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Review

Reforming Forest Policies and Management in Russia: Problems and Challenges

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Abstract: The future development of forest industries in Russia, besides the country's geopolitical issues, could be seriously undermined by the depletion of forest resources available under the current model of forest management that mainly relies on clearcutting mature coniferous forests and leaving these areas for natural regeneration. The introduction of a new model that prioritizes efficient forest regeneration faces many problems on the ground. The efficiency of the use of funds allocated by both governmental and private logging companies for forest regeneration and subsequent tending of young stands should urgently be significantly increased. The government should also develop pragmatic economic incentives to encourage logging concession holders to switch to the new model and to address the problem of the spatial shift (demarginalization) of the country's forest complex from northern and eastern "green fields" to secondary mixed and southern taiga forests. Instead of harvesting low-productivity northern taiga forests of European Russia and remote areas of Central and Eastern Siberia, wood sourcing should be mainly concentrated in the immediate vicinity of existing mills. Moreover, the development of "greenfield" projects in wilderness forest areas that currently lack any kind of infrastructure should not be encouraged. The focus on the regions with productive southern taiga, mixed and broadleaf forests, developed wood-processing infrastructure, and high forest roads density could ensure the economically beneficial transition towards resilient forestry.

Keywords: intensive and extensive forestry; spatial demarginalization of the Russian forest complex; intact primary forests; secondary forests; reforestation and afforestation; forest management intensity

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1. Introduction

Over the last 20 years, the forest industries in Russia have undergone a deep modernization driven by growing export opportunities. The industrial output of forest products grew much above the average national economy's figures. Russia, primarily an exporter of cheap roundwood in the late 1990s, emerged as the key global exporter of sawn timber and wood-based panels in the 2020s. The forest sector's further development mainly depends on a steady wood supply, if not taking into account current geopolitical issues raised due to the Russian–Ukrainian military conflict (including EU and Japanese sanctions introduced against the Russian timber industry export). Partly supported by export restrictions for roundwood of coniferous and valuable hardwoods species introduced by the Russian government from 1 January 2022, Russia has significantly increased the output of processed forest products, especially sawn timber, wood panels and fiberboard. If in the early 2000s the Russian export of wood products was dominated mainly by roundwood, now, after almost 20 years of industrial growth, sawn timber is the major export product. Sawn timber production between 2000 and 2021 grew from 20 million cbm to 42 million cbm, respectively (Food and Agriculture Organization of the United Nation. Forestry Production and

Trade. URL: https://www.fao.org/faostat/en/#data/FO (accessed on 24 January 2023)). Before the outbreak of the Russian–Ukrainian military conflict and following geopolitical consequences (including economic sanctions), almost three-quarters of sawn timber was exported, thus making Russia the second largest sawn timber exporter globally. Simultaneously, the roundwood output increased from 158 to 202 million cbm to cover the demand of wood industries.

After the peak in 2019, the sawn timber export from Russia started to slide down (Figure 1) following a shrinking demand due to the COVID-19 pandemic and related massive lockdown (2020). In 2021, export capabilities additionally decreased because of restrictions imposed by China on the rail transportation of non-containerized goods (https://www.kommersant.ru/doc/5141481 (accessed on 25 May 2023); in Russ). The overall decline was accelerated by EU sanctions against the Russian timber industry. At the moment, it is difficult to correctly evaluate how the demand for the Russian wood would change due to introduced economic sanctions. During the first quarter of 2023, the sawn timber export decreased by 21% [1], which corresponds to the decline in Russian timber export in 2022 (Figure 1). Potentially, these losses could be partially compensated for by re-orientating timber industry export from European countries to China and some other Asian (Uzbekistan, Turkey, Vietnam) and Middle Eastern countries, although economic profitability of export to those countries is significantly lower. "The turn to the East" of Russian natural resources export has encountered some logistical problems and bottlenecks, including competition of sawn timber export with coal and mineral fertilizers export.

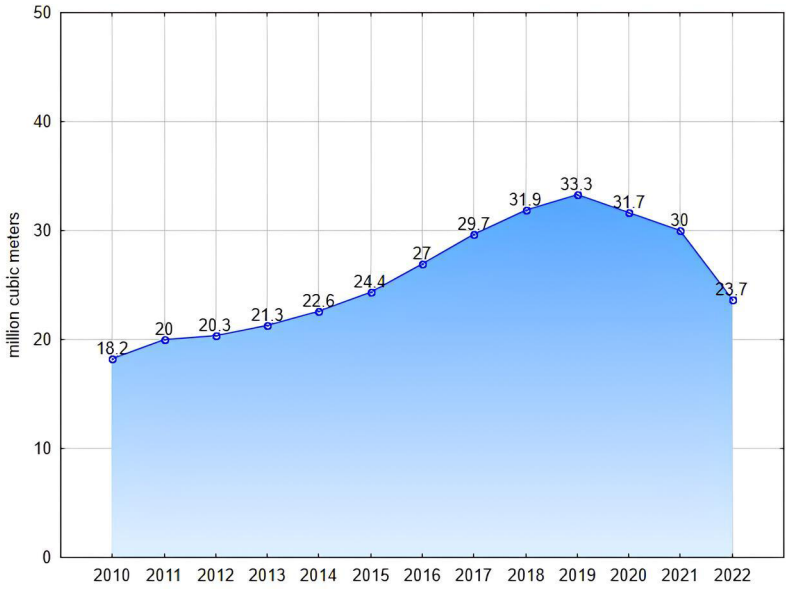

Figure 1. Export of softwood and hardwood sawn timber from Russia (million cubic meters) Source: Russian Sawn Timber Market Monthly Price Review, WhatWood [1].

The further development of the sector, however, could be seriously undermined by the depletion of forest resources available under the current timber extractive model of forest management in Russia, also known as "an extensive forest management model". In this model, after harvesting all old forests in one place, the frontier of clearcuts moves further to the mature primary intact coniferous forests. Clearcut areas are mainly left for natural regeneration, while human-made forest regeneration is sporadic and non-effective. The current model of timber extraction in the country is quite archaic and bears serious risks to the future development of the forest industries if not reformed. The current forest policy prioritizes the development of new areas (timber extraction) over enhancing the forest productivity of already developed areas using silvicultural methods. The policy is grounded on a misbelief that there are enough mature productive coniferous forests in

Russia to ensure continuous timber production in long run—even at a much higher level than now.

The extensive forest management model is essentially inherited from the Soviet times. The main difference is that most of the harvesting is now made in private logging concessions [2,3]. Therefore, logging companies are encouraged to spend their resources on forest road construction and maintenance, despite the fact that the roads will be abandoned after all old forests in the area are extracted [4,5]. Timber extraction is dominated by large (10 to 50 ha) clearcuts made in mature coniferous forests. Most harvesting is conducted in winter when the ground is frozen. The clearcut areas are left for natural regeneration.

