

Impacts of the transformation of Russian economy after invasion to Ukraine on the carbon sequestration by national forests

Introduction

1. Sanctions and other disturbances in Russia after the full scale invasion in Ukraine

2. Socio-economic impacts

2.1. The near-term implications

2.2. The longer-term impacts

2.3. Future economic perspectives

3. Impacts on the forest sector and carbon sequestration capacity

3.1. Russian forest sector transformations

3.1. Trends and projections of carbon sinks in forests

3.3. Impacts on carbon sequestration by Russian forests

4. Conclusions

Literature, information and data sources

Introduction

The ongoing impacts of sanctions against Russia after the full scale invasion in Ukraine in 2022, coupled with the fundamental transformation of Russian economy, logistical challenges, sectoral changes, and price fluctuations, pose a considerable influence on the Russian forest sector, including forest management, production of wood-based products, domestic and export supplies of timber. These impacts have various short- and long-term consequences for the socio-economic situation, technological basis, demographic trends, quality of labor force, business practices and many others.

The Russian forests play an important role for the global environment and climatic system. Net carbon removals by Russian forests are about 500-700 MtCO₂ per year. These forests also are a long lasting storage of huge amounts of carbon in biomass and soils. They are an important element of the global biodiversity conservation system.

The anthropogenic and climate change impacts on Russian forests are and will further be exacerbated by the consequences of long-lasting sanctions and associated socio-economic turmoils in Russia. As a result, one could expect worsening of the situation with the state of forests and their capacity to sequester carbon dioxide from the atmosphere.

The objective of this study is to conduct an in-depth policy relevant analysis on how impacts of sanctions and dramatic changes of Russian economy, logistics, sectoral and price turbulences can affect the Russian forests, forest management practices, production and demand for timber and, through that, the carbon sequestration potential of forests.

This analysis brings substantial added value to the work already conducted on Russia through the NDC APSPECTS project. The project is funded by the European Union.

1. Sanctions and other disturbances in Russia after the full-scale invasion in Ukraine

Since Russia launched its full-scale invasion of Ukraine on February 24, 2022, the EU, USA, and other nations have imposed significant sanctions on Russia. These sanctions build upon the measures already enacted since 2014 following Russia's annexation of Crimea and its failure to implement the Minsk agreements.

The sanctions, especially economic ones, are designed to impose severe consequences on Russia for its actions and hinder its ability to sustain its aggression. As Russia's major trading partner, the EU has implemented economic sanctions and other restrictive measures that have had the most substantial impact on the Russian economy. Different packages of sanctions were adopted by the EU since April 2022, targeting various sectors, products, legal entities and personalities. In June 2024, the most recent 14th package was introduced, targeting high-value sectors such as finance and trade, further complicating attempts to bypass EU sanctions.

By mid-2024, the EU had imposed various import and export restrictions on Russia. The list of prohibited products is strategically designed to maximize the negative impact on the Russian economy while minimizing the effects on EU businesses and citizens. Exceptions to the restrictions include products primarily intended for consumption, as well as those related to health, pharmaceuticals, food, and agriculture, to avoid harming the Russian population.

According to the European Commission, since February 2022, the EU has banned over €48 billion worth of goods that would have been exported to Russia and €91.2 billion worth of goods that would have been imported from Russia. Compared to 2021 trade volumes, 54% of exports and 58% of imports are now embargoed.

Additionally, the EU, in cooperation with other like-minded partners, has reserved the right to stop treating Russia as a most-favored-nation within the World Trade Organization (WTO) framework. Rather than increasing import tariffs, the EU has opted to establish a set of restrictive measures that include bans on the import or export of certain goods.

The embargoed products for export from the EU to Russia include, among others, cutting-edge technologies, chemicals, IT equipment, and other goods that could enhance Russia's industrial capabilities. Prohibited imports from Russia to the EU include wood, paper, and other goods that contribute to the strengthening of Russia's capacities.

Furthermore, there is a ban on numerous services for Russian enterprises, including financial services, accounting, auditing, market research, technical assistance, software for industrial design and manufacturing, certain transportation services, and more.

The USA has also implemented a range of sanctions against Russia, focusing on the most impactful bans on the export of technologies and finance, imports of key product categories from Russia, and cooperation with Russian industrial companies and financial institutions. The economic sanctions in response to Russia's invasion of Ukraine are primarily implemented through two programs: the

Ukraine-/Russia-related Sanctions program and the Russian Harmful Foreign Activities Sanctions program.

Other countries, such as Australia, Canada, Japan, Norway, Switzerland, and the United Kingdom, have similarly imposed sanctions and boycotts on Russia. Over time, these countries have worked to enhance the effectiveness of their restrictive measures, including strengthening the regime of secondary sanctions in other jurisdictions.

Besides the governmental decisions, many companies in various sectors stopped working and pulled out from Russia. The most impactful draw backs related to the technological companies, providing modern equipment, services, IT, industrial design, logistics, financial services and others.

In addition to government sanctions, numerous companies across various sectors have ceased operations and withdrawn from Russia. The most significant impacts have been felt in the financial and technological sector, with companies providing modern equipment, services, IT, industrial design, logistics, services, other critical areas halting their activities.

The embargoes on technical equipment have forced Russian companies to rely on domestic and Chinese alternatives, which are generally less efficient and reliable than their Western counterparts. In some industries, particularly where Western equipment and software are already integrated, such as in the forestry, wood processing and pulp-and-paper industries, replacement is nearly impossible. This growing dependency on imported industrial equipment, transportation means, and technologies from China introduces significant risks and increased costs for Russian businesses.

