make it very difficult for Russia to realize even a portion of this potential over the next two decades.

First, without US participation in the Kyoto Protocol the market for carbon credit will remain depressed at least through 2012. Carbon prices are likely to remain well below $10 per ton, which dramatically shrinks the potential for cost-effective carbon sequestration in Russia.

Second, at the Marrakech meeting in November 2001, the parties to the Kyoto Protocol changed the acceptable definition of carbon sequestration, but only for Russia. Prior to the meeting, countries could only claim carbon sequestered in newly planted forests – since such forests would provide additional sequestration capacity and thus would sequester carbon that would not otherwise have been captured from the atmosphere. At Marrakech, Russia was allowed to bank 33 million tons of carbon sequestered in existing forests for each of five years beginning in 2008. While this option is much less expensive, it does not promote additional carbon sequestration. It also makes it unlikely that Russia will invest in new forests when it can trade carbon permits obtained by simply managing and protecting existing forests.

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[1] World Resources Institute. *World Resources 1998–99: A Guide to the Global Environment* (New York: Oxford University Press, 1998), Data Table 11.1, p. 292.

[2] Alexander Golub, "Russian Forests for Climate Change Mitigation," BCSIA Discussion Paper 2000-04, ENRP Discussion Paper E-2000-4, Environment and Natural Resources Program (ENRP), Belfer Center for Science and International Affairs (BCSIA), John F. Kennedy School of Government, Harvard University (May 2000).

[3] Derived from information available in Gugale, Bernd and Manfred Ritter. August 2001. "European Community and Member States greenhouse gas emission trends 1990-1999." Copenhagen: Denmark. European Environmental Agency. p. 120. Available at http://reports.eea.eu.int/topic_report_2001_10/en.Information on EU target : Conference of Parties. 18 March 1998. "Report of the Conference of the Parties on Its Third Session, Held at Kyoto from 1 to 11 December 1997." FCCC/CP/1997/7/Add.1. < http://unfccc.int/resource/protintr.html>. Information on Russian potential is from Golub (2000).

This paper examines a third factor. If the value of carbon permits was sufficient to make carbon sequestration economically attractive, would Russia have the institutional capacity to develop and implement sequestration projects. Under either the option of planting new forests or managing existing forests, institutional disarray, insufficient legal and regulatory infrastructure and a lack of information and knowledge will impair any Russian effort and create measurable transaction costs and compliance uncertainty. Admittedly, some of these same problems face any foreign investment in Russia, but they are particularly acute for new carbon trading, because a credible system that can verify credits for carbon sequestration is vital to the success of the transaction.

Several factors diminish Russia's credibility as a carbon trader. To be acceptable to the international community, Russia must establish the means to measure and monitor its forests to assure investors that what it is selling is real. Russian environmental enforcement is weak in status, budget, and legal mandate. The country's *Rosleskhoz*, or Federal Forest Service (FFS), the main owner of existing and potential forest areas, has historically been self-enforcing with regard to any codes that relate to its forests and practices. Second, the Federal Forest Service is a fragmented organization, and has difficulty enforcing existing laws. Moreover, it is not, as an institution, familiar with carbon-maximizing techniques or the administration of such projects. Thus, without substantial increases in resources and trained personnel, it is unlikely that the Federal Forest Service will be able to administer such a program. Third, property rights both to FFS lands and to lands potentially available for sequestering carbon are not well defined. When carbon rights are allocated, these uncertainties are likely to add more complications. Finally, the existing tax code will tend to discourage investment, since in application, if not intent, it penalizes foreign investment.

To overcome these obstacles, Russia will need to:

- pass legislation to determine basic property rights and allocations of carbon within the forestry sector, as well as for the country as a whole;
- delineate the roles and responsibilities of pertinent Russian agencies at various levels of government; and
- allocate sufficient resources to regulate, monitor, measure, and enforce compliance so that the sequestration program proceeds in a clear, consistent matter that is credible to the international and domestic communities.

If "forest management" credits are allowed to meet standards that are more lax than those that would be reasonable to demand for new afforestation credits, it will greatly delay the implementation of a credible, sustainable system of new sequestration credit trading. Once one looks at the cost of afforestation or reforestation costs, it is clear that few to no new projects are going to be completed in the first commitment period. On the other hand, if the "forest management" projects must meet minimum standards of verification, then it will give impetus to fixing some of the factors we identify in this paper that will be faced by new sequestration projects. If not, few carbon sequestration projects will be developed in Russia, and those that are developed will contribute very little to reducing carbon dioxide concentrations in the atmosphere.

I: Russia's Forest and Sequestration Prospects

In 1999, annual emissions of carbon dioxide from human activities exceeded 6 billion tons.[4] Some of this carbon dioxide is, however, captured and stored by forests and other forms of biomass as a result of natural uptake. This natural uptake eventually levels off as a forest matures. It can be increased both by *reforestation* of cleared areas and by *afforestation*, that is, starting new forests on lands that are suitable but have not historically supported forests. It is possible that management techniques might also be able to increase carbon storage in existing forests. Finally, standing forests can be thought of as biological "carbon banks" that slowly accrue or simply store carbon out of the atmosphere. Use of forests to store carbon is a form of biological sequestration.[5]

Forests are not distributed evenly around the world. Right now, Russia has the world's largest standing forest, and with more than 36 Gigatons of stored carbon.[6] Russia also has tremendous potential capacity to reforest and afforest idle lands to sequester carbon. Its own initial estimate places the potential at roughly 140 million tons of carbon per year.[7] A more recent estimate places the potential even higher at 240 million tons of carbon per year (assuming a price of $30/per ton of Carbon (tC)).[8] This amount is equivalent to 262% of the EU obligation under the Kyoto Protocol.[9] "Forest management" practices of up to 33 million tons of carbon per year of the first obligation

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[4] Energy Information Agency. 2001. *International Energy Outlook 2001. Environmental Issues and World Energy Use.* <www.eia.doe.gov/oiaf/ieo/environmental.html> accessed June 5, 2001.

[5] In this paper, the two types of biological sequestration that we consider are those that seem the least controversial: reforestation, that is, "planting of forests on land which historically has contained forest but which has been used for another purpose since last being covered by forest," and afforestation, defined as "planting of forest on land which historically has not been covered by forest." The Australian Greenhouse Office, Emissions Trading and Carbon Credits, <http://www.gov.au/pubs/>.] The Intergovernmental Panel on Climate Change (IPCC) has a slightly different definition, and many other definitions exist, but new reforestation and afforestation were the only types of sequestration used in the Russian estimates, and we follow that lead for consistency.

[6] Second National Communication of the Russian Federation, 1998. Interagency Commission of the Russian Federation on Climate Change Problems, p.27. Online at: www.unfcc.de.

[7] Second National Communication of the Russian Federation, 1998, p. 9 (in Russian).

[8] Golub, A. "Russian Forests for Climate Change Mitigation: An Economic Analysis." 2000. BCSIA Discussion Paper 2000-04, ENRP Discussion Paper E-2000-04, ENRP, John F. Kennedy School of Government, Harvard University.

[9] Derived from information available in Gugale, Bernd and Manfred Ritter. August 2001. "European Community and Member States greenhouse gas emission trends 1990-1999." Copenhagen: Denmark. European Environmental Agency. p. 120. Available at < http://reports.eea.eu.int/topic_report_2001_10/en>. Information on EU target : Conference of Parties. 18 March 1998. "Report of the Conference of the Parties on Its Third Session, Held at Kyoto from 1 to 11 December 1997." FCCC/CP/1997/7/Add.1. < http://unfccc.int/resource/protintr.html>. Information on Russian potential is from Golub (2000).

period 2008-2012 are also allowed. This option will cost Russia very little to execute, and gives it a unique advantage because no other country has been granted this option.[10]

However, at this time, Russia has little incentive either to plant new forests or to protect existing forests for carbon sequestration. Although its emissions are still markedly below 1990 target levels negotiated under the Kyoto protocols, projects done simply for their carbon benefits are not likely to be on the Russian agenda for a long time to come.

Other industrialized countries, particularly the EU and Japan have some need to reduce their emissions because of commitments they made under the Kyoto Protocol, which is likely to enter into force in the near future. These countries see Russia as a potential source of low cost carbon reductions, both from new afforestation and reforestation and from the "forest management" clause negotiated in November 2001. Under the Kyoto Protocol, two general mechanisms exist to allow trades of carbon and other greenhouse gas credits between industrialized and transitional Annex B countries. The first is Joint Implementation. In this project-based method, an entity partners with the host government or other domestic entity to create a specific project. The funding entity earns credits for the additional carbon (in the case of sequestration) generated by the project. International trading is the other flexibility mechanism. In this method, a registry for carbon would be set up and carbon credits would be allocated to new carbon sequestration efforts. These credits, at least theoretically, could be traded in much the same way that a stock or a sulfur dioxide credit is currently traded.

In both cases, the credits are of value because a cap on total emissions is imposed and property rights and obligations are assigned under that cap. Since the US has bowed out of the Kyoto Protocol, we would not expect to see American investors value carbon credits. However, if the domestic agenda shifts so that meaningful carbon reduction is targeted, international credit trading will begin to look very attractive as a cost-saving measure.

If Russia were to find buyers for the estimated 240mm t/C available from afforestation and reforestation at $30/ton C, it would generate $7.2 billion gross revenue. This potential has been undermined by the United States' decision not to participate in the Kyoto Protocol, thus removing the largest buyer of carbon credits from the international market. Secondly, the COP-7 meeting in November 2001 allowed Russia to count 33 million tons of Carbon in existing forests as being managed for carbon sequestration. This means that Russia will be able to count carbon captured and sequestered in those forests at almost zero cost and sell the resulting permits at the international market price. However, to obtain the benefits of this very inexpensive source of carbon, Russia will need to address some of the same institutional challenges that would have had to be met

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[10] Conference of Parties. 18 March 1998. "Report of the Conference of the Parties on Its Third Session, Held at Kyoto from to 11 December 1997." FCCC/CP/1997/7/Add.1. <http://unfccc.int/resource/protintr.html>. p. 30.

under the Kyoto Protocol for new sequestration projects. It is those challenges and transaction costs that comprise the focus of this paper.

Institutional Underpinnings for a Credible Trading System

Establishing a market for carbon credits is predicated on the existence of institutional, legal, political, and economic factors.

More than ninety percent of Russia's existing forests, as well as most of the potential viable land for reforestation and afforestation, are under the control of the Federal Forest Service (FFS). Of the rest, 6 percent of potential forests and 6 percent of standing forests lie under the control of the agricultural, municipal, and military sectors.

The FFS is a department under the Ministry of Natural Resources, something like the US Forest Service in the Department of Agriculture. It has a skilled technical corps, but its expertise is in traditional silvaculture, not carbon sequestration. The FFS is subject to essentially no oversight of its environmental activities, but economic oversight is a different matter. Regional forestry efforts are subordinate to both federal forestry officials and to regional governmental authorities. Thus, two actors with different agendas control decision-making. Additionally, the FFS does not, or cannot, control illegal logging activities in its forests.

Several other factors also affect Russia's ability to trade sequestered carbon. First, Russia lacks a framework to determine carbon allocation in the forestry sector. Second, property controls and ambiguous ownership laws make it difficult to ensure that land designated for new sequestration is actually used for that purpose (this is less of a problem for existing forests). Weaknesses in existing environmental controls will make it difficult to establish monitoring and enforcement regimes crucial to credible trading. Finally, opportunistic behavior by regional authorities could greatly increase the price of sequestration projects.