The overall resilience of the system depends on the availability of large expanses of old-growth forests to where logging concessions could move their operations once resources on the previous area are depleted [3]. The next clearcut under such a system can be carried out after a considerable time period, often more than 100 years. Therefore, the efficiency of forest regeneration on clearcuts, investments into silviculture and maintenance of permanent road networks have a low priority, both for governments and private companies. The problem, however, is that the most productive and easily accessible mature forests have already been exploited [6–8]. The best of what is left is currently in logging concessions.

The use of intact forests as a timber resource may save some time for the forest industries, but not for long. The risk of forest depletion within the framework of such a model is of a complex nature. Growing wood procurement costs at some point in the very near future will make forest industries non-profitable. When planning wood supply from intact forests in the long run, the fact is usually ignored that three-quarters of the loss of intact forests can be currently attributed to wildfires, whose combined impact dramatically increased in recent years due to a complex of factors: global climate change, pest outbreaks, human-induced fires associated with the development of wilderness areas and poor forest fire management [9,10]. In addition, many of such forests are considered as globally unique intact forest landscapes having high conservation values and deserve conservation as protected nature areas [3,11,12].

This article has the following aims:

To search for potential opportunities and incentives to reform the Russian forestry system, considering both modern challenges and domestic and international experience accumulated over the past 20–25 years;

To propose potential drivers capable of stimulating the forestry reformation and introduction of new approaches to its management in the Russian Federation [13,14].

The problem of how to ensure the shift to resilient forestry management still makes sense in countries that try to reduce deforestation and transformation of primary natural forest cover, including Brazil, Malaysia, Indonesia and some others [15]. Based on this reason, we believe that the topic of the article has much wider significance than only internal Russia forestry discourse.

2. History of Problems and Literature Review

Russian forests play an important role in the global economy with respect to the impact of environmental requirements of global environmentally sensitive markets on forestry practices and innovations. However, only relatively recently this became adequately addressed in modern research [12,16–21]. The low interest could be partly attributed to the fact that over the last decade of the 20th century, Russia's market share in the world trade of forest products has dramatically decreased from 18% to 2% of the market (http://www.kremlin.ru/events/president/transcripts/64116 (accessed on 30 November 2020)). The last data for 2021—2.9% [22].

For the last 50 or so years, most of the raw wood in Russia has been sourced from Northwestern European Russia and Eastern Siberia (Krasnoyarsk and Irkutsk regions). The same regions also remain the leaders in wood industrial output. In 2019, Northwestern European Russia harvested 27% of all timber and produced 26% of all sawn wood in Russia,

while for the Siberian Federal district (mainly the Krasnoyarsk and Irkutsk regions), these numbers were 27% and 39%, respectively [23].

The current model of a steady supply of raw materials in these regions strongly relies on the harvesting of primary (intact) forests. These forests are mainly not very productive and are located in remote areas that require significant investments in the development of transport infrastructure and logistics [4,5]. Moreover, major sawmills as well as the key users of low-quality timber—pulp and paper mills—are located at significant distances from harvesting sites, and logistical problems become worse as a harvesting frontier moves further. Nowadays, harvesting operations are often conducted several hundred kilometers from large processing facilities, thus making transport costs very high.

In recent years, major pulp and paper mills built in the Soviet times in traditional areas with high concentrations of forestry industries went through deep modernization (Arkhangelsk, Republic of Karelia and Komi Republic in Northwestern European Russia; Irkutsk region in Middle Siberia). At the same time, in more southern areas (Republic of Tatarstan, Republic of Bashkortostan, Leningrad and Smolensk regions), a significant number of old timber processing facilities were also modernized and extended, or even new mills were built. Economic prospects here are much higher, since forests are more productive, and the infrastructure is much better developed. In addition, there are significant areas of abandoned agricultural fields, which can be used for growing forests [24]. However, these regions also cannot guarantee a steady supply of raw wood to timber processing enterprises in the long run if the quality of silvicultural practices is not significantly improved.

The two forest corporations marked in bold in Table 1 (Kronospan and Egger) do not own pulp and paper mills and large logging concessions. Both companies mainly procure timber from secondary, more biologically productive forests in the Central and Southern parts of European Russia. Authors believe that the economic success of those companies could be an indicator of the start of the "demarginalization" of the Russian forestry industry—i.e., the shift of timber production to more biologically productive secondary forests of Central European and Southern parts of Russia with relatively well-developed road infrastructure. And this is a viable alternative to the current practice encourage marching of a harvesting frontier further into much less productive primary forests of Northern and Northeastern European Russia and Siberia lacking roads and forestry infrastructure.

Table 1. Top 10 forest corporations of Russia by revenues in 2021 (source: Lesprom Network (Lesprom https://www.lesprom.com/en/ (accessed on 4 February 2023) with amendments) *.

Top 10 Forest Corporations	Macroregions	Major Sources of Resources	Revenues, Billions of Russian Rubles	Changes 2021/2020
Ilim Group	Nationwide company with a strong presence in Northwestern European Russia and Middle Siberia	Primarily coniferous wood	180.3	+46%
Segezha Group	Nationwide company with a strong presence in Northwestern European Russia and Middle Siberia	Primarily coniferous wood	92.4	+34%
Arkhangelsk Pulp and Paper Mill	Northwestern European Russia	Primarily coniferous wood	72.1	+71%
Mondi Syktyvkar	Northwestern European Russia	Primarily coniferous wood	71.4	+17%
Kronospan	Central and Southern European Russia	**Primarily wood from secondary forests**	60.7	+37%
Sveza	Northwestern European Russia	Primarily coniferous wood	57.1	+59%
SFT Group	European Russia, including South	Waste paper and secondary cellulose	36.2	+75%
Egger	Western and Central European Russia	**Primarily wood from secondary forests**	35.5	+38%
ULK Group (Ustianskiy Timber Complex)	Northwestern European Russia (Arkhangelsk region)	Primarily coniferous wood	34.0	+63%
Company group Vologodskiye lesopromyshlenniki, VLP	Northwestern European Russia	Primarily coniferous wood	30.0	+64%

* Note: companies in bold do not own pulp and paper mills and large logging concessions.

3. Introduction of "Intensive Forest Management Model" in Russia

Hereafter, we use the term "intensive forestry model", as it is called in Russia, to describe a forest management system that provides for all necessary silvicultural tending in young and middle-aged stands to increase their commercial value and productivity. Despite the name, it has nothing to do with establishing plantations of fast-growing tree species but rather represents a classical forest management with a long-known silvicultural sequence of practices: planting trees on clearcuts, the tending of young stands (non-commercial thinning in stands with ages of 0–20 or 0–40 years depending on tree species), commercial thinning and final felling. If applied to productive sites, it permits an increase in the timber harvest per unit area by 2–3 times and the production of more sawlogs. At the same time, the intensive forestry model may bear serious risks to high conservation values and the forest resilience and, therefore, shall be applied with due consideration of all aspects of sustainability.