The tightening of sanctions and the enforcement of "secondary sanctions" in other countries have compelled Russian businesses to shift from traditional Western export markets to Eastern countries like China, India, and Turkey. However, the eastward transportation infrastructure, including the Baikal-Amur Railway (BAM), the Trans-Siberian Railway (Transsib), and the marine ports in the Russian Far East (Eastern polygon), is severely limited. Various companies and sectors are now competing for these constrained railway capacities, necessitating government regulation and control. The rising transportation costs are particularly challenging for forestry companies in Northwestern Russia, as the railway delivery of timber, paper, wood, and other products to Asian markets has become increasingly expensive.

2. Socio-economic impacts

Since February 2022, the Russian economy has faced significant challenges due to a confluence of factors. These include unprecedented sanctions imposed by the EU and other countries, the loss of traditional (primarily European) markets, the exodus of foreign companies and investors, and the depletion of financial reserves. These pressures have triggered tectonic transformations within Russia's economy and society, resulting in both short-term consequences, such as financial losses, disturbances in transportation systems, and labor force deficits, and long-term implications that will shape socio-economic development in the coming decades.

Meanwhile, the Russian economy has already begun to shift. Military expenditures have surged, now accounting for up to 40 percent of the state budget. The prioritization of weaponry, military machinery, and equipment production has led to a restructuring of the economy in favor of non-civilian sectors. Additionally, the vital nature-exploiting industries have suffered significant setbacks due to the loss of traditional European markets. This has forced a pivot towards Eastern markets, which presents a host of logistical, financial, and operational challenges. The exit of major global energy companies has further compounded these issues, leading to a shortage of modern technologies and services, which affects current production and future prospects, particularly in difficult environments like Siberia and the Russian Far East, and areas with difficult logistics and transportation problems.

Understanding these ongoing and future transformative changes in Russia's socio-economic landscape is essential for evaluating the effectiveness of policies and measures aimed at resolving the conflict in Ukraine and envisioning a post-war future for Russia based on peace, international collaboration, and sustainability. This study explores the key factors, trends, and future outlook for Russia's socio-economic development in the context of the Ukraine conflict, with a focus on analyzing the repercussions of sanctions and other external influences on the Russian economy, society, and policymaking.

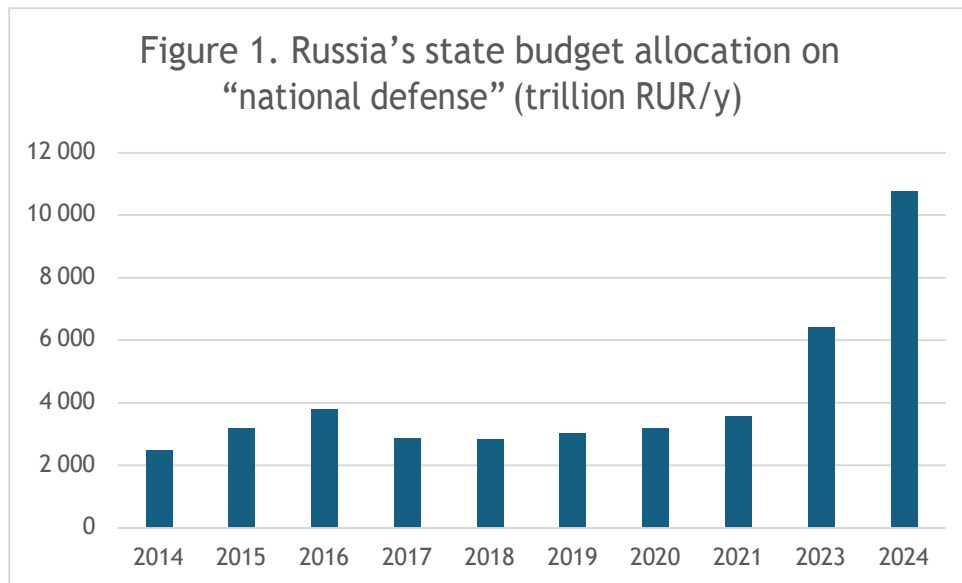
2.1. The near-term implications

The war in Ukraine has triggered a series of socio-economic transformations in Russia. The immediate effects include a redistribution of assets of former foreign companies as well as unfavored Russian owners to the clans close to Putin's regime. This process has been accompanied by the persistence of traditional corruption practices, among other factors. However, certain transformations have more profound and far-reaching implications, even in the short term, significantly altering the overall socio-economic landscape.

Increased military expenditures and militarization of the economy

One of the most striking changes has been the substantial increase in military spending. The consolidated state budget's defense and military-related expenditures have risen sharply, from approximately \$69.3 billion in 2014 to around \$84 billion in 2023. When expressed in nominal Rubles, this represents nearly a threefold increase. The upward trend is expected to continue, with projections indicating that military spending will reach approximately \$100 billion in 2024 (as illustrated in Figure

1). Notably, more than 80% of these military expenditures are classified as confidential, underscoring the opacity of Russia's defense spending. It's important to highlight that in 2021, the projected defense budget for 2024 was only half of what is currently allocated.



Sources: Ministry of Finance of Russia (2023, 2024).

Cash injection in the economy

The Russian government has adopted aggressive policies to inject liquidity into the economy. These measures carry significant risks and long-term consequences. One of the key strategies has been the controlled devaluation of the Russian Ruble (RUR). From January 2022 to August 2024, the exchange rate of the Ruble against the US dollar increased by about 20%. This leads to higher inflation, as imported goods become more costly, eroding the purchasing power of the average Russian consumers.