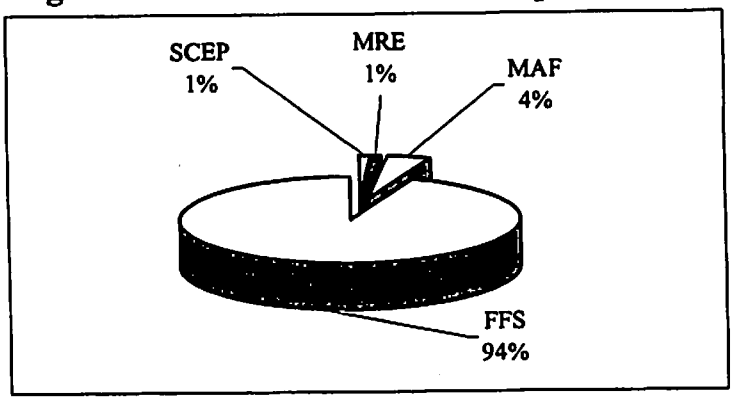
This paper provides an overview and discussion of Russia's forestry sector and the challenges that will have to be overcome, if it is to pursue any type of formal carbon sequestration program, and to suggest how the challenges might be met. This section is followed by a discussion of how a carbon sequestration program could be implemented. Section four shows how Russia's property rights system, currently incomplete and confusing, is likely to affect sequestration projects. The final section reviews compliance and verification issues.

II: The Forestry Sector

Russia's Forestland

Russia has vast forest resources. The total area of Russia's so-called Forest Fund — its publicly held forest assets — is 2.95 billion acres.[11] The total biomass of Russia's Forest Fund has been estimated at 79.3 gigatons. Total carbon stock, which is defined as all stored carbon, is 38.6 gigatons of carbon.[12] About 69 percent of Russia's total area is part of the Forest Fund. This includes all land that is suitable for forest production — both forested areas and non-forested areas — apart from defense lands and the lands of populated settlements.[13] About 94 percent of Forest Fund lands (2.78 billion acres) are administered by the Federal Forest Service (FFS), currently a government department within the Ministry of Natural Resources.[14] The remaining publicly owned forest lands are administered by the Ministry of Agriculture and Food (4 percent or 118 million acres), by the State Committee for Environmental Protection (1 percent or 29.5 million acres), and by the military or by research and educational institutions (1 percent or 29.5 million acres).[15] (See Figure 1.)

Figure 1. Forest Land Ownership in Russia



SCEP – State Committee for Environmental Protection; MAF – Ministry of Agriculture and Food; MRE – military, research, education; FFS – Federal Forest Service
Source: The World Bank, 1997. "Forestry During Transition"

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[11] The Forest Fund was first defined about 200 years ago when the Russian Forest Service was established. Records of changes in the boundaries and territory of the Forest Fund have been kept over two centuries and are still available.

[12] Second National Communication of the Russian Federation, 1998. Interagency Commission of the Russian Federation on Climate Change Problems, p.27. Online at: www.unfcc.de.

[13] Forest Code of the Russian Federation, 1997. The English version of Russia's Forest Code can be found online at www.forest.ru/eng/legislation/. (last accessed 5/1/01).

[14] Russian Federation Climate Change Country Study. Task 6, "Climate Change Action Plan," Report, 1999. By presidential decree No. 867 of May 17, 2000, both the State Environmental Committee and the Federal Forest Service were abolished; they became departments of the Ministry of Natural Resources.

[15] The World Bank. 1997. "Russia: Forestry During Transition." Pg. 54 Washington, D.C. : World Bank.

Forest Fund lands are subdivided into forest and non-forest lands. Non-forest lands (736 million acres) comprise arable fields, hay fields, pastures, water bodies, gardens, roads, settlements, swamps, etc.[16] Forest lands include lands that are actually covered by forests, known as "stocked" lands, as well as lands that are part of the forest landscape, but currently not covered with forest, called "non-stocked" lands. A small, but separately defined group of free growing unenclosed plantations and nurseries is also included in Forest Lands. According to the State Forest Account of 1993, stocked lands in Russia constitute about 1,910 million acres, or 85% out of a total of 2,216 million acres of forest lands in the total state forest funds. Non-stocked lands comprise some 175 million acres, or 8% of the total forest lands, of which 40 percent (70 million acres) have been cleared by different types of human action, such as fires, illegal harvesting, clear-cutting, etc.; they are mainly located in Siberia and the Russian Far East. Twenty-five percent (43.8 million acres) are burned areas, while 10 percent (17.5 million acres) are clear-cut areas that have not been replanted.[17] The remaining 25 percent are natural open woodlands and glades and barrens. (Figure 2 shows the distribution of land in these categories.)
The "stocked" lands are those that could be considered for the new forest management activities, while "unstocked" lands are those that may be suitable for new afforestation and reforestation activities. Because afforestation and reforestation are better defined, and have a more complex set of economic and technical questions associated with them, we will principally discuss this approach. However, we will indicate the areas where forest management will face similar considerations.

Forests in Russia are classified into three groups (Groups I, II and III) by their ecological and social role, biodiversity, and location. These groups of forests are managed differently, and different types of cutting are allowed in each. Group I forests are noncommercial and protected forests. They are divided into five categories mentioned below, including protected forests, nature reserves, and natural parks and monuments which comprise approximately 131.25 million acres, or 3 percent of the total land area of Russia.[18] The State Department for Environmental Protection (SDEP) has oversight of Group I lands. Group II forests are defined as protected forests where limited commercial cutting on a sustainable basis is allowed. These are mostly forests and parks located in urban areas and belong to municipalities. Group III forests are commercial forests where clear-cutting is allowed. Unstocked lands fall mostly under Group III oversight. It isn't completely clear which group "forest management" will be drawn from, but if significant management techniques are used, it is likely to be Group III forests. If these forests are actually carbon banks it would be logical to designate current Group I lands as the managed forests. The FFS is the sole overseer of Group III lands. Figure 3 shows how the three forestry types are delineated.

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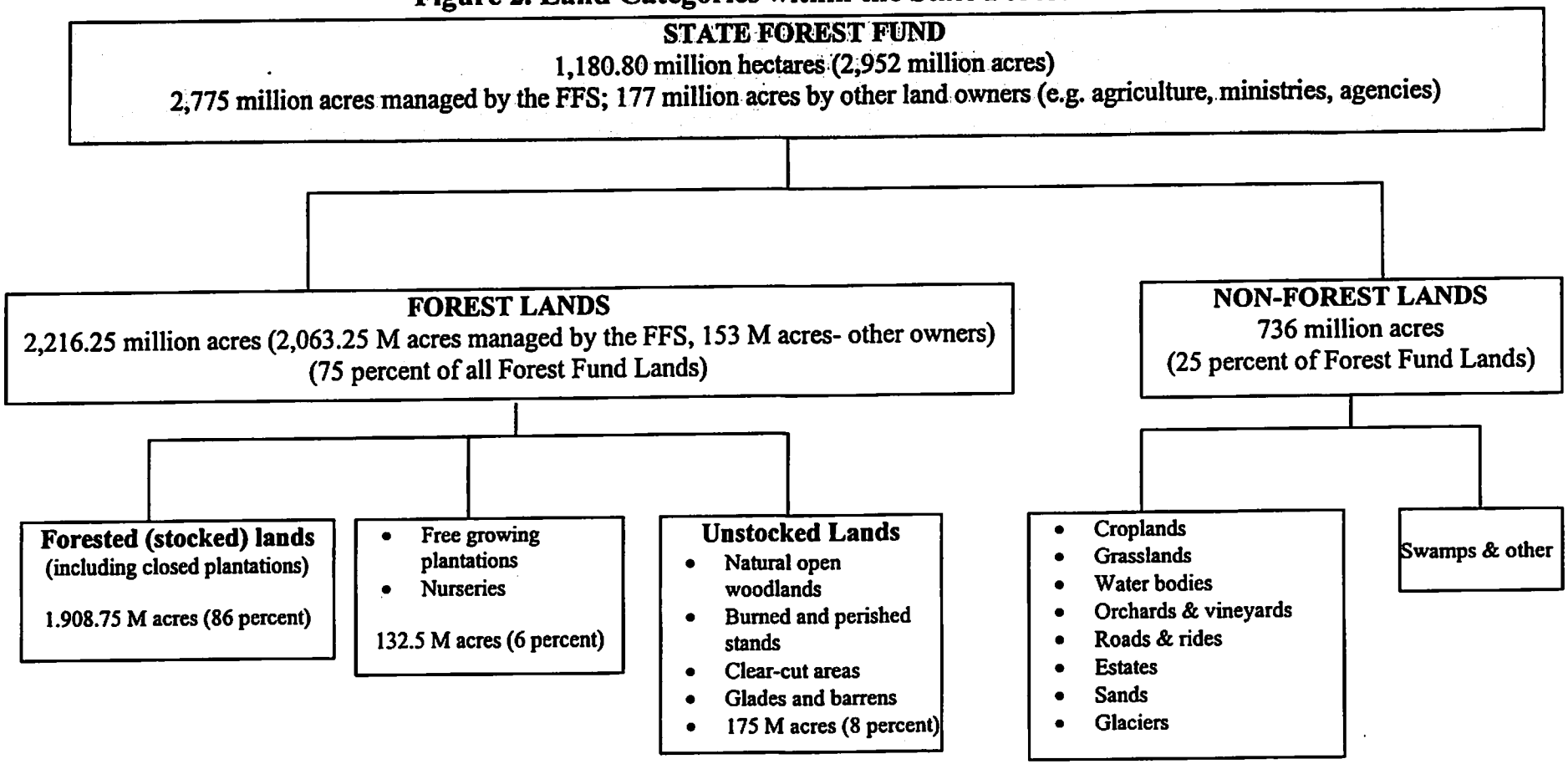
[16] The World Bank, 1997. "Russia: Forestry During Transition." Pg. 33-35
[17] Interagency Commission of the Russian Federation on Climate Change Problems. 1998. "Second National Communication of the Russian Federation," pp. 27–28.
[18] The Russian government has declared that it intends to expand the protected territories to about 276.5 million acres (or 6.5 percent of Russia's total land area) by 2005.

Figure 2. Land Categories within the State Forest Fund*



* Source: Russian Federation Second National Communication, 1998.

Figure 3. Categories of Stocked Forest Lands

Group I – Protected forests Overseen by: State Committee for Environmental Protection, municipalities, Ministry of Agriculture and Food.	Group II – Protected forests with limited commercial value Municipal oversight	Group III – Commercial forests FFS oversight
Hydrological protection forests along river banks; Anti-erosion forests and shelter belts; Municipal forests around cities and industrial complexes; Protected forests with scientific or historic value; Nature reserves, national parks, protected territories, national monuments. (See Appendix 1 for more details.)	Mostly located in densely populated areas and reserved for recreational purposes. Cutting is allowed only on a sustainable basis.	Final cutting is allowed.
414.3 M acres	**145.1 M acres**	**1,349.5 M acres**

Opportunities for Forest Sequestration

Under Article 3.3 of the Kyoto Protocol, lands that are already forested are not eligible for carbon credits. Eligibility is limited to new forests, that is, to reforested or afforested lands. The largest category of land available for reforestation in Russia is that of non-stocked lands under the control of the Federal Forest Service (approximately 175 million acres). These are mainly burned and dead stands, cut-over areas, and natural open woodlands. Over 50 percent of those lands are located in the Russian Far East, about 39 percent in East Siberia, 5 percent in West Siberia, and less than 6 percent in the European-Ural regions of Russia.[19] If estimates of the potential represented by these lands are correct, stocking this land with new forests could offset more than 25% of the EU's obligation under the Kyoto Protocol.[20]

The new "forest management" sink of 33 million tons of C for each of the five commitment years is a one-time use of Article 3.4 under the Kyoto treaty. These credits cannot be banked for future commitment periods, and Russia is the only recipient of this type of sequestration credit. These credits alone are equal to 72% of the carbon credits needed for the EU to hit its target by the 2008-2012 commitment period.