The Federal Forestry Agency (Rosleskhoz, the agency under auspices of the Ministry of Natural Resources of the Russian Federation) generally understands the risks of the extensive forest management model and has made important steps in creating a normative framework for a so-called alternative "intensive forest management model" [25,26]. However, the introduction of this model faces many problems on the ground [2,3,7,13,27,28].

The situation with the availability of forest resources for timber industries in the country cannot be improved until the government, which owns 100% of the Russia's forest, dramatically changes its attitude on forest policies and management practices, which need serious and immediate reforms. And, just as a new forest cannot grow over night, the reforms of forest policies and management practices cannot produce fast results. However, some steps can be made at relatively low costs to bring some tangible results already in a 10–20-year perspective.

The problems and contradictions accumulated in the forestry of the Russian Federation during the late Soviet and the entire post-Soviet periods [2,3,27,29]. Thus, to ensure "multi-purpose" forest management, the government administratively prescribes to implement the same set of "universal" rules in all forests. As a result, all commercial forests, both in logging concessions and outside of them, as well as forests reserved for implementing environmental, conservation and recreational functions, are actually managed according to the same archaic rules with identical KPIs. These KPIs are totally process-based and obsessed with growing coniferous monocrops for forest industries everywhere. At the same time, forests play a particularly pivotal environmental role in densely populated areas with a high recreational load. Therefore, silvicultural approaches in such conditions should be flexible and cannot only be focused on obtaining productive coniferous stands. Simultaneously, economic incentives for effective forestry are lacking. The key problem with the government's current approach to forest management is that, on one hand, its basic principles remain mainly unchanged from Soviet times. On the other, the amount of funds allocated by both the government and private logging concession holders for forest regeneration and subsequent tending of young stands remains inadequate, and what is of more concern, the efficiency of their use is quite poor. According to the authors, the decisions made at the State Council Meeting on the Development and Decriminalization of the Forest Complex (30 September 2020) did not help to solve the problems identified at it. These decisions just strengthened various types and forms of administrative control and prohibitions, which may be partially useful [27,30], but are clearly insufficient [31].

A comparison of the forestry sector's efficiency in the countries of the boreal zone shows that Sweden (whose forest area is equal to about 3.5% of Russia's forests) until recently produced 34% of the volume of timber harvested in Russia; Sweden and Finland (forest areas of both countries are equal to 6.2% of Russia's forests) produced about 63% of the volume of timber harvested in Russia (Figure 2; for earlier data, see [25]). Russia's raw softwood export to China in the period between 2010 and 2017 became almost 1.5 times less than that of New Zealand [32].

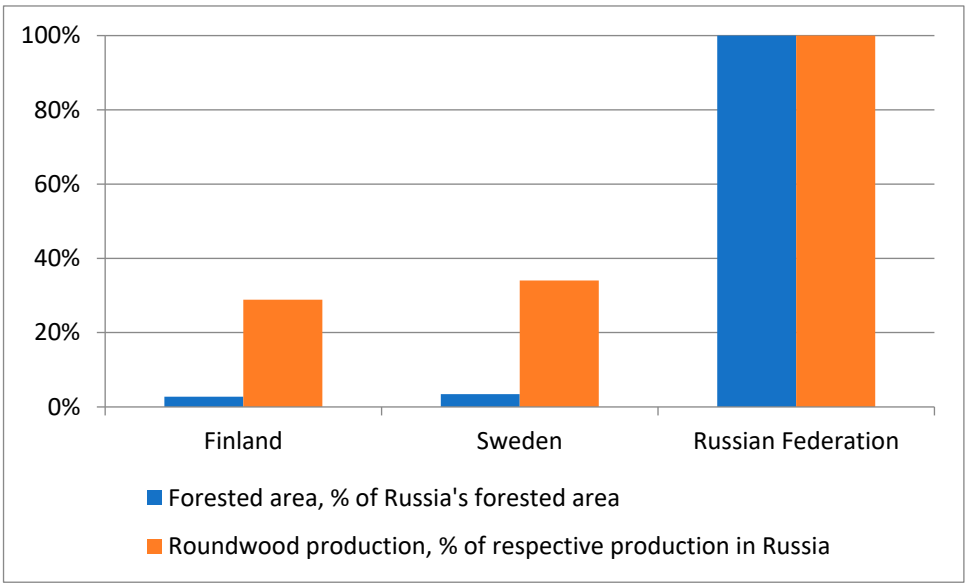

Figure 2. Forested area and roundwood production in Sweden and Finland as a percentage of respective values for Russia, which are taken for 100% (based on average values for 2016–2020). Source: FAOSTAT. https://www.fao.org/faostat/en/#data/GF, https://www.fao.org/faostat/en/#data/FO/ (accessed on 14 October 2022).

The conventional forestry system in Russia did not correspond to many of the economic, geographical and environmental realities of Russia even in the 20th century [7,16,20,27]. In Russia, the frontier of extensive forest management moved like a fire from the forests of temperate and southern taiga latitudes with high biological productivity in the old developed regions of European Russia (ER), to the north and northeast of ER, into the less biologically productive forests of the northern taiga. This process is driven by a so-called "annual allowable cut" (AAC) concept that does not have a real economic meaning. Presently, the method to calculate the AAC level in Russia is mainly designed to simplify the collection of fees from harvesting companies, is based on low-quality and/or obsolete forest inventory data and ignores the different economic accessibilities of forests in various parts of logging concessions. The use of this concept gradually led to a certain managerial paradox: a decrease in the share of coniferous species in forests along with a simultaneous focus on artificial regeneration and growing coniferous monocultures [27,33,34].

As a result, many logging companies face severe depletion of available forest resources despite formally harvesting at a much lower level than the AAC [8]. Scientific works demonstrate that the real allowable cut in a number of the most important forest industries regions does not exceed 35% of the officially operating one [35,36]. Environmental studies also demonstrate a decrease in the area and share of noble late successional hardwoods [37] and valuable Siberian pine (*Pínus sibírica*) and Korean pine (*Pinus koraiensis*) stands (these pines are keystone species with valuable timber and important sources of edible nuts for people and wildlife), as well as an increasing loss of intact primary forests [11,38].

4. Why Is the Intensive Forestry Management Model Good for Timber Industries, Biodiversity and Primary Forests in Russia When Compared with Nordic Countries?

The current criticism of the intensive forestry model is mainly arising from Swedish and Finnish researchers [39–41]. In fact, most of their concerns are not applicable to the Russian conditions and will likely not be applicable at least in the near and middle terms due to the very specific structure of forest management in Russia. In Scandinavia, 60–70 years following the introduction of the intensive forestry model, even-aged stands with primitive structure occupy more than 90% of all forest lands. At the same time, in Russia, forestry concessions for industrial harvesting make up only 19.2% of all forests (169.3 million hectares). And from this area, just a miserable 1.5 million hectares are fully

or partly managed according to the intensive forestry model. Another highly debated topic in Scandinavia is that intensive forestry there is associated with the high levels of the use of stumps and slash residues for biofuel production [42]. Currently, this is not a point of concern because the use of stumps and slash residues is not commercially attractive in Russia. Furthermore, poor domestic demand for pellets produced from low-quality timber is currently one of the main obstacles for the wider introduction of the intensive forestry model in the country.