The Russian Ministry of Finance has turned to the bond market as a major source of funding, issuing record-high amounts of federal bonds. By mid-2024, the total value of these bonds had exceeded 20 trillion RUR (approx. \$220 billion)¹. The bonds offer rather high returns of over 8% per annum, which raises concerns about the long-term sustainability of the state budget. The cost of servicing these bonds is becoming increasingly burdensome, with some projections suggesting that interest payments could rise to as much as 20% of Russia's GDP. This scenario could severely limit the government's fiscal flexibility in the future and might necessitate further borrowing, creating a cycle of debt that is difficult to escape. Moreover, the government's borrowing activities are crowding out private sector financing by absorbing available financial resources. This makes it more difficult and expensive for businesses to access credit, potentially stifling investment and economic growth in the private sector.

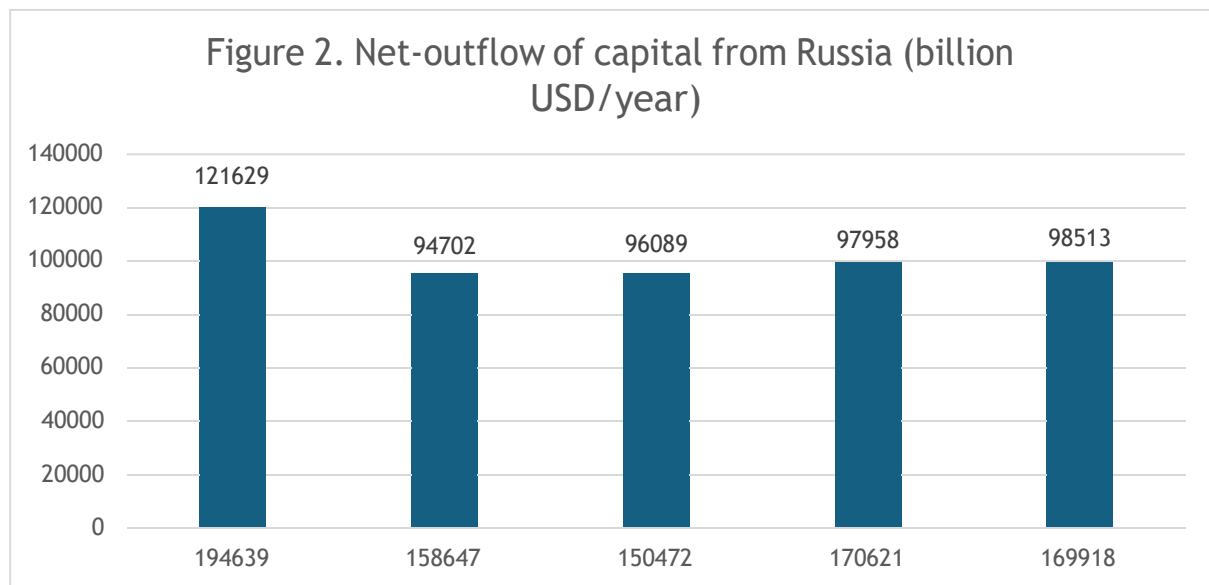
A significant portion of the state's financial resources is being funneled into military expenditures. These payments are a form of direct cash injection into the economy, which, while providing short-term support, contributes to the overall growth of the money supply. The monetary aggregate M2, which includes cash and money held in bank accounts, grew by 61% from February 2022 through

¹ Ministry of Finance of Russia, Volumes of the state bonds by 21.3.2024.

August 2024². This rapid expansion of the money supply is a major driver of inflation, as more money chases the same amount of goods and services, leading to price increases. The continued expansion of the money supply, if not carefully managed, could lead to hyperinflation, further exacerbating the economic challenges facing Russia.

Capital outflow

After February 2022, over 1000 foreign companies shuttered their operations and withdrew from Russia. Many of them curtailed activities within the country that resulted in total losses of foreign companies estimated at \$200-240 billion³. The net outflow of capital from Russia surged by 3.4 times in 2022 compared to 2021, reaching \$251 billion (Figure 2). Such significant “running out” of capital underscores a profound lack of trust among both foreign and domestic investors.



Source: Mid-term forecasts of the Bank of Russia: in 2022 https://www.cbr.ru/collection/collection/file/43430/forecast_221028.pdf; in 2023 https://www.cbr.ru/collection/collection/file/46535/forecast_231027.pdf; and in 2024 https://www.cbr.ru/Content/Document/File/160781/forecast_240426.pdf

Savings to spend

The Russian government views the population's savings, estimated at over 40 trillion RUR (nearly \$440 billion), as a valuable source for financing state budget expenditures. Finance Ministry suggested that these savings could serve as a significant financial resource for the state. Some financial schemes may allow to transfer of money from people's bank accounts into individual pension accounts, which would then be used to purchase government bonds and provide more funds for the war. The government is also interested in corporate sector profits and savings. In 2023, a new windfall tax was introduced to collect at least \$3.6 billion from exporters that benefited from the higher prices in foreign markets in 2022-2023. It also introduced a Ruble devaluation tax in 2023, which will impact about one-third of Russian exports.

² Central Bank of Russia, Monetary aggregates – estimates.

³ Center for Strategic Studies, Picture of foreign businesses, report, 2022.

No new capital investments

Amid uncertainties and high costs of capital, many companies are opting to reduce expenses on the strategic development goals and employ cost-effective measures to sustain current production. They prefer to reap the benefits without engaging in capital-intensive project activities. Russian businesses are encountering significant challenges in executing complex operations due to the withdrawal of foreign technological partners as the existing capacities of domestic often do not allow to carry out high-tech intensive operations.