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[19] Second National Communication of the Russian Federation. 1998. Online at www.unfccc.de.

[20] Derived from World Resources Report, 2000-2001, and from details of the Kyoto Protocol.

The rate of reforestation in Russia during 1970–90 was 4.75 million acres per year. However, as logging decreased due to Russia's economic decline in the 1990s, the rate of reforestation also went down. Current reforestation rates are 2.75–3.5 million acres per year.[21] However, while both official cutting rates and reforestation rates have declined, illegal cutting has grown significantly. As a result, effective reforestation rates are well behind rates of logging.

The other two categories available in Russia for reforestation are degraded agricultural lands and abandoned mining sites. There are approximately 20 million acres of such agricultural land and about 3.75 million acres of former mining sites.[22]

There is also good potential for afforestation in Russia, with other benefits as well. It is estimated that about 35 million acres of additional protective forests are required to provide Russia with adequate protection from droughts, water and wind erosion, and the like.[23] Currently only 19.4 million acres of protective forests exist, just 36 percent of the estimated forests needed for thorough protection.

Forest Sequestration Potential

Investment decisions are driven by assessment of probable costs and benefits, but unfortunately, high levels of uncertainty as to both costs and benefits afflict forestry projects in Russia. For reforestation projects to be viable under an international credit regime, the cost of sequestering carbon cannot be higher than the international market price for carbon abatement. Since the United States is not participating in the Kyoto Protocol the world clearing price will be much lower in the 2008-2012 period than was anticipated prior to the US withdrawal. If the United States eventually decides to join an international regime, trading becomes very important. For example, the Pacific Northwest National Laboratory's Second Generation Model (SGM)[24], simulated different scenarios of carbon trading to estimate that total mitigation. Using Kyoto targets as a benchmark, the cost to the US without trade is about US $27.6 billion (US$139/ton C). If Annex B international trading was allowed, the same indices are estimated as US $26.2 billion (US $106/ton C) and, further, if international trade were allowed, the indices plummet to US $10 billion (US $24/ton C).[25] This analysis suggests that under an international trading regime that included the US, the marginal cost of carbon would be below $25/ton C. Therefore, if they are to be attractive to international investors, the cost of carbon sequestration projects must be lower than these estimates. If one adds the sovereign and regulatory risks of doing business in Russia, the break-even cost would be even lower, since investors would need to be compensated for these risks.

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[21] Climate Change Country Study, Task 6. 1999 "Climate Change Action Plan."
[22] Second National Communication of the Russian Federation, 1998. Online at: www.unfccc.de.
[23] Climate Change Country Study, Task 6. 1999. "Climate Change Action Plan."
[24] Edmonds, J., H.M.Pitcher, D. Barns, R. Baron, M.A. Wise. 1995. "Modeling Future Greenhouse Gas Emissions: The Second Generation Model Description." *Modeling Global Change*. United Nations University Press, Tokyo, Japan, October 1995.
[25] Edmonds, J., M.J. Scott et al. December 1999. "International Emissions trading and Global Climate Change." Pew Center on Global Climate Change.

Several studies have estimated cost components for carbon-transfer forestry projects and unit costs of carbon sequestration. Unit carbon costs for some sequestration options (such as plantations, shelterbelts, drainage and thinning, and fire management) have been estimated between $0.59 - $1.90 per ton of carbon.[26] These are extremely low cost estimates. Two demonstration projects also reported relatively low unit prices for carbon sequestration. The RUSAFOR reforestation project in Saratov oblast, currently being implemented, reported unit costs of $2.5 - $4/t$CO_2$ ($9.17–14.67/tC).[27] The feasibility study of the Vologda Reforestation Project (now suspended) estimated unit costs at $40.3- $44/tC for assisted natural regeneration.[28] The Russian National Strategy Study on Greenhouse Gas Emissions Reductions also estimates carbon sequestration costs for different regions and species in the lower brackets, between $9.90–45.80/tC.[29] However, more recent analysis suggests that these estimates are low compared to the overall cost of new sequestration projects in Russia.

An all Russia study of sequestration potential found that very little carbon could be sequestered for less than $25/ton C.[30] Other studies report even higher costs. In a study of the most heavily forested region in Russia, the Khabarovsky Krai, estimated costs, depending on major species and regeneration methods, ranged from $168.7–1001/tC at a 5 percent discount rate.[31] These cost estimates are significantly higher than those for the northern Great Lakes states in the United States that have similar forests.

Table 1: Comparison of Studies on Russian Cost Estimates

Source	Cost Estimate (USD per ton of Carbon)
"Forest Management" under the COP-7 agreement	Close to zero
Krankina and Dixon, 1994. All Russia	.59-1.90
Golub *et al*, 1999. RUSAFOR Project	9.17-14.67
Golub, 2000. All Russia	20-80
Golub *et al*, 1999. All Russia	9.90-45.80
Hamburg and LeBlanc, 1995. Vologda Project	40.30-44
Vincent and Strukova, 1998. Khabarovsky Krai	85-704

[26] Krankina, O.N. and R.K. Dixon, "Forest Management Options to Conserve and Sequester Terrestrial Carbon in the Russian Federation," *World Resource Review*, Vol. 6, No. 1 (1994).
[27] Golub, A., A. Averchenkov, V. Berdin, A. Kokorin, M. Martynova, and E. Strukova, 1999. "Study on Russian National Strategy of Greenhouse Gas Emissions Reduction," World Bank and Bureau of Economic Analysis, State Committee of Russian Federation on Environmental Protection.
[28] Hamburg, S. and A. LeBlanc, March 1995. "Reforestation in Russia: Building Institutional Capacity for Joint Implementation Through the Vologda Demonstration Project," Environmental Defense Fund.
[29] Golub, A., A. Averchenkov, V. Berdin, A. Kokorin, M. Martynova, and E. Strukova, 1999. "Study on Russian National Strategy of Greenhouse Gas Emissions Reduction," World Bank and Bureau of Economic Analysis, State Committee of Russian Federation on Environmental Protection.
[30] Golub, A., A. Averchenkov, V. Berdin, A. Kokorin, M. Martynova, and E. Strukova, 1999. "Study on Russian National Strategy of Greenhouse Gas Emissions Reduction," World Bank and Bureau of Economic Analysis, State Committee of Russian Federation on Environmental Protection.
[31] Methods considered were natural regeneration, bare-root seedling planting, and containerized seedling planting.

These figures have a large margin of uncertainty, since accurate data is limited; costs of land are unpredictable; and there are large variations in costs between regions. It is reasonable to assume that costs in regions in Siberia and the Far East will have a different structure than costs in the southern European part of Russia. In the latter, the climate is moderate, so the growth rate is higher, and territories are more easily accessible. These factors reduce start-up and maintenance costs. However, for these same reasons, the opportunity costs will be higher, since the land could more easily be used for agricultural or timber production or other commercial functions.

Another reason for the range of estimates is the disparate treatment of cost components. For example, official Russian expenditure data do not normally include fixed costs such as overhead. Many studies also assume that land costs are zero, and do not account for foregone timber sales or agricultural production. This is perhaps acceptable as an initial assumption, but it is unlikely to hold up for large-scale sequestration programs. The higher estimates do include some of these important cost components, and we think such estimates are closer to the true costs of doing business for a large-scale sequestration program.

Depending on how they are accounted for, land costs can represent a very large portion of total project costs. For the Vologda Reforestation Project, where the forest was to be planted on hay fields, the cost of land was estimated at $4/acre. After summing over the project life and discounting, it constituted 68 percent of the total project cost. However, in other regions where population density is very low and there is no competition for use of the land, the fixed costs of land would be negligible.[32]

Even if the United States had remained a party to the Kyoto Protocol, much of Russia's carbon sequestration potential would not have been cost effective at a world carbon clearing price of $25/ton C or less.[33] At clearing prices of less that $5/ton C, some of the sequestration credits from managed forests may be priced out of the market by the high transaction costs and regulatory uncertainties.

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[32] Vincent, J. and E. Strukova, 1998. "Carbon Sequestration Costs in Russian Forests."
[33] Stavins, Robert N. (1999), "The Costs of Carbon Sequestration: A Revealed-Preference Approach," *American Economic Review*, 89(4).

III: Russia's Forestry Institutions

Climate change policies have received only limited attention in Russia, and important institutional issues have yet to be addressed. Questions of property ownership, allocation of carbon rights, proper oversight of sequestration projects, and compliance have not been settled. Environmental protection is weak, and funding structures are relatively undeveloped. Historically, the Forest Service was allowed almost complete environmental and operational self-oversight. There is also evidence that it has not been able to enforce its own codes for conventional logging practices. There seems to be little coordination between agencies or even within the FFS at the regional and national levels. In this section, we explore the institutional challenges these factors present for establishing a carbon trading policy in Russia.

Federal Forest Service

The role of the Forest Service and general oversight of its climate-related actions are currently unclear, for two reasons. First, the overall climate-policy apparatus is in flux. The Interagency Commission on Climate Change Problems lacks internal power; in addition to poorly defined roles for various governmental organizations, this has led to jurisdictional problems and duplication of duties. At the same time, the Forest Service lacks control and enforcement ability over its local branches and units; this leads to conflicts between its *krai* (provincial) branches and local units.[34]

The jurisdictional issue most likely to become a source of conflict between the federal and regional authorities is the right of regions to share in revenues from carbon projects. Conflicts of interest, with potentially significant revenues involved, will be impossible to avoid unless enabling legislation is developed that defines the role of the forest authorities in carbon sequestration activities and repairs breaches in its vertical structure.[35] This is likely to be true to a greater extent for new sequestration activities, but the regions may argue that they deserve a slice of the "forest management" pie as well.

There is a need for a national policy to address the regulation and management of carbon sequestration projects. While regional and local issues relating to the actual implementation of such projects are important, the development of a national policy and legal framework for property rights (see section 4) has an overarching significance.

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[34] Mabel, Marian. 2000. "The Flexible Domestic State: Institutional Transformation and Political Economic Control in the Khabarovsk Krai Sector." International Institute for Applied Systems Analysis (IIASA),. IR-00-037.

[35] Susan Legro. September 1999. "Climate Change Policy and Programs in Russia: An Institutional Assessment." Pacific Northwest National Laboratory, PNNL-13034.

Forestry Sector Administration

The forestry management system is organized in a hierarchical way from the central Moscow level down to regional and municipal levels.[36] The Forest Code designates the Federal Forest Service as the federal body with responsibility for forest administration and state regulation of forest management and conservation. The Federal Forest Service is an autonomous body within the Ministry of Natural Resources.

The Federal Forest Service is represented throughout Russia by 81 Regional (*krai*) Forest Committees responsible for forest management, protection, and regeneration. The Regional Forest Committees operate through 1,831 forest management districts (*leskhozy*) and 7,851 forest districts or ranges (*lesnichestva*).[37] The Federal Forest Service also has thirteen forest planning and inventory enterprises, as well as numerous research institutes and training units. Forest planning and inventory enterprises conduct forest inventories every ten years and prepare management plans for each *leskhoz*, as shown in Figure 4.