5. Discussion

5.1. How to Promote the Introduction of the Intensive Forestry Management Model in Russia?

The further development of the Russian forestry sector, not taking into account geopolitical issues and related sanctions on the export of Russian timber products, to a significant extent depends on a steady wood supply. The current model of timber extraction in the country is quite archaic and bears serious risks to the future development of the forest industries. The current forest policy prioritizes timber production through the development of new forest areas over enhancing the forest productivity of already developed areas using silvicultural means. The policy undermines the conservation values of intact forest landscapes and sees them primarily as a source of timber.

The depletion of forest resources available for forest industries under the currently dominating extensive forest management model is unavoidable. The intensive forest management model is the only pragmatic alternative to it. This model includes tree planting on the most productive and accessible sites; mandatory subsequent tending of stands, including thinning operations; and a high proportion of sawlogs before final harvest. It is only a matter of time until a switch to the intensive forest management model will become the common trend, at least for logging concessions.

Therefore, the government should seriously change the current forest policies and management practices in Russia if it wants to ensure further sustainable development of the forest industries sector and to ensure the efficient protection of biodiversity and ecosystem functions in Russian forests. We suggest to significantly change the priorities and practices of forest management in Russia to realize the potential of forest adaptation to climate change and carbon sequestration.

It is necessary to abandon the financing of forestry as a "process" and move towards results-oriented, project-based approaches for forestry and forest fire fighting to cease being a "budget consumption tool". These approaches should differ for logging concessions and forests managed for other purposes, including climate regulation, environmental and biodiversity conservation and recreational and reserve functions.

The management objectives should be different for state-managed forests, logging concessions and concessions for recreational purposes. The management objectives for state-managed forests should be shifted towards management for environmental and climate purposes and include appropriate performance indicators. Thus, it is necessary to abandon regulatory incentives for regeneration with coniferous monocultures (including seedlings with a closed root system) in forests managed by the government. For state-managed forests, the restoration of the most environmentally and climatically valuable hardwood and mixed forests (with late successional broadleaf species as well as other keystone species like Korean and Siberian pines, oaks, etc.) should be one of the main goals.

The number of target species used for artificial regeneration should be generally increased. To ensure long-term resilience of stands (to pest outbreaks, forest fires, etc.) mixed stands should be preferred over monocultures. Such mixed multispecies stands should include both early (birch *Betula* spp. and aspen *Álnus incána*) and late (linden *Tília* spp. and oak *Quercus* spp.) broadleaf species.

The Concept of Intensive Use and Regeneration of Forests (IURF) was adopted by the Rosleskhoz in 2015 [26]. The concept aims to increase the productivity and economic returns from forests to concession holders. It has been preceded by more than 15 years of broad

and heated discussions and approbation in model forests and projects [26,43–45]. Unlike in the Nordic and the Baltic countries, the practical implementation of this direction in Russia (except for the development of forestry regulations) was carried out almost exclusively by the efforts of enthusiastic concession holders, of which many already had experience with the IURF in other countries (Ilim Group, Mondi Group, International Paper/Sylvamo Corporation, *IKEA*, Metsä Group, later Segezha Group). However, after 24 February 2022, the majority of international forestry companies made the decision to leave Russia. The forests in which the IURF system is used grew to 1–1.5 million hectares in five years. If the program aims to introduce the intensive system model for at least 50 million hectares of forest (about 30% of all forest logging concessions (https://rg.ru/2020/11/05/s-2021-goda-lesegais-pozvolit-otslezhivat-vsiu-cepochku-nachinaia-s-delianki.html (accessed on 1 December 2020)), then it would take another 160–240 years.

The historical, economical and resource aspects of the transition from extensive forestry to a modern resilient system of IURF have been repeatedly analyzed in the relevant scientific literature [3,7,46–48], especially in terms of comparing the development of modern forestry practices in the Nordic countries and in the northwest of ER ([2,6,28,29]; also see Table 2). Earlier similar approaches advocating the use of high-yield plantations within the zoning paradigm as a means for biodiversity conservation have been expressed for Canadian forestry [49]. The transition from an extensive to an intensive use and regeneration of forest (IURF) may be evaluated as a step toward resilient forestry [50].

Table 2. Silvicultural activities in Russia, Finland and Sweden.

Country	Share of Artificial Regeneration Area from the Clearcut Area, %	Share of Non-Commercial Thinning in Young Forests Area from the Artificial Regeneration Area, %	The Total Harvest Volume (m^3) per Hectare of Clearcut Area **
Russia (2021) ***	17%	108% *	184
Finland (average for 2016–2020)	72%	140%	455
Sweden (average 2016–2020)	77%	246%	313

* Non-commercial thinning was performed only in 54% of planted forests in Russia. ** The total harvest also includes harvesting during the selective felling. *** To calculate these values, the authors used the planned area of clearcuts for 2021 from the plan of the State Program of the Russian Federation Development of Forestry. Source: LUKE—Natural Resources Institute Finland, https://statdb.luke.fi/PXWeb/pxweb/en/LUKE/LUKE__04%20Metsa__02%20Rakenne%20ja%20tuotanto__12%20Metsanhoito-%20ja%20metsanparannustyot/06a_tyomaarat_1950.px/table/tableViewLayout2/; Swedish Forest Agency, https://www.skogsstyrelsen.se/en/statistics/subject-areas/silvicultural-activities/ (assessed on 14 November 2022); The state program of the Russian Federation "Development of forestry", approved by the Decree of the Government of the Russian Federation of 15 April 2014 No. 318 "On approval of the State Program of the Russian Federation Development of Forestry", volumes of forest regeneration and felling works carried out for maintaining planted forests in Russia—Environmental bulletins (electronic versions). Information on reforestation and afforestation for 2016–2021. Available online: https://rosstat.gov.ru/compendium/document/13295 (accessed on 20 September 2022).

Today, planted forests constitute only one-fifth of the total forest regeneration area in Russia. This means that most clearcut areas, even those lacking a sufficient potential for natural regeneration of commercially valuable tree species, are still left for natural regeneration. In many cases, restoration of coniferous forests takes more than a hundred of years and/or is featured by continuous domination of early successional broadleaved tree species, like birch and aspen. This means that it is necessary to radically revise the requirements for all types of felling, considering all increasing possibilities for the utilization of low-quality timber, including that resulting from thinning operations.