Worsening access to finance

Significant financial shifts have also occurred in Russia in 2022-2024. Increased state budget expenditures provided substantial financial resources to state-controlled and military-related companies, which operate under highly favorable conditions, as their funding is guaranteed by government. The commercial sector companies, contrary, are facing challenges. The Central Bank raised the key rate to 18% per year in early 2023. As a result, interest rates in commercial banks became very high so that the required rate of return on investments is unfeasible for many enterprises. Simultaneously, these businesses are experiencing rising labor costs and other expenses.

2.2. The longer-term impacts

General impacts on the economy and finance

The ongoing socio-economic transformations in Russia are expected to lead to predominantly negative long-term consequences. The loss of the European market for Russia's energy and other exports is a major blow, as this market was historically crucial for cooperation and trade for centuries. The absence of this market might persist for decades, possibly becoming a permanent loss (as in case of the pipeline gas supplies).

The ban on technological cooperation between Russia and the West is likely to have lasting repercussions. This includes the deterioration of Russia's technological infrastructure and a diminished capacity for innovation, modernization, and research and development.

The financial outlook is particularly concerning. With state reserves frozen in Western banks⁴ and rising state budget expenditures⁵, there's a significant risk of depleting Russia's accumulated financial resources. The substantial government borrowing will likely result in high repayment costs for state bonds over the next several decades. Additionally, the rapid depletion of resources from the National Wealth Fund, which was initially intended to support the pension system, could lead to financial instability in the mid-term future, posing significant risks to the financing of pensions.

The high rate of inflation⁶, the devaluation of national currency, and increasing risks of stagflation are expected to have enduring effects on the socio-economic situation in the country. Despite government

⁴ According to the Global Sanctions Dashboard, Western allies have blocked \$58 billion worth of sanctioned Russian oligarch assets and \$300 billion of sovereign assets. Source: Donovan K., Nikoladze M. (2023)

⁵ In national currency, the state budget expenditures increased by 67% from 21 trillion RUR in 2021 to (forecasted) 35 trillion RUR in 2024. Source: Ministry of Finance of Russia, Federal budget, 2024.

⁶ The official annual inflation rate was 7.5% in 2023 (Rosstat data), but the inflation of consumer goods for population reached 23% in 2023 (as of the independent research center Romir).

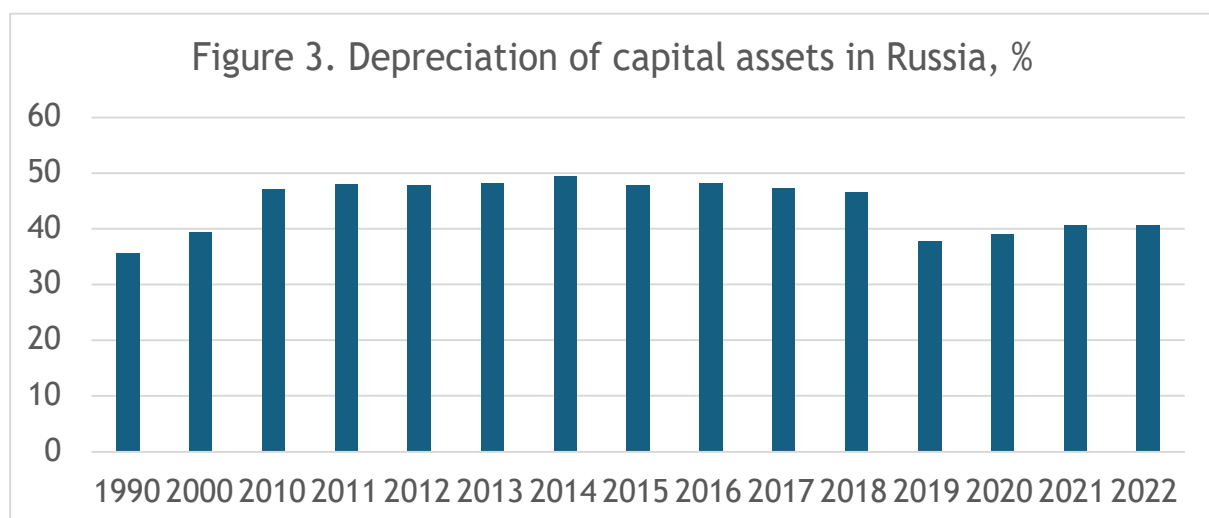
claims of poverty reduction, the reality is that the number of people living below the standard of living is increasing.

The technology-import sanctions also delay the planned technological developments aimed at improving labour productivity, and thus reducing the labour force in the economy. One of the strategic economic policy target of Russian government to reach 5% labor productivity growth per year by 2024⁷ and maintain it further on is unfeasible in the current context.

Depreciation of capital assets and technological dependency

The capital assets in Russia are significantly depreciated, with much of the infrastructure ranging from 40 to 70 and more years old. Nationwide, the average amortization of capital assets reached 41% in 2022, indicating that over 40% of these assets are outdated and no longer perform efficiently (Figure 3).

The situation in several sectors is even more alarming: in 2022⁸, transportation infrastructure had a depreciation rate of 57%, health systems at 54%, processing industries at 54%, and the power, heat, and gas supply sectors at 51%. The depreciation of machines and equipment is particularly concerning, ranging from 58% to 71%. Buildings showed depreciation rates between 50% and 61%, and vehicles between 44% and 59%.



Source: Rosstat, 2024.

Russia's economy is heavily reliant on imports for technologies, semi-finished products, and materials, with around half of all imports, representing roughly 10% of GDP, linked to technologies. Key sectors dependent on Western imports include machinery and equipment (40%), medicine (35%), and automobiles (28%). Replacing these imports is extremely challenging.

⁷ The national project "Labor productivity" of the Russian government.