Political-economic tensions in power relationships exist at two levels: federal-regional and regional-local. Tensions at the federal-regional level stem from the old Soviet practice of "dual subordination" in which the regional agencies were subordinated to both the Communist Party and the executive organs. This "dual subordination" still exists in a slightly modified form: each regional committee on forests is subordinated both to the FFS, as the central authority, and to the executive body of the region.[38] The tensions at the regional-local level appeared when 1997-1998 legal reforms granted regional (*krai*) administration the control over use of and revenues from forest resources at the expense of local administrations. Similarly, local branches of the Forest Service, *leskhozes*, lost their financial independence. Regional authorities participate in the legislative process, grant leases for forest parcel use and logging, and (along with the governor and regional legislators) may influence the calculation of the annual allowable cut. They establish tax and lease rates (although the minimum stumpage fee is established federally) and they collect 60 percent to 100 percent of stumpage fees and other taxes.[39] However, while regional authorities have legitimized their expanding control, many local administrations and *leskhozes* persist in their prior administrative and economic authority to govern forest use and the returns from exploitation. This creates a direct conflict of interest among the

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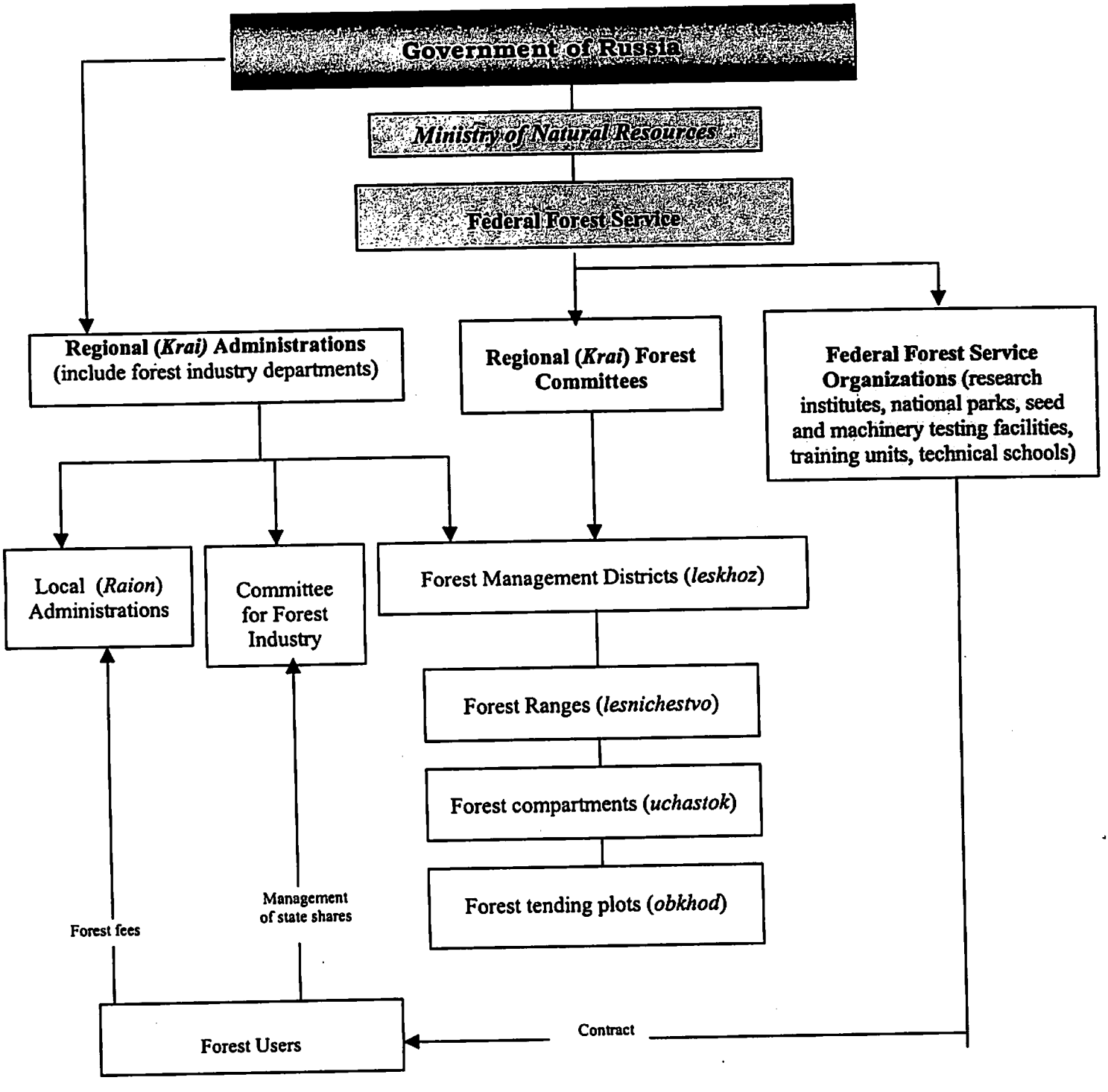
[36] Carlsson, L. and M.-O. Olsson. 1998. "Institutions and the Emergence of Markets: Transition in the Tomsk Forest Sector," IIASA, IR-98-084, p. 32.

[37] The FFS does not have a department that specifically deals with carbon sequestration issues. Such a department could be established only if a significant number of projects existed. Its departments of reforestation and sustainable growth, as well as its scientific department, seem appropriate to work on the methodology and scientific aspects of sequestration projects.

[38] Carlsson L. and M.-O. Olsson. 1998. "Institutions and the Emergence of Markets: Transition in the Tomsk Forest Sector." IR-98-084, International Institute for Applied Systems Analysis (IIASA), Vienna, p. 40.

[39] Fees for cutting are generally calculated by an examination of the tree stumps remaining, from which cubic volume of wood taken is calculated. 40 percent of the revenues from minimum stumpage fees go to the general federal budget and 60 percent goes to the provincial *(krai)* subject. Only the stumpage revenue above the minimum federal rate goes directly to *leskhoes* to finance forest management.

Figure 4. Structure of the Forest Sector



Source: The World Bank. 1997. *Russia: Forest Sector in Transition*

federal, regional and local state institutions.

Regional authorities must also authorize any federally approved projects, and revenues from any project might be claimed by federal, regional and local institutions. Unless regional authorities receive a certain portion of the profit from sequestration projects, they will have very little incentive to cooperate with the Federal Forest Service, to continue to make efforts to ensure that carbon sequestration projects are maintained and to comply with their commitments. The dual subordination will create confusion and distortions in the decision-making process, unless carefully handled.

Institutional Capacity

Although the Federal Forest Service is the only existing entity suited to implement a carbon sequestration program, there are some concerns regarding its ability to monitor and sanction the behavior of the actors.[40] A study of the forest sector in the Arkhangelsk region of Russia found that "violations of forestry rules are common and tolerated." Some of the most common violations include over-cutting in certain areas, supposedly compensated by under-cutting in other areas, and the practice of concealing significant changes in species composition by stretching the definition of "coniferous stand." Instances of illegal felling are growing; it is estimated that 29 million cubic meters of wood per year are illegally felled, an amount equal to 20 percent of the total (legal and illegal) harvest in Russia.[41] Concerns over illegal operations are related mostly to industrial operations, but in any case they must be addressed, because they are symptoms of serious flaws in FFS oversight.

Another problem arises because there are few ties between forestry regulators and environmental regulators. The State Department of Environmental Protection (SCEP) oversees only Group I lands, a small fraction (3 percent) of the total forest. In Class III lands, the category containing most of the unstocked lands of interest, FFS actions and policies are largely self-regulated, with very little third-party oversight. Since the FFS is also the owner of the forest lands (and the most logical owner of all of the sequestration rights, once these are allocated), a conflict of interest is likely to arise between the regulation and the regulated. As it stands, the Forest Service has little incentive to act in a transparent way, since no auditing function exists to monitor any of its activities. A program of carbon sequestration is likely to require the development of a clearer legal allocation of responsibilities between the environmental regulatory agencies and the forestry implementation agencies.

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[40] Carlsson, L., N.-G. Lundgren, M.-O. Olsson, and M.Y. Varakin. 1999. "Institutions and the Emergence of Markets: Transition in the Arkhangelsk Forest Sector," IIASA, IR-99-021, p. 75. Online at: <www.iiasa.ac.at/Publications/catalog/PUB_PROJECT_FOR.html>.

[41] Russian NGOs Forest Club. 2000. "Survey of Illegal Forest Felling Activities in Russia." Online at: <www.forest.ru/eng/publications/illegal/>. The Russian Forest Club NGOs is an organization composed of representatives of non-governmental environmental organizations working to conserve Russia's forests.

Carbon sequestration projects require not only proper institutional and financial conditions, but also scientific support. The basic structure of forestry expertise exists, but additional sequestration information is needed. The staffs of the regional forestry committees already perform regular forest monitoring and have adequate general technical background and professional experience to implement reforestation projects. However, they lack the specific knowledge required to make carbon stock estimates or to calculate timber volume/C ratios; they also lack broad-based expertise in sequestration techniques.[42]

Lack of funds for routine forestry improvement projects suggests that additional funding for special sequestration projects will be difficult to find, at least in the near term. The FFS has little funding to educate its employees and improve management of its forests. It has participated in several major forest inventories, some of which can be useful for climate projects. For instance, it was one of the major state contractors of the federal program called "Russian Forests in 1997–2000," intended to carry out a complex set of forestry, economic, organizational, and technical measures aimed at preservation and regeneration of forests.[43] As a continuation of that program, the FFS adopted a special program in 1998 to develop information systems and to start using Geographic Information Systems (GIS) technology in forestry, but it has never had the resources for full implementation.

Another program adopted by the FFS in 1998, "Criteria and Indicators of Sustainable Management of Forests in Russian Federation," indicates that the FFS is at least aware of possible carbon sequestration projects. The main task of this program was "to ensure [the fulfillment of] basic requirements posed by international commitments of the Russian Federation according to the UN Convention on Biodiversity, the Framework Convention of Climate Change, and the UN Conference on Environment and Development."[44] The document does not contain direct instructions on measures relating to climate change, but it does recommend estimating carbon deposition in forest stands every five years (Criterion 4, indicator 4.7). It also outlines measures for afforestation, improvement of forest composition, and enhancement of forest productivity. While the program has potential, it also has never been implemented, due to lack of funding.

Conclusions on Institutional Capacity

Russia's institutional forestry framework has three areas that need to be addressed: dual subordination of the regional forest committees, shortcomings in the FFS's control over forestry operations, and the technical skill level of the forest management employees. FFS control "on the ground" is probably of greatest concern, since there is evidence that

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[42] Russian NGOs Forest Club, 2000. <www.forest.ru>

[43] The other state contractors for the "Russian Forests in 1997–2000" program are the Ministry of Food and Agriculture and the Ministry of Defense. "Climate Change Action Plan: Report," 1999, Russian Federal Service for Hydrometeorology and Environmental, Russian Federation Climate Change Country Study (cooperative agreement de-fco2-93po10118).

[44] Ibid.

violations of forestry rules are common. Environmental enforcement is weak in status, budget, and legal mandate; the Forest Service is fragmented, has difficulty enforcing current law, and is not yet technically capable of carrying out large-scale projects unaided; and the environmental and forest agencies have little mutual contact or institutional history in working together on issues.