Formally, the area of artificial regeneration in Russia has grown in recent years (Figure 3). However, its quality suffers due to poor tending (both agrotechnical and silvicultural) in planted forests. Timely thinning in young stands is critical for the forma-

tion of productive coniferous stands. In reality, the total area of non-commercial thinning in young forests decreases and is now equal to the area of artificial regeneration. Moreover, according to the official statistics, only half of all planted forests are thinned. A comparison of the thinning and regeneration area in Russia and Belarus, which initially had a similar forest management system, shows that the ratio between the thinning and regeneration areas in Belarus is 3.9–5.4 times bigger than in Russia [27]. The experience of Sweden and Finland in forestry (Table 2) shows that the area of non-commercial thinning shall be 2–3 times greater than the area of planted forests and/or plantations, since thinning must be repeated several times in the same area to achieve a significant silvicultural effect. A serious problem is the quality of thinning in young forests. To reduce the cost of the forest management plan implementation, concession holders often prefer to perform thinning just along the rows of planted trees (so-called corridor thinning) rather than thinning throughout the whole stand. Corridor thinning mainly produces only an insignificant and very short-lived silvicultural effect because coniferous trees soon become outcompeted by fast-growing early successional broadleaf trees (mainly birch and aspen) growing along the corridor borders. In addition, coniferous trees in rows could be planted too close to each other.

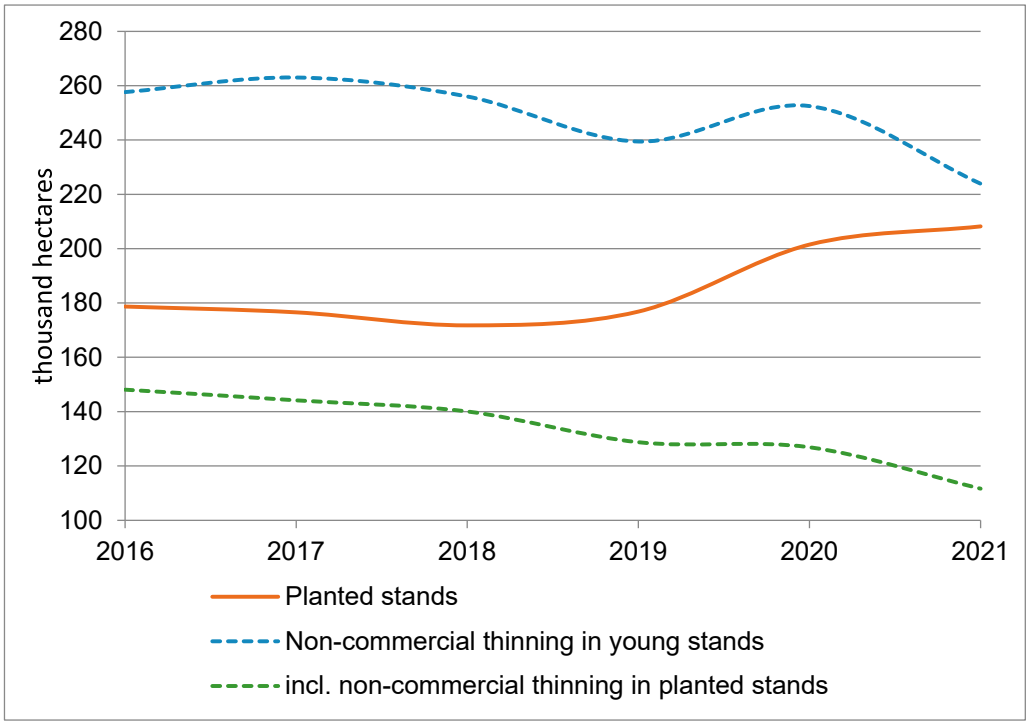

Figure 3. Dynamics of areas of artificial regeneration and thinned young forests. Source: Bulletins on Environmental Protection (Byulleteni ob okhrane okruzhayushchey sredy) (electronic versions). Information on Reforestation and Afforestation for 2016–2021 (Svedeniya o vosproizvodstve lesov i lesprazvedenii za 2016–2021) (Electronic resource), https://rosstat.gov.ru/compendium/document/13295 (accessed on 15 October 2022).

The potential area where the IURF model could be introduced in the coming years in Russia will still be several times less than the area under the conventional extensive forest management model. Therefore, regeneration of clearcuts will still predominantly occur through natural regeneration, in the absence of silvicultural activities. As a result, forest regeneration will be entirely driven by natural ecological succession patterns specific to habitat types. Therefore, the forest authorities (and responsible forest industries that plan to carry out forest management on forest concession areas not only in the next 5–10 years, but in the long term) shall be interested in the replacement of conventional clearcuts with retention forestry. For example, this may imply retention of forested patches or individual

trees when making large-sized clearcuts to provide habitat diversity and to protect scenic, conservation and other values, for at least one rotation [51]. The maintenance of the mosaic forest cover and preservation of viable coniferous undergrowth and seeding sources and ecologically valuables habitats (retention trees and patches [52]) are far better methods to provide better renewal conditions for coniferous species, although at the cost of reducing the total harvest on the plot by 5%–15%.

When assessing the quality of works on artificial regeneration, the focus should be shifted from the area of planted forests to the assessment of the result at a stage when young stands reach the pole-size, i.e., to assess the work on the actually obtained areas of economically valuable young forests.

The current volume of works on thinning of planted forests (and in areas with high natural regeneration) is absolutely insufficient. Non-commercial thinning treatments in young stands that did not pass the sapling stage (or precommercial thinning, as it is called in Finland and Sweden) are the key silvicultural operations to gaining a long-term silvicultural effect. In the future, their area shall be increased by several (4–6) times [27]. We think that to ensure a sustainable forest supply, the government should aim to manage at least 30–50 million hectares according to IURF by the years 2030. Therefore, it is better to concentrate available resources on the most promising areas of planted forests to deliver silvicultural measures in time and in full than to thinly distribute them throughout a larger area but without a sound silvicultural effect. Obviously, so called "corridor thinning" in young forests in most cases does not yield a significant silvicultural effect. It is still used, though, because it is much cheaper than perform thinning of the whole area, it does not require qualified personnel, and it permits the reporting of a greater area of performed works to the authorities in charge.

The authors think that both extensive and intensive management models could successfully coexist even within the same forest logging concession. Only 75.8% of the total area of forest concessions, that is, 25.4% of all forests of the Forest Land Category—Goslesfond forests [22] actually suit for forestry purposes. In addition, in the future, potential private forests on abandoned agricultural lands also could be used for forestry purposes. The remaining 74.6% of forest on Goslesfond lands can be still primarily used for other purposes than timber harvesting (environmental, climatic, recreational, conservation, etc.).

At the same time, it is necessary to introduce economic incentives for the intensive use and reproduction of forests (IURF), considering changes in the market demand:

Economic mechanisms should stimulate forest management in secondary and previously developed forests located in southern areas with better climatic conditions a higher road density, rather than to maintain an extensive forest management model aimed at the development of remote forests in areas that lack roads and are characterized by low natural productivity.