⁸ Source: Rosstat. <https://rosstat.gov.ru/folder/14304#> [last accessed 29.08.2024].

A recent study highlights that the average share of imports from the countries imposing sanctions on Russia stands at 60%⁹. The finance sector shows a dependency rate of 76%, pharmaceuticals 72%, and the automobile and transport sector around 70%.

Inefficient management and maintenance of capital assets on the local level led to a surge in infrastructure disruptions and accidents. The situation is expected to worsen as the permafrost, covering two-thirds of Russia's territory, continues to thaw, which threatens to destroy critical infrastructure, including roads, pipelines, electricity grids, heat networks, and fuel storage facilities.

Corporate management revisions

In recent years, the bulk of capital investments in commercial sectors in Russia has come from corporate profits, with a mere 20% sourced from loans. However, the sustainability of these profits is increasingly jeopardized by the government's escalating trend of takeovers. As a result, businesses are leaning toward short-term decisions rather than making strategic, long-term investments.

The introduction of "regulatory innovations" by the government poses significant risks to companies. One such measure involves the appointment of "currency exchange supervisors" in key industries, who are responsible for monitoring and reporting on foreign currency transactions. Corporate management must now obtain the approval of these supervisors for their foreign trade activities. Additionally, the rules for converting export revenues into hard currencies have been changing: from 40-80% to 100% exchange of US dollar and euro export revenues into Rubles. The new currency control rules, effective from January 1, 2024, grant the Central Bank authority to restrict the operations of selected traders in buying and selling hard currency. This implies that the Ruble's exchange rate will no longer be market-determined but rather assigned by Russian authorities.

The willingness of Russian businesses to transition towards "green" business models is uncertain due to several factors. The absence of international ranking agencies and foreign partners with global corporate reporting and policies makes it difficult for businesses to align with ESG (Environmental, Social, and Governance) standards, which are increasingly important to sustainability-focused investors and stakeholders, primarily the foreign ones. Without external pressure or incentives, such as ESG rankings, FSC and MSC certification, eco-labelling requirements, Russian businesses lack motivation to prioritize sustainability initiatives.

Furthermore, domestic financial and customer loyalty schemes do not currently mandate adherence to ESG standards or reductions in corporate carbon and ecological footprints. Without regulatory requirements or market incentives for green practices, most businesses perceive the costs of adopting sustainable practices without recognizing the potential financial benefits or competitive advantages. Additionally, the lack of feasible opportunities for green finance and investments in Russia further discourages businesses from pursuing environmentally friendly initiatives. Without access to green capital or financial instruments specifically designed for sustainable projects, businesses tend to prioritize short-term profitability over long-term sustainability.

⁹ Karpov A. Assessment of dependency of Russia from import of intermediate products, Bank of Russia, Series of reports on economic studies, #106, December 2022.

The implementation of carbon pricing, which could incentivize businesses to reduce greenhouse gas (GHG) emissions, seems unlikely in Russia in the near or long term. Public debates and expert discussions on this issue have diminished since 2022. The absence of strong domestic regulations on pollution and the lack of plans to strengthen environmental regulations in the coming decades reduce the incentives for businesses to invest in pollution reduction efforts and other green initiatives. Overall, the current business environment in Russia is not conducive to fostering widespread adoption of green business models.

Depopulation and labor shortages in Russia

Russia is experiencing significant depopulation trends, as projected by various scenarios in the UN World Population Prospects (2022). Figure 4 illustrates a general decline in population size across most scenarios. According to Rosstat, Russia's population is expected to decrease from 146 million in 2023 to 139 million by 2046¹⁰, but there are more pessimistic forecasts.

This demographic decline is exacerbated by the rapid loss of qualified specialists due to several factors. These include casualties in the Ukraine conflict, which have exceeded 400,000 people, and significant emigration, with over 700,000 people leaving the country. Among those emigrating are entrepreneurs, scientists, journalists, and other professionals, further diminishing the pool of skilled labor. As a result, the middle class is increasingly shifting towards lower income brackets, leading to a rise in poverty levels, despite official reports of reduced poverty.