IV: Property Rights in Flux

The uncertain system of land property rights in Russia has been widely criticized as a barrier to commercial activity and economic growth; even after years of reforms it remains ambiguous. The language on forest ownership that appears in the Constitution, the Civil Code, and the Forest Code is inconsistent. Russia's Constitution (Article 9) and its Civil Code (Article 212) state that land and other natural resources can be held in private, state, municipal, or other forms of ownership. At the same time, however, the Forest Code, adopted in January of 1997, recognizes ownership of forests only by the federal government.[45] The Forest Code does allow transfer of rights to use forested land (whether Forest Fund or non–Forest Fund parcels), but it does not permit any purchase, sale, lien, or other deal that would lead to outright sale of such parcels.

This gave rise to confusion about the ownership of forested lands. Article 72 of the Constitution states that all decisions regarding the ownership, use, and management of land and other natural resources are to be made jointly by "the Russian Federation and its subjects." This article has led many regional administrations to believe that they could claim ownership of natural resources within their boundaries, and has prompted them to develop their own forest regulations.[46] Many regional governments have exercised such "rights" and assumed a lead role in managing and utilizing the forests within their jurisdiction. This issue was partially settled in the Constitutional Court in 1999 in a suit brought by the Karelian Republic and the Khabarovsky Krai. The court interpreted the Constitution as stating that forests are under federal ownership and may be transferred to a subject only by means of federal legislation. This ruling has the effect of making all efforts by the regional governments to introduce their ownership and regulation unconstitutional. The recent Federal Law on Division of State Property on Land also states that Forest Fund lands are the property of the Russian Federation.[47] However, the law has not yet developed to determine how the regions, which are largely autonomous, will be convinced to relinquish their claims to the carbon credits.

But will the regions quietly accept this ruling and give up all claims to decisions that will affect potential from sequestration, or will this tension between the federal and regional levels of government lead to battles over administrative control? This question can be legitimately asked of both new sequestration projects and those involving "forest management." Even if investors are not legally required to deal with the regions, they will almost certainly be forced to do so politically. The Federal Forest Code allocates responsibilities among different levels of government for utilization, protection, and regeneration of the Forest Fund forests (see part II for more information). The federal

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[45] The English version of Russia's Forest Code can be found at <www.forest.ru/eng/legislation/>.
[46] Samara region and the Republic of Tatarstan have moved toward adopting their own land codes; the Karelian Republic has enacted its own rules allowing private ownership of natural resources.
[47] Federal Law of Russian Federation No. 101-F3 On Division of State Property of Land. July 17, 2001. www.akdi.ru/gd/proekt/081233GD.SHTM Can be also accessed through www.duma.ru, Russian Duma's official website.

level deals mainly with issues of ownership, use, and disposal of Forest Fund lands, but the regional governments have the responsibility for developing and implementing regional forest plans, administering leases and permitted use of the lands, and establishing most forest tax and lease rates. Thus both federal and regional governments will affect how these lands are used; introducing a level of uncertainty surrounding both the transactions and the compliance. These uncertainties will drive up the financial risks of projects, making them more costly.

Land Allocation Mechanisms

Current mechanisms for forest resource allocation are intended for commercial use of forests. They include contracts for the lease or concession of forest parcels for up to 49 years, uncompensated use, and short-term use.[48] The leases are granted at auctions by commissions chaired by regional administrations, which include representatives of the regional forestry department and the regional environmental protection committee. Leased parcels do not remain the property of a lessee after the lease expires, but revert to federal ownership. The Forest Code provides detailed guidelines concerning the obligations and rights of forest users.

Uncompensated (free-of-charge) use of Forest Fund parcels can be granted by regional authorities for 49-year periods. This mechanism is currently used most often to grant agricultural organizations and hunters' associations the right to use Forest Fund parcels for specific purposes.[49] Forest concessions are a relatively new concept in Russian forest legislation. They may be granted to any person considered an investor by Russian law, and are awarded by the federal government or its authorized agency, the Federal Forest Service. The concessions are normally awarded for a 49-year period; at the end of that period the parcel may be transferred to a different user by the FFS. The Forest Code is silent on the possibility of renewal. Since carbon sequestration is likely to involve stocking lands in perpetuity, this lease structure may need to be amended.

Compliance

There are a number of difficulties in adapting these resource allocation mechanisms to carbon sequestration. For example, enforcement is not consistent throughout Russia. Rules and regulations are not always regarded as legitimate, and are not applied equally to similar actors. Individuals or organizations that have personal connections to regional government often receive "special treatment" at the auctions. Some forest users seem to enjoy unusual privileges, suggesting that corruption may be a problem. These factors create a potential disincentive for foreign investors.[50]

Another potential problem revolves around the concession agreements. These leases assume that the user will pay taxes, fees, and other charges for forest use; this could further undermine the economic viability of carbon sequestration if the same structure

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[48]Forest Code of the Russian Federation, 1997. Chapter 4, article 22.

[49] Some 327.5 million acres of forest are presently in long-term lease to agricultural enterprises.

[50] Carlsson, L., N.-G. Lundgren, M.-O. Olsson, M.Y. Varakin , 1999. "Institutions and the Emergence of Markets: Transition in the Arkhangelsk Forest Sector," p. 75.

used for logging is used for sequestration concessions. The current system, geared toward commercial timber harvests, must be adapted before any program of sequestration is implemented.

Because "forest management" looks like it will only require Russia to identify managed tracts, it is likely that the government will be the seller, so taxes and fees will probably not apply. This will make it easier to sell the management credits, since the problems associated with concession agreements is likely to be circumvented.

Along with most other countries, Russia has not developed a special legal status for carbon credits. Current allocation mechanisms for land use rights might be adapted for sequestration projects, but at present they are intended specifically for logging. Rights for sequestered carbon would need to be legally recognized and specific legislation would need to be developed to implement and allocate these rights.

One of the few experiments to show how this could be done took place in New South Wales, Australia. Realizing the great potential for investment in planted forests for carbon credits, the New South Wales government passed the first Carbon Rights Legislation Amendment Act in 1998.[51] It enabled the rights to carbon sequestered in planted forest to be separated legally from the land on which the planted forest grows and from the timber rights that were attached to the planted trees. Development of a carbon trading system would provide a range of opportunities for landholders to diversify their farm income, such as by renting their land to an organization (state or private) without contributing their own capital to the establishment or management of the planted forest, or by creating their own private commercial planted forests. Carbon credits generated would be calculated and verified against a national accounting standard, and could then be sold into an emissions trading market. Land and forest ownership laws are very different in Russia, but the Australian example demonstrates the type of action required to legalize carbon sequestration and to establish carbon credits as a tradable commodity.[52]

Given the uncertainties of Russia's land and forest property rights and its ever-changing laws, the easiest way to secure a land parcel for a new carbon sequestration forestry project would be for the federal government to designate it with the "special status of a protected forest." This way was chosen for the two "Activities Implemented Jointly" (AIJ) projects in Russia.[53] In both projects, forests were granted the status of a protected forest. The territory of the Saratov Reforestation Project (total of 2,250 acres replanted) was designated a Regional Park and Soil Erosion Protection Area. The land that was

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[51] Text of the Act can be downloaded online from: www.forest.nsw.gov.au/business/carbon/legislation/default.htm.

[52] Bureau of Rural Sciences, Department of Agriculture, Fisheries, Forestry of Australia. June 2000. *Climate Change Newsletter*, Vol. 12, No. 2.

[53] The two "Activities Implemented Jointly" (AIJ) projects are the Saratov Reforestation Project (RUSAFOR) (currently under way) and the Vologda Reforestation Project (suspended after the initial feasibility study). AIJ is a form of Joint Implementation (JI) approved in the UN Framework Convention on Climate Change (FCCC) of 1992; it involves demonstration projects that are like JI activities, but without the exchange of carbon credits.

intended for use by the Vologda Reforestation Project would have been annexed to an adjacent National Park.[54] This status leaves a new forest in permanent protection. It also is the only class of land subject to oversight by the State Committee on Environmental Protection, a body that is charged with monitoring environmental conditions. This protection may be paper thin, however, since the department has little ability to enforce its decisions. (For more information on Russia's system of protected territories, see Appendix 1).

Such an approach might work well for a few projects, but it is hard to imagine that thousands of acres of forestland would be transferred to protected status, if a commercial demand exists. A more realistic option would be to establish a class of "sequestration lands" to be governed by regulations appropriate to the long-term, commercial nature of sequestered forests. New regulatory and legislative acts, with significant changes in tax, land, and commercial legal codes will be necessary to accommodate carbon trading as a legitimate commercial activity.

Fallow and Agricultural Lands

The second largest category of lands after the FFS non-stocked forestlands available for reforestation is that of marginal or unused agricultural lands. This category, however, has its own problems. The idea of using marginal croplands and other agricultural lands for sequestration projects is not new.[55] It is based on the argument that, as Russian agricultural production has been declining, lands formerly used for farming have become available for other uses. The transfer of land from agricultural use to other uses is, however, constrained by law. The Russian Constitution of 1993 states that "land and other natural resources may be in private, state, and other forms of ownership" (Article 9) and grants owners the right to use and decide on disposition of land freely (including trading, bequeathing, mortgaging, renting, or exchanging land) as long as the use or disposition is legal and is environmentally safe. However, the Russian Civil Code, adopted in 1994, while recognizing various forms of land ownership (private, municipal, state), imposed constraints on the use of such land. The landowner must preserve the fertility of the land and may use it only for previously specified purposes, i.e. farming.[56] These obligations apply even to private owners, and non-compliance could result in administrative termination of their land tenure.[57] These provisions are aimed at avoiding the reemergence of absentee landlords, but they also restrict changes in land use, even those that might be more environmentally and economically rational.[58] Unless they are amended, these laws will limit Russia's carbon sequestration potential, because marginal

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[54] Framework Convention on Climate Change, 1999, "Activities Implemented Jointly. US Initiative on Joint Implementation Uniform Reporting Document." <www.unfccc.de/program/aij/aijact/rususa01.html> and <www.ufnccc.de/program/aij/aijact/rususa04.html>.

[55] Golub, A. Bureau of Economic Analysis (Russia), personal communication, December 2000.

[56] Civil Code of the Russian Federation, 1996.

[57] Wegren, Stephen K. 1997. *Agriculture and the State in Soviet and Post-Soviet Russia.* Pittsburgh: University of Pittsburgh Press.

[58] Lerman, Z. and K. Brooks. 1996. "Russia's Legal Framework for Legal Reform and Farm Restructuring," *Problems of Post-Communism*, Vol. 43, No. 6 (November–December), p. 51.

agricultural lands that could otherwise be afforested for carbon sequestration purposes are legally prevented from being used for purposes other than farming.

Taxation

Generation and trading of carbon credits will be affected by the existing tax structure. Existing trade and taxation rules discourage carbon transfer and foreign investments. For example, forest enterprises in Russia's Arkhangelsk region identified problems with the taxation system and the size of the tax burden as the biggest obstacles to normal commercial forestry.[59] There are multiple taxes in Russia, levied by different jurisdictions that rarely coordinate their policies, and to complicate matters, they have been known to change with little or no notice.

A forest user in Russia can expect to be charged unsanctioned local "add-ons" by municipal (*raion*) administrations, usually in the course of negotiations for municipal permits.[60] These fees, additional to officially sanctioned taxes, can take different forms: "voluntary" contributions to the social fund that provides funding for local kindergartens, hospitals, boiler stations, or road construction; additions to the federally established minimum stumpage fees; or improvised taxes based on loopholes and technicalities in the law. Foreign companies are often hit the hardest, since they are considered wealthy.[61] Such discretionary "add-ons," and flexible interpretation of the rules on revenue sharing between different levels of government, make taxation an unpredictable issue for any investor.