To move away from charging forest fees based on "allowable annual cut" (AAC) as a non-economically sound tool (set up by the Federal Forestry Agency) for a payment for a leased forest area (forest concession), which is controlled by federal executive authorities independent from the Federal Forestry Agency (like the Federal Agency for State Property Management—Rosimushchestvo—and the Federal Services for State Registration, Cadaster and Cartography—Roskadastr). It should encourage leaseholders to intensify afforestation, including thinning, a conscious choice of seedlings, seeds, etc. In this case, everything that has grown due to the leaseholders' investments will go to their profit and will not increase rent payments.

To switch to diameter-based felling instead of age-based felling. As a result, this will stimulate transition from "process"-based financing of forestry activities to achieving the planned results. One may expect that this would make it possible to decrease the minimum felling age of forest stands without compromising environmental damage.

According to the market demand, all types of forests in forest concessions require thinning operations, including deciduous forests dominated by early successional tree

species (for example, to increase the yield of plywood birch logs and to reduce a share of low-grade birch assortments and others).

Information on forest resources should be publicly available to attract investments and investors to the forestry sector of the economy. The information of the remote satellite monitoring system (ISDM-Rosleskhoz) from the very beginning is based on data from various satellite systems [53,54], and most of the information is based on data from foreign satellites. As a result, the basic information on the characteristics and stocks of wood in the forests of Russia has been known for a long time. Therefore, attempts to hide it by the forest management authorities only reflect their desire to avoid being controlled, both by the society and the government. Forest declarations (a document containing stand-level information on planned harvesting operations, including production volumes and maps that concession holders should annually submit to regional forest authorities) should also be posted on the Internet [30].

5.2. Challenge of "Spatial de-Marginalization" of the Russian Forestry Complex

It is obvious that a transition to the IURF model is more beneficial in the regions with a higher natural productivity of forests, a denser network of forest roads, and a developed wood-processing infrastructure. The task of the demarginalization of the Russian forest industries within the forested part of the country is quite an urgent task that includes a shift in main harvesting activities and respective processing infrastructure from low-productivity northern taiga forests of ER and from "greenfield" projects in wilderness forest areas currently lacking any kind of infrastructure in Central and Eastern Siberia to more productive secondary mixed and broadleaf forests (currently dominated by early successional broadleaf species) in southern areas with better climatic conditions with a relatively dense network of roads (6–7 km per 1000 ha and above). This statement is confirmed by the increasing foreign investments before 2022 in wood processing and production of wood-based panels, sheet materials, etc., by companies like Kronospan (processing facilities in the Republic of Bashkortostan, Moscow and Kaluga regions—a priority investment project in the field of forest development for 2016–2025 was registered in the latter), Egger (processing facilities in Smolensk and Ivanovo regions) and KASTAMONU (processing facility in Elabuga, Republic of Tatarstan) and by an increasing number of birch plywood producers (i.e., Nizhny Novgorod region), etc. These projects and facts seem to be more significant (see Table 1) than the "universal" disappointment with the lack of invested billions of dollars and Euros into the construction of new traditional pulp and paper mills, especially given the decline in demand on newsprint and graphic paper grades because of digitalization and growing demand mainly only for packaging materials and products. The regions mentioned above lost their large primary forests a long time ago. They do remain, however, in the specially protected natural areas of the federal level, some of which are even sparsely forested (the forest area of the Republic of Tatarstan occupies 17.5% of the region), but it is obviously compensated for by a significantly greater productivity of the southern belt forests than of the northern taiga [55,56].

At the same time, vertically integrated forest industry companies mainly think in terms of wood supply for already existing industries like sawmills, pulp and paper mills and of the remote and roadless "greenfields" development that requires much more investments than just in building a new pulp and paper mill itself (estimated at USD 2.2 billion). As a result, forestry businesses will sooner or later move to regions with more productive forests and more accessible logistics having a higher road density. In recent years, a strong steady growth in investments into the wood processing (for example, into the production of plywood and wooden housing construction) was observed in the middle and southern parts of ER forest belt, much south of the area dominated by large timber companies, which are usually integrated with the pulp and paper mill built in the Soviet period in Northwestern ER. Additionally, the profitability of investments into the old developed regions of ER should be potentially ensured by gains in logistics [4,5]. In many traditional forestry regions of Russia (Northwestern ER, Irkutsk region), the haulage distance to the

railway terminus is 200–300 km, and the secondary forests of the old-developed regions of ER and forests on agricultural lands are often located 10–90 km away from the mill.

The strategy of switching to forest concessions and private forests on agricultural lands seems to be more beneficial than the implementation of projects in the remote primary forests of Siberia and the Russian Far East. In the latter, infrastructure is poorly developed and there are high risks of environmental conflicts that could be critical for exporters. The socio-economic effects of intensive forestry on former agricultural lands also seem to be more significant, since every ruble invested into the road infrastructure of the region has cumulative effects on the development of agriculture and recreation and on improving the quality of life in the old developed regions of Russia.

The other side of the problem of abandoning the extensive forestry model and moving to the IURF model is the protection of private investments into the improvement of the forest fund and forest management infrastructure, as it ensures a simple and transparent forestry regulatory framework. The obvious solution to this problem is the emergence of private forests on agricultural lands. It does not require any revolutionary political and legal changes since agricultural lands can be privately owned under the current legislation and agricultural production and export are growing in Russia [57] (Figure 4). A significant part of these lands (12% of the country's agricultural lands) is already in the allocated and delimited property of physical persons (7%) and legal entities (5%), i.e., in real private ownership [58] 21% of agricultural land is in undivided shared properties, i.e., it is in a complicated and slow process of determining a private owner. In fact, to solve the problem of the lack of forest resources, it would be sufficient to ensure legalization and de-bureaucratization of forest management on agricultural lands, around 50–70 million ha of which are abandoned and are being overgrown by forests. From an economic, social, and environmental points of view, forests on agricultural lands should be used for any form of intensive forestry, including plantations and forests for climate regulation [59,60] in compliance with the requirements of fire and sanitary safety rules common to all land categories and requirements for timber trade. A certain exception is probably the management system in former rural forests, which can be equated to protection forests. The logging regime in these should correspond to the category of protection forests, included into the group of "forests that perform functions of protecting natural and other objects".

An attempt to solve this problem was the Government Decree No. 1509 of 21 September 2020 "On the Peculiarities of the Use, Protection and Reproduction of Forests Located on Agricultural Lands", which legalized private forestry on abandoned and overgrown agricultural lands (See the original text https://old-deples.government-nnov.ru/?id=236257 (accessed on 15 January 2023). According to the Ministry of Agriculture of the Russian Federation, by January 2022 the territorial authorities of the Rosselkhoznadzor (Federal Service for Veterinary and Phytosanitary Supervision) received 2487 notifications from the owners of land plots requesting permits to use agricultural lands for the purposes of forestry. This includes 10,116 land plots with a total area of 552.73 thousand hectares (the average size of the plot is about 55 hectares). However, the successful start of the implementation of this Government Decree was cancelled after the government adopted another Decree No. 1043 "On Amending Regulations on the Peculiarities of the Use, Protection, and Regeneration of Forests Located on Agricultural Lands" on 8 June 2022. This decree made it practically impossible to develop a cost-effective IURF on agricultural lands since it actually provides only one-time forest use with a subsequent reclamation and includes traditional agriculture. Probably, these changes were introduced because the Ministry of Agriculture of the Russian Federation and the Rosselkhoznadzor were afraid that due to the Resolution No. 1509, they would not receive 58.9 billion rubles of federal budget funds within the framework of Government Decree No. 731 of 14 May 2021 On the State Program for the Effective Involvement in the Turnover of Agricultural Lands. This money is aimed to return 13 million hectares of abandoned lands back for agricultural uses by the year 2032. Economically, it does not make sense because reclamation costs are too high. Furthermore,

many agricultural lands have been reclaimed formally and soon became abandoned, thus permitting trees to grow on them once again.