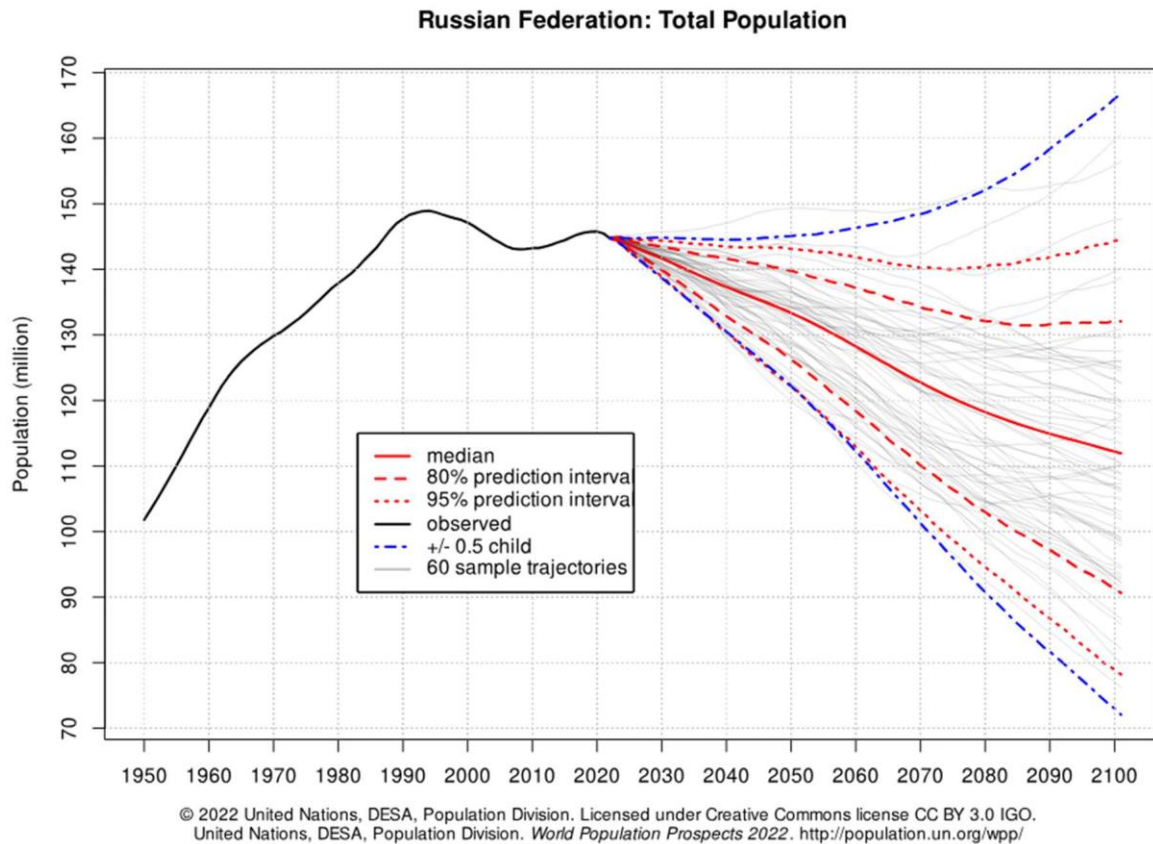
The aging population adds another layer of complexity to the issue. The post-WWII generation is now entering retirement age, while the younger generation born during the crisis years of the 1990s is relatively small and declining due to the war. This demographic shift contributes to the overall decline in the working-age population.

A severe labor force shortage has emerged as a critical challenge across multiple sectors. Estimates from the Russian Academy of Sciences suggest a labor deficit of approximately 5 million people in 2023. This shortage has become a major barrier to business expansion and growth, impacting various industries and hindering their operations. The combined effects of depopulation, emigration, and an aging population are creating significant socio-economic challenges for Russia, threatening its long-term economic development.¹¹

¹⁰ Rosstat, Demographic forecast by 2046, 2023.

¹¹ Akhupkin N.YU. Russian economy under sanctions: dynamics and structural changes. Vestnik Instituta ekonomiki RAN, Issue 6, 2023, pp. 7-25.

Figure 4. Scenarios of dynamics of total population dynamics in Russia.



Source: the UN DESA population division, 2022.

Degradation of social capital

The country is experiencing significant deterioration in its social capital. A notable shift towards a less favorable educational environment has occurred, driven by the severance of collaborations with the world leading universities. International scientific research projects have largely ceased, and there has been a substantial exodus of highly qualified professors, researchers, mentors, and teachers from the country. This brain drain is further exacerbated by the growing trend of talented youth opting to study and pursue careers abroad, draining Russia of its future intellectual capital.

The rise of active military propaganda has also contributed to the erosion of social cohesion within Russian society. This propaganda has polarized the population, leading to divisions among families, friends, and colleagues based on their views about the war in Ukraine. These societal rifts have strained relationships and deepened the fractures within the community.

Moreover, Russia is facing a concerning trend towards increased criminalization and a weakening adherence to the rule of law, leading to a more unsafe societal environment. Instances of criminal behavior are becoming more common, fostering a sense of insecurity among the populace. This is coupled with a growing lack of trust among individuals, which has led to social distancing and further deepened societal divisions.

The pervasive sense of uncertainty and pessimism about the future has also contributed to a widespread lack of confidence among individuals. This has impacted personal and professional decisions, with many people hesitating to start or sustain businesses and showing reluctance to invest in domestic projects. The dominant negative outlook and the atmosphere of uncertainty are significant barriers to economic growth and development in Russia.

2.3. Future economic perspectives

The expected socio-economic changes in Russia, given the current trajectory, are likely to have profound effects on the country's economic performance in both the short and long term, such as the following:

Physical Capital

- **Short-Term:** The impact of changes in physical capital is expected to be relatively minor in the immediate future. However, the ongoing depreciation of man-made assets, combined with insufficient investment in infrastructure renewal, will gradually erode the country's physical capital.
- **Long-Term:** Over time, this deterioration will likely become more significant, leading to infrastructure that is less efficient and more prone to failure. The depletion of natural resources, particularly those that are economically viable to extract, could exacerbate this issue. The poor environmental quality in industrial areas, combined with a lack of investment in environmental management, will further hinder the long-term sustainability of physical capital.

Impact on Economy

A declining physical capital base will reduce the productivity of the economy, increase maintenance costs, and ultimately lower economic growth. Poor infrastructure and environmental degradation may also deter investments, further straining economic performance.

Human Capital

- **Short-Term:** The deterioration of human capital is already underway, with an aging population, emigration of skilled workers, and casualties in military operations. The degradation of the education system, due to the loss of highly qualified professors and the breakdown of international cooperation, will contribute to a shrinking and less skilled workforce.
- **Long-Term:** If these trends continue, Russia's human capital will decline further, leading to a severe shortage of skilled professionals and workers. This will undermine innovation, productivity, and the overall quality of the labor force.

Impact on Economy

The diminishing pool of human capital will limit the country's ability to innovate and compete globally. A less educated and less skilled workforce will lead to lower productivity, stifling economic growth and reducing the potential for future development.