In addition, taxes differ from region to region, and sometimes can amount to 90 percent of profits.[62] Among the major taxes currently levied are an enterprise profit tax, levied at the beginning of each quarter, based on estimated gross profits for the coming quarter (in 1997 this tax was 13 percent federal tax, plus up to 22 percent territorial tax); value-added tax (VAT) of 20 percent levied on fuel, spare parts, and equipment; payroll taxes, assessments for social and medical insurance, unemployment, and pension reserves, amounting to 40 percent of payroll costs; territorial taxes including land use tax, stumpage fees, and a timber lease fee; municipal taxes of up to 3 percent of an enterprise's gross revenues; customs duties of 0.05 percent of product's value; and "miscellaneous taxes," an expanding category that sometimes accounts for the majority of the total tax liability.[63]

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[59] Carlsson, L., N.-G. Lundgren, M.-O. Olsson, and M.Y.Varakin, 1999. "Institutions and the Emergence of Markets: Transition in the Arkhangelsk Forest Sector," p. 68.

[60] After being awarded a lease for the use of a forest tract, forest users must register with the local (*raion*) administration and obtain its permission to develop the leased land.

[61] The accountant of a foreign logging company operating in the Khabarovsky Krai complained that every time anyone is making money and has positive economic effects, the tax inspectors appear at the door. Mabel, "The Flexible Domestic State."

[62] Mabel, "The Flexible Domestic State."

[63] The World Bank, 1997. "Russia: Forest Policy During Transition;" Carlsson L. and M.-O. Olsson, 1998. "Institutions and the Emergence of Markets: Transition in the Tomsk Forest Sector," p. 46.

Political intervention is a serious problem with the taxation system that has a counterproductive effect on the development of market relations. Forestry enterprises in arrears might negotiate with the authorities to be exempt from certain taxes and fees, agreeing in exchange to give regional administrations shares in the enterprise. This makes the regional administrations joint owners of the enterprise and, in effect, obstructs free trade and the development of independent firms (Appendix 2).

If new sequestration and "forest management" projects are treated like more traditional logging projects, it is unlikely that many sequestration projects would be undertaken, since any revenue would be taxed, raising prices. If, in an international system, the market clearing price is less than $10/ton C, then several million tons of carbon could be sequestered in Russia annually post 2010, but if additional taxes are levied, the effective price of the sequestered carbon and its revenue stream is much less attractive to investors. However, the clearing price of carbon is likely to be quite low in the short to mid term, and taxes, even if levied on the least expensive forest management projects, may price the credits higher than the world market for carbon credits.

Delineating Property Rights

Three important steps are required with regard to property rights if Russia is to realize even a portion of its carbon sequestration potential. First, it must establish clear legal rights to the sequestered carbon, and it must resolve the conflicting political claims over forestry ownership and management by federal and regional forest services, regional administrations, and agents or consultants acting on behalf of these parties. Second, an appropriate taxation system that encourages, rather than discourages, investment in carbon sequestration must be developed. And third, interests in carbon credits from sequestration projects should be allocated in such a way that the participants have incentives to cooperate with the carbon trading system on a voluntary basis. This will increase the flexibility of participants and allow them to decide when to enter or exit the carbon market. In Russia, all three of these aspects of carbon ownership need further development.

Granting carbon-credit ownership to the owners of the land seems to be a sensible way to administer carbon credits. Politically, this may be difficult to carry out in practice. Forest ownership is Federal, but federal and regional authorities jointly control oversight for forest resources. Moreover, the participants at the various federal and regional levels are not represented by single agencies. Rather there will be multiple participants at every level, including the Federal Forest Service, Regional Forest Committees, individual *leskhozes*, regional administrations, and enforcing agencies. The potential for conflicting claims is large, unless a mutually acceptable method of allocating revenue and authority is determined.

The state monopoly over forest and land resources means that initially the state is most likely to be the owner of the credits. However, a federal government monopoly on forestry-generated carbon credits would significantly dampen the enthusiasm of regional and local entities to participate in sequestration projects. The Russian government should

consider options to stipulate who owns the carbon, and to share any revenue generated by such programs with regional and local governments.

Finally, Russia's tax code will need to be amended to accommodate carbon credits appropriately. To the extent politically possible, tax treatment of carbon sequestration projects must encourage rather than impede trade.

Given the estimated price of new sequestration, and these additional political, regulatory and sovereign risks that will further drive up the price, it is unlikely that many regions, except those blessed with the lowest priced new projects, would have much of an incentive to develop capacity to sell carbon credits. On the other hand, if "forest management" credits were given to regions, they might have an excellent incentive to set up enough of an institutional structure to properly account for their share. It isn't clear at this point, however, that the Russian Federal government has any interest in sharing the windfall credits with regions.

V: Compliance and Verification

A good compliance system is a crucial prerequisite for successful carbon generation and sale. Without it, it is impossible to determine whether a carbon sequestration project that is claimed was actually put in place. Systems for recording transfers, monitoring and certifying sequestration, and demonstrating compliance must account for all transfers and emissions; must be accurate, transparent, public, and easily accessible; must be administered efficiently; and must meet international guidelines to ensure consistency among parties to the relevant treaties and agreements. This suggests that Russia will need a national registration body. Several unresolved issues include its financing, how different financing options might create incentives for effective functioning of the body, what control functions it would have and, most importantly, how much authority it would have to levy sanctions on domestic trading parties that are out of compliance.

Verification through independent audit is a well-established procedure that has been applied to a wide range of activities internationally such as arms control and financial audit. However Russia, in contrast to other developed countries, does not have many such procedures that it could build upon or use as models.[64] The old Soviet environmental monitoring and reporting systems hardly work, while new systems that are formally under development do not seem to be functioning yet. Russia lacks good systems of an independent auditing and of environmental enforcement, monitoring, and measurement.[65]

Monitoring carbon sequestration should be possible in the forest sector, although there are significant uncertainties in the forest inventory data. Ensuring a proper monitoring and verification system for carbon sequestration projects will be one of the most important tasks for the Federal Forest Service. Any compliance system developed for carbon credits for either forest management or new sequestration is likely to be built upon the current forestry laws and enforcement mechanisms. However, these laws and mechanisms are not flawless, and the problems faced by traditional forestry will also affect carbon sequestration projects. If Russia cannot afford to implement a rudimentary monitoring program to improve conventional forestry management, it may be unreasonable to expect that it can establish an effective carbon sequestration monitoring system unless there are major changes in governmental priorities.

There are two parts to the verification system: how the verification will be performed, and who will perform it. A national carbon accounting standard will be needed that relates the proportion of carbon that is likely to be sequestered and traded with the level of accuracy and precision of the measurement system. Base data should include the net

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[64] One of the few examples of such a system in the former Soviet Union was the Sanitary and Epidemiologic Service, which among other functions, checked regularly the sanitary conditions of a wide range of enterprises and organizations from grocery stores to industrial plants.

[65] Söderholm, Patrik, Environmental Policy in Transition Economies: The Effectiveness of Pollution Charges, May 1999. WP-99006. Center for Energy and Environmental Policy Research, MIT.

planted area, how it is stocked, and measures of productivity. Different accounting approaches are required for areas where forests already exist and areas where additional carbon might be sequestered in the future, and for where the forest will be harvested and where it will not be. Because potential buyers are interested in purchasing carbon credits during a particular time period, growers will need to be able to predict future forest growth. This may be a simple "default" assumption, based on species and site conditions, or it may be based on sophisticated growth models, using past measurements or independent estimates of site quality. Those areas identified for "forest management" will need to be properly inventoried and tracked. Whatever standard is chosen, it should be consistent with international agreements and standards. Significant work has been conducted on the general technical guidelines for reporting and verifying forestry projects.[66]

A thorough verification will be necessary before credits can be issued to the buyers of carbon rights. Such a verification should be performed by an independent entity that is government-accredited or internationally accredited; has experience in certification processes; is financially independent and free from commercial pressures; and has experienced analysts and assessors under direct management. The process of applying sanctions against entities not in compliance with the laws and rules must be very clear and based on the findings of an independent audit. The sanctions may be applied by an international or national body, or alternatively by the auditors themselves.

A systematic approach will be necessary to ensure proper verification of a project's progress and reported carbon uptakes. This could be a challenge, because it is not now clear that any agency, company, or non-governmental organization (NGO) in Russia has the technical capability and credibility to be accepted by all parties as a legitimate verifier. The State Environmental Department lacks the capability to provide routine verification and enforcement of existing laws. The governmental reorganization of May 2000, in which it was changed from an independent agency to a department within the Ministry of Natural Resources, suggests that it will not be able to build any more capacity in the near future, especially since budget pressures will likely continue. Most Russian NGOs are still relatively weak and are mainly involved in political rather than technical issues. They therefore have little technical ability or staff to verify project results. Private environmental companies that could perform this kind of service do not exist in Russia.

However, forest certification programs have recently become a focus for the Russian NGOs. With support from international environmental organizations, the Forest Club is promoting ideas for voluntary and mandatory certification programs, as well as third-party verification. This is the first such attempt in the forest sector, and it could become the basis for the much larger verification system that will be required for carbon sequestration.[67]

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[66] Vine, Edward; Sathay, Jayant, and Makundi, Willy. "Guidelines for the monitoring, evaluation, reporting, verification and certification of forestry projects for climate change mitigation." March, 1999, LBNL-41877. Online at: <www.epa.gov/globalwarming/publications/reference/merv/forestry.html>.
[67] Russian NGO's Forest Club. 2000. Online at: <www.forest.ru>

The exact structure of the enforcement system, another important aspect of carbon sequestration, will have to be determined by negotiations and legislation. It will be necessary to strengthen contract laws and their enforcement, so that contracts cannot be easily breached. An effective penalties system should reflect costs of non-compliance. Penalties should be set in such a way that individual participants perceive the costs of sanctions as greater than those of complying with the obligations, thus creating incentives for correct reporting. The largest potential problem is that while verification may take place, sanctions may not be enforced in cases of non-compliance, or the parties may collude to cover misinformation.

A Proposed Design for Verification

One can chart a schematic of potential overall institutional structure for sequestration. Solid lines in Figure 5 show the institutions and the links that already exist, while dashed lines signify missing components of the system. The boxes to the right outline major function of each rank, and indicate the current level of completeness.