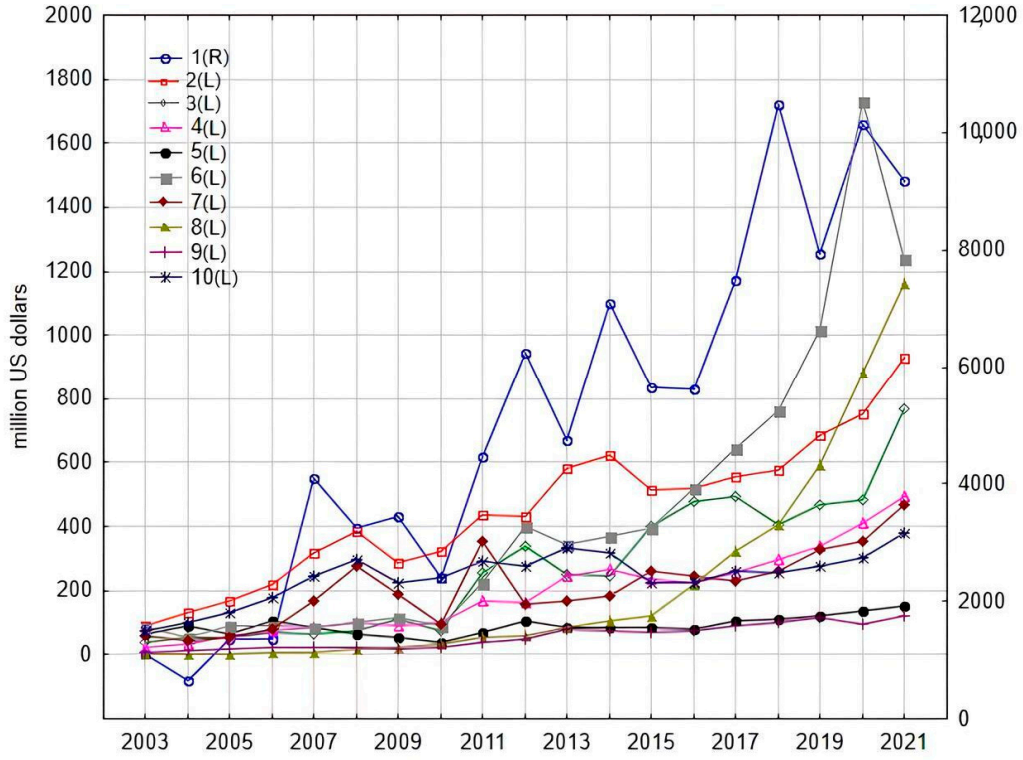

Figure 4. The years 2003 to 2021 according to the data of the Federal Customs Service (1 is cereals; 2 is prepared products from cereals, flour, starch or milk, and flour confectionery; 3 is vegetables and some edible root crops and tubers; 4 is processed vegetables, fruits, nuts or other parts of plants; 5 is edible fruits and nuts, peels of citrus fruits or melon peels; 6 is oilseeds and fruits; other seeds, fruits and grains; medicinal plants and plants for industrial purposes; and straw and fodder; 7 is products of the flour and cereals industry, malt, starches, inulin and wheat gluten; 8 is meat and edible meat offal; 9 is products of animal origin, not elsewhere specified or included; 10 is dairy products, eggs of birds, natural honey, edible products of animal origin not elsewhere specified or included in dairy products). R—right y-axis; L—left y-axis.

It seems that the Decree of the Government of the Russian Federation No. 1043, dated 8 June 2022, is only a temporary compromise solution that considers the interests of two departments, which can be changed or canceled if the current situation in forestry and agriculture develops further. It is important to understand that forest management and logging in the zone of mixed forests and especially taiga is a more profitable industry than agriculture. Thus, almost all economically accessible forests on the lands of the state forest fund in ER are leased. At the same time, forested agricultural lands are used illegally for forestry purposes.

Thanks to the smart decisions of the former vice-governor of the Vologda region V.V. Grachev (1949–2018), the symbiosis of agriculture and forestry on the old-developed periphery of the Non-Chernozem region in the Tarnogsky district of the Vologda region [61] shows that the consolidation of private agriculture and forestry does not destroy agricultural production, but preserves and maintains its economic sustainability. The regional specifics of forestry (collective farms' forests owned by agricultural enterprises were offered to them for 49-year concession on preferential terms, even before the adoption of the Forest Code in 2007) permitted agricultural enterprises to maintain logging and small woodworking, thus assisting to sustain agriculture [61]. Similar observations were made by the first author in August 2021 during a field survey of the Voskresensky and Semenovsky municipal districts of the Zavolzhye of the Nizhny Novgorod region, where a successful owner of the farm,

Seraya Loshad (Grey Horse) breeding plant, owns agricultural lands and has forest lands in concession, using funds from forest harvesting to protect pastures of the breeding stud farm from overgrowing with forests.

It is important to understand that the cost of returning forested agricultural lands, including uprooting, to agricultural use is extremely high. The value of forests in previously treeless areas is also likely to increase due to the emergence of a new market for forest carbon sequestration.

The detailed geospatial analysis of the dynamics of forest vegetation development on abandoned agricultural lands demonstrates the real scale of the issue [62,63]. It also shows the huge potential of a mutually beneficial coexistence of private agriculture and private forestry and the absence of real threats to food security in Russia [24,57,64]—Figures 4 and 5. In the case of the legalization of forestry on agricultural lands, it is potentially possible to expect a synergistic effect in the quality of forest management of state-owned forests on the legal forest lands (Goslesfond) due to the increased transparency and efficiency of forest regeneration and management and an increase in the environmental orientation of state forest management. The effectiveness of private forestry companies on agricultural lands will be probably countered only by relatively successful efforts in another area of state forest management, such as the regeneration of broadleaf forests in sparsely forested regions, etc.