Social Capital

- **Short-Term:** Social capital in Russia is eroding rapidly, exacerbated by the war in Ukraine and the state's propaganda efforts. Trust in government institutions and among individuals is declining, leading to increased social fragmentation and polarization.
- **Long-Term:** The continued erosion of social capital could lead to further social instability and unrest, as divisions within society deepen. The lack of social cohesion will make it difficult for the country to mobilize collective efforts toward economic recovery and growth.

Impact on Economy

A fractured society with low trust levels will struggle to support a stable and thriving economy. Social unrest and polarization could lead to increased crime, lower consumer confidence, and a more volatile business environment, all of which are detrimental to economic performance.

Governance

- **Short-Term:** Governance in Russia is moving towards increased authoritarianism, with diminished rule of law and growing corruption. The centralization of power and control over institutions by the state and security services will likely stifle business innovation and reduce economic efficiency.
- **Long-Term:** Over time, the erosion of governance structures could lead to a more corrupt and less accountable system, further weakening the country's economic foundations. The extension of Putin's presidency suggests that these trends will continue, potentially leading to greater repression and instability.

Impact on Economy

Weak governance and corruption will deter investment, both domestic and foreign, reduce economic efficiency, and stifle entrepreneurship. Over time, this will lead to slower economic growth and a less dynamic economy.

Financial Situation

- **Short-Term:** The financial situation in Russia is challenging, with high inflation, shrinking reserves, and limited access to capital. Rising interest rates are making borrowing unaffordable for many businesses, adding to the financial strain.
- **Long-Term:** These financial difficulties are likely to persist, with long-lasting negative effects on the economy. The lack of access to capital will hinder business expansion and innovation, while high inflation will erode consumer purchasing power.

Impact on Economy: Persistent financial strain will limit economic growth and increase the risk of financial crises. High borrowing costs and limited access to capital will stifle business investment, leading to slower economic development.

Innovation and Modernization

- **Short-Term:** The ecosystem for innovation and modernization in Russia has largely failed, with little enthusiasm for new business models or technological advancements.
- **Long-Term:** The lack of innovation and modernization will likely continue, further hindering economic growth. As other countries advance, Russia risks falling further behind, both technologically and economically.

Impact on Economy

Without innovation, the economy will struggle to grow and compete globally. The absence of technological advancements will limit productivity gains and reduce the potential for economic diversification.

International Relationships

- **Short-Term:** Russia's international relationships have been severely strained, particularly with the West, due to the ongoing conflict in Ukraine and the resulting sanctions.
- **Long-Term:** The deterioration of international relations is expected to persist, limiting Russia's access to global markets, technology, and investment. This isolation will likely hinder economic growth and exacerbate the challenges facing the Russian economy.

Impact on Economy

The prolonged strain in international relationships will limit trade, reduce foreign investment, and isolate Russia from global technological advancements. This will further weaken the economy and reduce growth prospects.

Overall Economic Performance

- The combined impact of these socio-economic changes suggests a trajectory of continued economic decline for Russia. The deterioration of physical, human, and social capital, coupled with weak governance, financial instability, and poor international relations, will likely result in slower economic growth, reduced productivity, and increased risk of social unrest.
- In the longer term, these challenges may lead to a stagnating or even contracting economy, with worsening living standards for the population and limited prospects for recovery.

The outlook for Russia's economy, based on the current trends, is therefore quite bleak, with significant risks of further deterioration in the years to come.

3. Impacts on the forest sector and carbon sequestration capacity

Since Russia boasts the largest forested area in the world, encompassing 795 million hectares, with 539 million hectares consisting of valuable coniferous species. Protected natural areas account for 18 million hectares of these forest lands. Broadly speaking, forest resources include not only the forested areas themselves but also all biotic components—plants, animals, fungi, and microorganisms—along with their associated features that contribute to forest environments and a wide range of products and services.

Although the forest sector contributes approximately 0.7% to Russia's GDP, it holds significant importance in the country's climate and environmental policies at local, national, and global levels. It also play an important social and economic role, especially for the local communities and, in some regions, is the key sector of economic activities for the population.

Globally, the key players in the forest industry nowadays are the USA, China, Canada, Germany, and Finland. Russia's share in total round timber production stands at 5%, in sawn timber at 5%, in sheet wood materials at 3%, and in paper and cardboard at 2%. In terms of global exports, Russia accounts for 18% of round timber, 12% of sawn timber, 3% of sheet wood materials, and 3% of paper and cardboard exports.¹² The strong dependency on the round wood production and export is worrisome for the government, and several policy decisions had been adopted aiming to diversify national forest economy and enhance deep processing of wood, production and export of more advanced wood-based products.

The sanctions and other impacts related to the invasion in Ukraine have clearly led to significant changes for the Russian exports of wood products. For instance, in 2021, Russia's wood product exports were distributed among several leading countries, with China accounting for 30%, Finland 5.4%, Japan 4.9%, Uzbekistan 4.8%, the USA 4.6%, and Germany 4.5%. However, by the end of 2023, 98% of Russia's wood product exports were directed to Asia, compared to 87% in 2022 and 76% in 2021.¹³ According to Roslesinforg, China remains Russia's primary partner, importing around 13 million cubic meters of lumber from Russia in 2023, a volume consistent with 2022 levels. Uzbekistan ranks second, with over 2 million cubic meters exported, an 8% increase from 2022. Kazakhstan follows in third place, with 926,000 cubic meters, marking a 17% increase over the 2022 figures. The top ten importers also include Azerbaijan, Tajikistan, Kyrgyzstan, Iran, South Korea, and Hong Kong.