Figure 5. Functions Needed for Sequestration

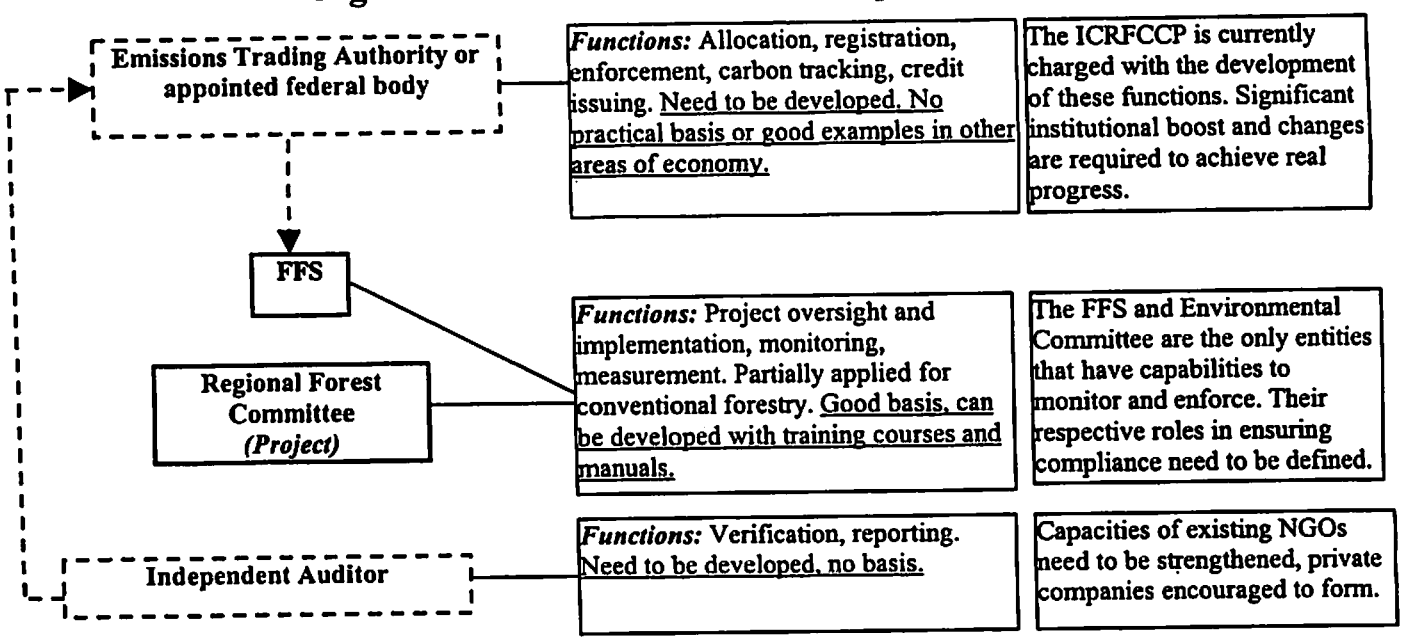


Figure 5 shows that only at the national level do forestry institutions have a practical capability to expand their activities to include a carbon transfer system. Management and compliance functions will need to be performed jointly by regional forest committees and federal forest management units, the same organizations responsible for monitoring the current use of the forests. However, for this to be feasible, there must be an increase in both the education of both federal and regional staff and in financial resources to support monitoring and compliance operations.

For similar reasons, the verification issue will also be a challenge. There are no established audit practices in Russia in any sector. Even in banking and corporate finance, fledgling programs are just beginning to emerge. Hence, designing an audit program for carbon sequestration projects will be a major undertaking and will require new institutions and procedures.

A proposed schematic for carbon transfer implementation is presented in Figure 6. Obviously, many aspects of such implementation will be subject to international negotiations and national policy. However, based on institutions, strengths and weaknesses that we have found in the Russian forest sector, the following steps could serve as a basis for building a verification system.

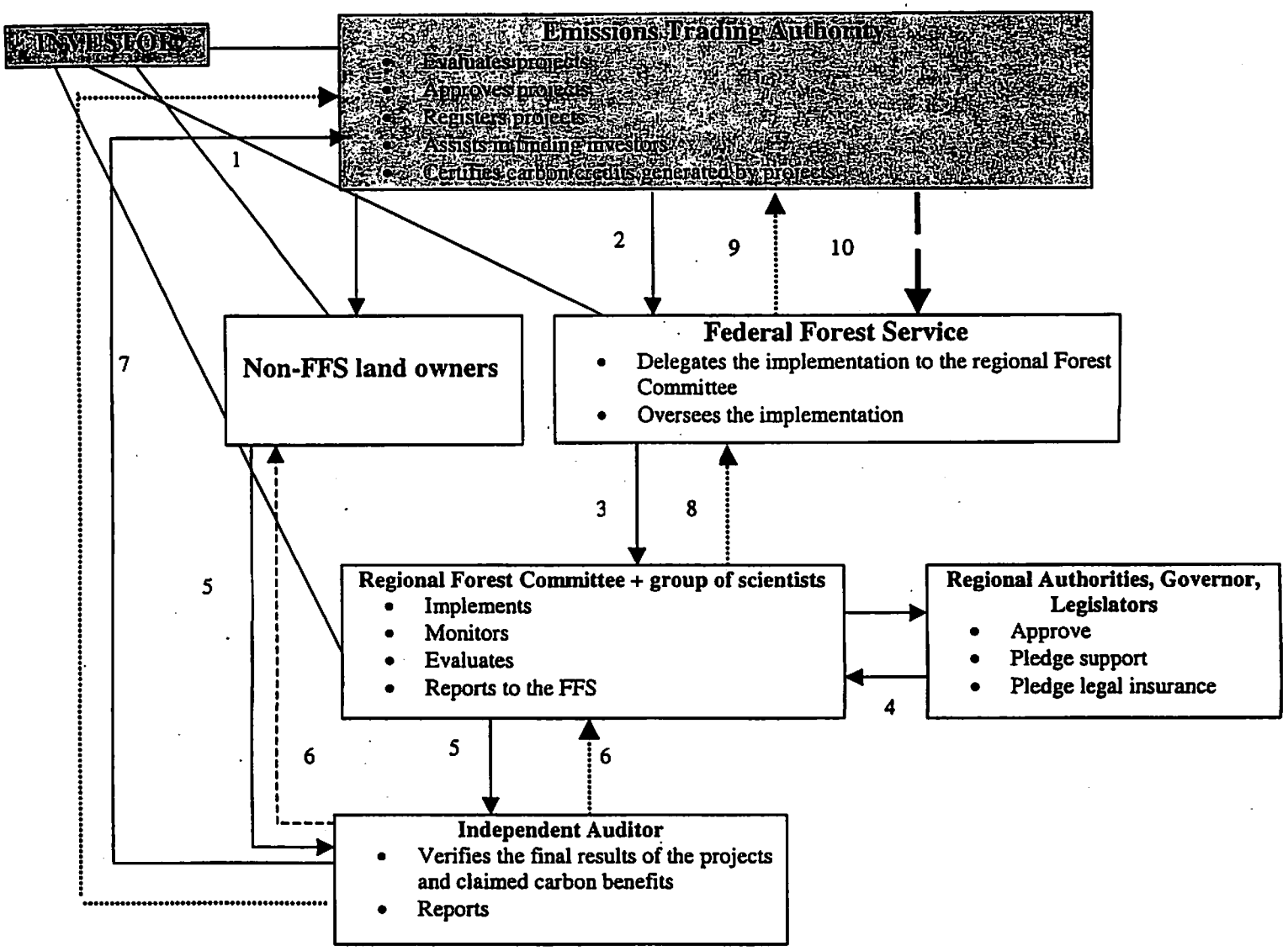
- An Emissions Trading Authority needs to be established by the federal government, and the regional forest committees need to have the capacity, interest, and incentive to undertake a carbon sequestration project. This goal could be furthered through several activities:
  - A successful educational campaign.
  - Training of federal and regional employees.
  - Creation of economic incentives to induce investors to participate

- If the general oversight of the project is assigned to the Federal Forest Service, its capacity to enforce necessary new forestry rules will need to be strengthened to fulfill this oversight role. Reforestation projects for carbon production will need to be subject to special monitoring, verification, and insurance, to avoid leakage and illegal operations. Given the current extent of violations and the lack of assured control by the FFS of traditional reforestation and forest preservation activities, it will be important to bolster its enforcement capacity by increasing its ability to monitor and report on activities. Similarly non-FFS forests need to be monitored and controlled by their correspondent authorities.

- Increased coordination between the federal, regional and local government is critical. Presently, regional authorities play an important role in commercial forestry operations, such as issuing licenses for logging and establishing fees. Defining their role in future sequestration projects will require development of specific regulations governing carbon and land ownership and revenue sharing.

- Independent auditors are needed to verify a project's results.

Figure 6. Potential Institutional Scheme for Carbon Transfer Implementation



Steps:
1: Regional Committee submits project proposal;
2: ETA approves and recommends for implementation;
3: FFS oversees the project;
4: The implementation of the project is coordinated with the regional authorities;
5: Implementers hire an independent auditor to verify the results;
6,7: Auditor reports its observations to the project implementers and to the ETA;
8, 9: Regional Forest Committees and the FFS report to the ETA about the completion of the project;
10: The ETA issues credits.

VI: Conclusions and Recommendations

Establishing a program to sequester carbon and trade the resultant carbon credits in Russia will require substantial legal change. Fundamental property rights are not fully developed for the ownership and use of the forests, much less for allocating the entirely new property of carbon credits. Relevant tax law is still unwritten and must be carefully designed, or else it could place such a high burden on investment projects as to render virtually all new sequestration projects uneconomic. No legal structure is yet in place to guide verification and compliance, even if the institutional capacity existed to pursue them. All of these challenges must be met.

Without a functioning institutional framework, no policy aimed at carbon sequestration can be successfully implemented. Overall, there are three major obstacles for developing a climate change policy in Russia: institutional disarray, insufficient regulatory and legislative basis, and poor familiarity of key people with climate-change issues. If these problems are not resolved, even the simplest real carbon sequestration program will not work effectively. In this section we summarize our findings and recommendations.

Institutional Disarray

The institutions charged with environmental regulation are very weak in Russia at this point. Furthermore, they play a small role in the administration of forestlands, having little historical basis for interfering with the FFS.

Several institutional obstacles plague the FFS. It is subordinate to the Federal and regional governments, making oversight contentious and complicated. Evidence exists that the FFS cannot presently control illegal logging, suggesting that without significant changes and increased resources it is not likely to be able to oversee the implementation of carbon sequestration projects credibly and effectively.

Insufficient Legal and Regulatory Basis

Property rights are not well established for Russia's forest resources. Although a recent court case appeared to grant jurisdiction over the forests to the Federal government, the law has not yet developed to determine how the regions, which are largely autonomous, will be convinced to relinquish their claims to the carbon credits. Nor has the problem of property rights to fallow agricultural lands been addressed. Ownership of carbon rights has not yet been determined at any level, nor has guiding legislation been passed; thus it is impossible to say who will actually receive the rights to the sequestration potential.

Even if all of the legal details are established, the regulatory structure is not likely to be able to oversee the system. Russia's environmental agency has great difficulty in enforcing laws regarding conventional pollutants, and it lacks the legal mandate to oversee most forest activities. The Forest Service is largely self-regulating, and at this point, it has no incentive to act in a transparent way, since no auditing function exists to monitor its activities.

Lack of Technical Knowledge about Climate Change
Most people who administer Russia's forests have little training about climate change or sequestration, though they may know a great deal about silviculture. In Russia's government overall, few people outside those directly involved in international climate negotiation have studied the implications of climate change, or understand the legal and institutional remedies needed to take advantage of the potential gains from trading. This suggests that it will be difficult to push new laws and allocate sufficient funding to build the initial structure needed to implement carbon trading.

Recommendations
Given the problems outlined in the paper, it is unlikely that Russia will complete many new sequestration projects. The economic cost is simply too high, particularly since Russia was given the gift of an uncapped 1990 emissions baseline and "forest management" credits that will apply to existing forests.

COP-7 has given Russia a one-time gift of "forest management" credits. Because these credits cannot be banked, they should be looked upon as a windfall that will allow Russia to sell some cheap credits while building its capacity to conduct sound measuring, monitoring and verification activities. The real danger, for both Russia and the international community is that the federal government of Russia will sell the "forest management" credits, but the institutions and basic legal and technical framework will not be adequately built by the end of the 2008-2012 commitment period. Without the basic framework, Russia will not be able to capitalize on new sequestration opportunities which will become more economically attractive as the easier, inexpensive options are exhausted.