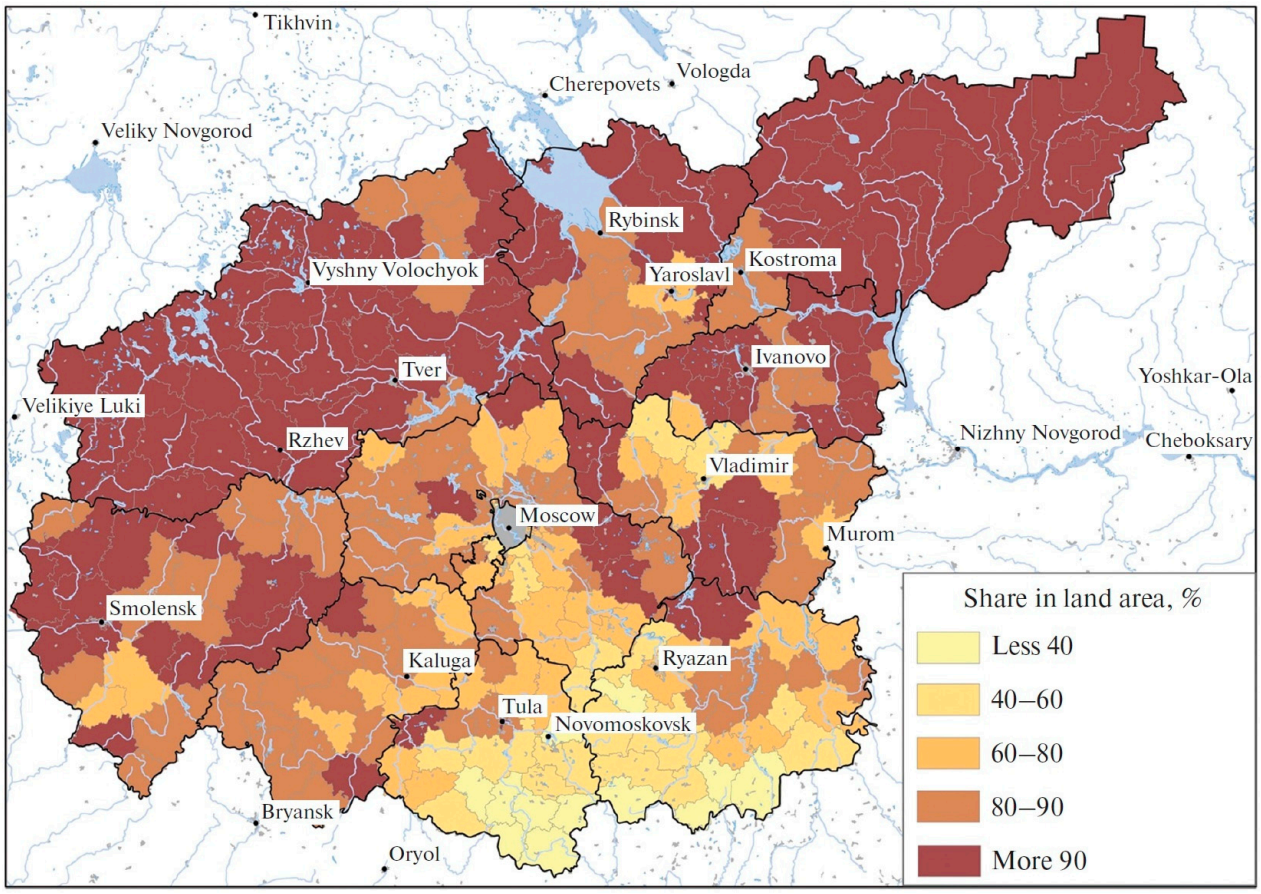

Figure 5. The share of unused land in the total area of agricultural land, in % [64]. Calculated based on thematic spatial data obtained from remote sensing analysis.

In this regard, it makes sense to conduct a more detailed analysis of the experience gained in the Nordic countries. In Finland and Sweden, the separation of regulatory, methodological and economic activities has been successfully carried out by creating forest state companies that operate in less economically attractive forests (mainly in the north of forest lands and non-forested lands of private companies and owners). In Finland,

35% of forests are concentrated in state ownership; in Sweden, it is 14% (respectively, the companies Metsähallitus Forestry Ltd. (Tikkurila, Finland, 4.8 million hectares without protected areas) and Sveaskog (Kalix, Sweden, 3 million hectares)). It is significantly less than 50% of the forests and thus allows Scandinavian state-owned companies to concentrate on the actual state functions, i.e., the management of protective forests, reserved forests and forests of protected areas, instead of competing with private timber companies in intensive forestry [27,65].

6. Conclusions

The Russian government should stimulate the introduction of the IURF now, not wait for the moment when the resource crisis becomes obvious. Some problems with the efficiency of IURF require just fine tuning, with most of the instruments currently being in the hands of the government. The problems are rooted in the legal barriers; in the wrong choice of forest management objectives and means for assessing their achievement by the government; and in the lack of incentives for silviculture, biodiversity conservation, etc. The normative framework and its implementation practices shall be modified to lower the risks of biodiversity loss and to strengthen long-term resilience of the stands.

The authors propose to replace process-based KPIs with result-based ones. The efficiency of silvicultural operations shall be assessed not by the areas where tending was made but by the area where acceptable silvicultural results were achieved. At the same time, it is necessary to remove regulatory and legal barriers that hamper the transition to IURF and its economic stimulation. To ensure a sustainable forest supply, the government shall aim to manage at least 30–50 million hectares according to IURF by the years 2030. Conditions should be improved for the use of low-quality timber derived from thinning.

A transition to an intensive forestry model does not mean that the extensive forest management model will completely disappear from Russian forests. A significant part of Russia's forests is quite suitable for the use of such a model. However, its implementation should be restricted to specific natural conditions. Its normative framework and implementation practices should also be modified to permit more effective natural regeneration and biodiversity conservation on clearcuts. This may include, but it not limited to, tree retention, the protection of valuable habitats, requirements for the configuration of clearcuts, including maintaining a mosaic structure, etc.

The government should also think strategically in terms of rational geographical aspects of the development of the forest-based industries and investments in forests and forest management. Forest-based industries should be located near productive commercial forests, in areas where it is possible to maintain a dense network of forest roads at acceptable cost. Forests on abandoned agricultural lands could become one of the key objects for the introduction of intensive forest management practices. To ensure a stable wood supply of the forest complex, to increase its economic efficiency, as well as its social and environmental significance, the "migration" of forest management to more productive secondary temperate and southern taiga forests should be systematically stimulated and supported.

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Abbreviations

AAC	Annual allowable cut set by the forest authorities
ER	European Russia
Goslesfond	Forests that grow on the legal forest land category
IURF	Concept of Intensive Use and Regeneration of Forests
KPI	Key performance indicators
Rosimushchestvo	Federal Agency for State Property Management
Roskadastr	Federal Service for State Registration, Cadaster and Cartography
Rosleskhos Federal	Forestry Agency under auspices of the Ministry of Natural Resources of the Russian Federation
Rosselkhoznadzor	Federal Service for Veterinary and Phytosanitary Supervision under auspices of the Ministry of Agriculture of the Russian Federation

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