In order to help ensure that real carbon reductions, as well as the necessary institutional underpinnings are met, the international community must insist that even forest management credits are accurately recorded, measured and monitored. This is especially important for the forestry sector because our cost analysis suggests that new Russian sequestration projects are likely to be too expensive in this first commitment round. Furthermore, unless the federal government in Russia simply uses the "forest management" credits to meet its own obligations, many of the same barriers to transactions exist for "forest management" credits as they do for sequestration credits. In the short run, it may seem appealing to sell assets as quickly as possible and to use the money for unrelated projects. In the long run, however, building the institutional foundation for credible carbon trading will create a healthier, less expensive system. These fundamentals require the following actions:

- pass legislation to determine the basic property rights and allocations of carbon within the forestry sector, as well as for the country as a whole;

- delineate the roles and responsibilities of Russian agencies and levels of government; and

- allocate sufficient resources to regulate, monitor, measure, and take appropriate compliance measures to ensure that the sequestration program proceeds in a clear, consistent matter that are credible to the international and domestic community.

The big unanswered question is whether these fundamentals will be met. Perhaps the fledgling compliance rules will give Russia the right incentives to build this capacity, and encourage international buyers to insist on good initial conditions. However, it is possible, given the agreement in November 2001, to put off facing the structural problems in anything more than a superficial way. Will politics and rhetoric prevail, or will this time and potential funding be used to build solid foundations for carbon trading? Only time will tell.

Appendix 1. Protected Areas

Protected lands in Russia are divided by their purposes into several categories. Strict nature reserves (*zapovednik*) are intended for biosphere preservation and scientific research. All economic activity in them is prohibited. There are 83 *zapovedniks* covering some 70 million acres. National Nature Parks are areas with special ecological, historical, or aesthetic value; limited educational, recreational and agricultural activities are allowed. There are 24 national parks and they occupy about 32.5 million acres. Protected territories (*zakaznik*) are designated for the protection of specific flora or fauna populations, and cover an additional 28.75 million hectares.[68] There are numerous *zakazniks* and they are considered a more flexible conservation instrument, as they are easy to establish and their regime can be adjusted to the specific management objectives. Other categories of protected areas include national monuments; hydrological protection forests along river banks; anti-erosion forests and shelter belts; and health and municipal forests around cities and industrial complexes.

[68] The World Bank, "Russia: Forest Policy During Transition," 1997.

Appendix 2. The Free Market and Forestry

Russia's forestry industry faces severe economic problems. It cannot be characterized as a free market, because it lacks:[69]

- transparent constitutional rules;
- a well-defined and settled structure of property rights;
- rules and regulations that are accepted as legitimate, and that are applied equally to all market participants;
- a market that decides the prices of property and goods;
- the ability for private investors to realize a return on their investments;
- rules to prevent the depletion of natural resources; and
- functioning enforcement system.

None of these criteria are entirely met in the forest sector. We can hardly expect that a new market could easily be established in a sector where the practices of free-market trading are not common, the regulatory system is not transparent, and there is no adequate institutional framework to address all the needs of the sector.

However, establishing an adequate institutional framework will be impossible without a comprehensive policy for the forest sector as a whole. The role of the authorities should be limited to minimizing political risks and providing stability for business development, as well as developing transparent rules and imposing regulations. Development of market relationships in the forest sector is vital to make carbon trading realistic because these projects require many of the same factors that make any market function, including transparency, relatively low transaction costs and clear property and allocation rules. Government should encourage formation of private companies that specialize in carbon sequestration, and work to create a regulatory environment that would let those companies freely participate in the trades and realize return on their investment. This system is nowhere in view in Russia. Thus, only if the above conditions are met can a carbon sequestration system be successful.

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[69] Blam, Y. et al., 2000. "Institutions and the Emergence of Markets — Transition in the Irkutsk Forest Sector," IR-00-017, IIASA, p. 69, <www.iiasa.ac.at/publication/catalog/PUB_PROJECT_FOR.html>.

Bibliography

Australian Greenhouse Office. 1999. "National Emissions Trading," Discussion Paper 3, <http://www.gov.au/pubs/>

Blam, Y. *et al.*, 2000. "Institutions and the Emergence of Markets — Transition in the Irkutsk Forest Sector," IR-00-017, IIASA, p. 69. Online at: <www.iiasa.ac.at/publication/catalog/PUB_PROJECT_FOR.html>.

Bush, George W. March 13, 2001. "Letter to Senators Hagel, Helms, Craig and Roberts from President Bush." Online at: <www.whitehouse.gov/news/releases/2001/03/20010314.html>

Carlsson, Lars, and M.O. Olsson. 1998. "Institutions and the Emergence of Markets -- Transition in the Tomsk Forest Sector," IR-98-084, International Institute for Applied Systems Analysis (IIASA), Vienna.

Carlsson, Lars, N.G. Lundgren, M.O. Olsson, and M.Y. Varakin. 1996. "Institutions and the Emergence of Markets: Transition in the Arkhangelsk Forest Sector," IR-99-021, IIASA, 1999, < www.iiasa.ac.at/Publications/catalog/PUB_PROJECT_FOR.html>

Civil Code of the Russian Federation.

Climate Change Country Study. 1999. Task 6, "Climate Change Action Plan," Report, Russian Federal Service for Hydrometeorology and Environmental Monitoring, Russian Federation Climate Change Country Study (cooperative agreement de-fco2-93po10118).

Conference of Parties. 18 March 1998. "Report of the Conference of the Parties on Its Third Session, Held at Kyoto from 1 to 11 December 1997." FCCC/CP/1997/7/Add.1. < http://unfccc.int/resource/protintr.html>.

Constitution of the Russian Federation. Available in English at <www.departments.bucknell.edu/russian/const/constit.html>

Edmonds, J., H.M.Pitcher, D. Barns, R. Baron, M.A. Wise. 1995. "Modeling Future Greenhouse Gas Emissions: The Second Generation Model Description." *Modeling Global Change*. United Nations University Press, Tokyo, Japan.

Edmonds, J., M.J. Scott et al. December 1999. "International Emissions trading and Global Climate Change." Pew Center on Global Climate Change.

EIA, December 22, 2000. *Annual Energy Outlook 2001 With Projections to 2020.* "Emission of Greenhouse Gases in the United States, 1999," Report#:DOE/EIA-0383(2001),. Washington, DC. <www.eia.doe.gov/oiaf/1605/ggrpt/index.html>.

Federal Law of Russian Federation No. 101-F3 On Division of State Property of Land. July 17, 2001. www.akdi.ru/gd/proekt/081233GD.SHTM

Fleisher, Ari. March 28, 2001. "Press briefing for the President, topic 5. Kyoto Treaty/ President's Position," <www.whitehouse.gov/news/briefings/20010328.html. >

Forest Code of the Russian Federation. 1997.English version online at: <www.forest.ru/eng/legislation/>.

Golub, Alexander, A. Averchenkov, V. Berdin, A. Kokorin, M. Martynova, and E. Strukova 1999. "Study on Russian National Strategy of Greenhouse Gas Emissions Reduction," The World Bank, Bureau of Economic Analysis, State Committee of Russian Federation on Environmental Protection, <http://ceeri.ecoinfo.ru/climate/english/projects/golub.htm>

Golub, Alexander. "Russian Forests for Climate Change Mitigation: An Economic Analysis," 2000. BCSIA Discussion Paper 2000-04, ENRP Discussion Paper E-2000-04, ENRP, John F. Kennedy School of Government, Harvard University,.

Hahn, Robert W., and Robert N. Stavins. 1999. "What Has Kyoto Wrought?" BCSIA Discussion Paper 99-02, BCSIA, John F. Kennedy School of Government, Harvard University,

Gugale, Bernd and Manfred Ritter. August 2001. "European Community and Member States greenhouse gas emission trends 1990-1999." Copenhagen: Denmark. European Environmental Agency. < http://reports.eea.eu.int/topic_report_2001_10/en>

Hamburg, Stephen P., D. G. Zamolodchikov, G.N. Korovin, V.V. Nefedjev, A.I. Utkin, J.I. Gulbe, and T.A. Gulbe. 1997. "Estimating the Carbon Content of Russian Forests: A Comparison of Phytomass/Volume and Allometric Projections," *Mitigation and Adaptation Strategies for Global Change*, Vol. 2.

Hamburg, Stephen P., and A. LeBlanc. 1995. "Reforestation in Russia: Building Institutional Capacity for Carbon Transfer Through the Vologda Demonstration Project," Final Report, Environmental Defense Fund.

Intergovernmental Panel on Climate Change. May 2000. "Land Use, Land Change, and Forestry," Montreal: Canada.

Environmental Protection Agency, April 2000. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–1998*, 236-R-00-001,

Krankina, Olga N., and R.K. Dixon. 1994. "Forest Management Options to Conserve and Sequester Terrestrial Carbon in the Russian Federation," *World Resource Review*, Vol. 6, No. 1 (1994).

Legro, Susan *et al.* September 1999. "Climate Change Policy and Programs in Russia: An Institutional Assessment," Advanced International Studies Unit, Pacific Northwest National Laboratory,

Lerman, Zvi, and K. Brooks.1996. "Russia's Legal Framework for Legal Reform and Farm Restructuring," *Problems of Post-Communism*, Vol. 43, No. 6 (November–December 1996).

Mabel, Marian. 1999. "The Flexible Domestic State: Institutional Transformation and Political Economic Control in the Khabarovsky Krai Forest Sector," IR-00-037, IIASA 2000.

"National Pollution Abatement Facility: Profile," IBRD Environmental Management Project (Russian Federation), Moscow. < www.emissions.de/climate-ru/organizations/national-pollution-abatement-facility.html>

Pappila, Minna. 1999. "The Russian Forest Sector and Legislation in Transition," IIASA Interim report IR-99-058.

Russian NGOs Forest Club. 2000. "Survey of Illegal Forest Felling Activities in Russia." <www.forest.ru>

Second National Communication, Russian Federation. 1998. Interagency Commission of the Russian Federation on Climate Change Problems. <www.unfccc.de/resource/natcom/nctable.html

Söderholm, Patrik. May 1999 "Environmental Policy in Transition Economies: The Effectiveness of Pollution Charges." WP-99006. Center for Energy and Environmental Policy Research, MIT.

Stavins, Robert N. 1999. "The Costs of Carbon Sequestration: A Revealed-Preference Approach," *American Economic Review*, 89(4).

UN Framework Convention on Climate Change (UNFCCC). 1999. "Activities Implemented Jointly: United States Initiative on Joint Implementation. Uniform Reporting Document."

Vincent, Jeffrey R., and E. Strukova. 1998. "Carbon Sequestration Costs in Russian Forests," (unpublished)

Vine, Edward; Sathay, Jayant, and Makundi, Willy. March, 1999."Guidelines for the monitoring, evaluation, reporting, verification and certification of forestry projects for

climate change mitigation." LBNL-41877. Online at: <www.epa.gov/globalwarming/publications/reference/merv/forestry.html>.

Wegren, Stephen K. 1997. *Agriculture and the State in Soviet and Post-Soviet Russia*, (Pittsburgh: University of Pittsburgh Press).

The World Bank. 1997. "Russia: Forest Policy During Transition,"

World Resources Institute. 1998. *World Resources 1998–99: A Guide to the Global Environment.* New York: Oxford University Press.

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