3.1. Russian forest sector transformations

In mid-2022, as part of the sanctions package, Russian timber exporters were cut off from European markets. All major product groups fell under the embargo: timber and products made from it, including

¹² Ministry of Economic Development of Russia (2021) The forecast of longterm socio-economic development of Russian Federation until 2030. Adopted by the government of Russia on 06.10.2021 #2816-r.

¹³ Roslesinforg portal <https://roslesinforg.ru/>

plywood, boards, and pellets, as well as pulp and certain types of paper and cardboard. Simultaneously, a Russian law banning the export of raw and semi-processed timber came into effect. Both of these factors hit the timber industry hard, regardless of the scale of production or ownership structure.

The loss of traditional export markets (in the EU and North America) could have been offset either by increasing supply to the domestic market or by reorienting exports. However, the mass shift of producers to the domestic market led to market oversaturation, reduced demand, and a price collapse by the end of 2022. For example, the price of plywood for the domestic market decreased by 31%. The key challenges faced by timber industry enterprises included the loss of traditional markets due to sanctions, difficulties in purchasing production equipment, and rising transportation costs.

The Forest Stewardship Council (FSC) International Board decided that certification in Russia is no longer possible. As a result, all Russian FSC certificates were annulled at the end of April 2023, and the territory of Russia was excluded from the accreditation scope of certification bodies. This will have longer-term implications for the demand and prices of Russian wood products exported to the world market.

After the shock in 2022, most timber industry companies were able to reorient their sales to new markets (in Asia and the Middle East) and overcome logistical challenges in 2023. The recovery of exports was facilitated by an increase in transportation subsidies from the government, as well as the weakening of the national currency.

According to “The Forestry Development Program until 2030” adopted by the Russian government in 2021, timber harvesting was expected to increase by 30% by 2030 (compared to 2020 levels), reaching 286 million cubic meters. This target will require a change in strategic planning in the industry: the previous export-oriented development model is assumed to be revised in favour of the mostly domestic supply model. The key factors for such shift could be the development of wooden housing construction and the construction and modernization of pulp and paper mills. An increase in production is projected for five types of products: cardboard, household and wrapping paper, pulp, and charcoal. Among the factors restraining development are difficulties in acquiring modern high-tech production equipment, insufficient protectionist measures, and the need for constant adaptation to external sanctions, as well as the tightening of Russian legislation concerning relations with “unfriendly” countries.

Several policy decisions were adopted by the Russian government to support forestry sector, which should have both short- and long-term impacts, including as follows:

- In 2023, the Federal State Forest Information System was launched—a key digital platform that integrates dozens of government services, forest registry data, and up-to-date information on forest use, protection, preservation, regeneration, afforestation, wood accounting, traceability, and transaction details.
- Also in 2023, a public forest map was introduced, allowing access to all current data about forests, including the boundaries of forestry districts, forest plots, logging areas, information on forest roads, wood storage locations, and more.

- In February 2023, the Russian Government decided to increase the maximum amount of subsidies for exporting products from 300 million to 500 million rubles, with the forestry sector receiving the most significant support.
- As part of a new initiative, the Russian authorities compensated up to 100% of transportation costs for forestry enterprises when delivering wood-based products through northwestern Russian ports until June 30, 2023 and 80% afterwards. Setting a relatively high priority (the 5th grade) for transportation of forest industry products by trains, most importantly, for the Eastern export routes. The primary goal of the government was to support forest exporters in the European part of Russia, as they were most affected by EU restrictions.
- The increased customs duties on the export of rough-sawn timber, including lumber and beams from coniferous and valuable hardwood species, have been extended until the end of 2025. This measure is intended to encourage deeper processing of timber within the country and the production of higher value-added products.
- Starting October 1, 2023, the Russian Government introduced flexible export duties on a wide range of products tied to the ruble exchange rate. The list includes pulp, paper, and cardboard products. The duty ranges from 4% to 7%, depending on the exchange rate.
- In 2023, the Federal Forestry Agency (Rosleskhoz) approved 27 investment projects aimed at developing the timber industry. To implement these approved projects, it is planned to allocate forest plots with an annual timber harvesting volume of approximately 15 million cubic meters.
- In 2022, new reforestation rules came into effect, requiring that by March 1, 2025, at least 20% of the areas designated for reforestation in the Russian Federation must be planted with seedlings and/or saplings with a closed root system. Starting from March 1, 2025, this requirement will increase to at least 30% of the designated areas.
- Development of wooden housing construction is one of the key areas of Russia's forestry development strategy up to 2030. Since November 2022, a government program has been in place to subsidize the production of wooden house kits costing up to 3.5 million rubles. Manufacturers offer a 10% discount when selling these kits and receive a corresponding subsidy from the state. By the end of 2022, the number of wooden houses in individual housing construction exceeded the number of houses built from other materials for the first time. Alongside the development of the wooden houses market, the government intends to promote the construction of social facilities using wood. In October 2023, the Russian Government supported three legislative bills aimed at developing wooden housing construction.
- Throughout 2024, all regions of Russia will transition to a unified State Forest Register. The register will consolidate all forest-related data into a single information system, including qualitative and quantitative characteristics of forests, information about forestry districts, forest maps, and analytics. The system will also integrate a module for tracking wood transactions, storage facilities, and wood processing sites. This approach is intended to enhance oversight in the forestry sector, making it more transparent and user-friendly for both forest users and government agencies.

In the long term, the effects of sanctions and boycotts on Russian industries, transport companies, and financial institutions are likely to result in technological decline, a shortage of investment resources, and weaker economic performance in the forestry sector. This could lead to higher risks of forest

mismanagement and increased disruptions, such as losses of timber and forest ecosystems due to wildfires, windstorms, forest diseases, illegal logging, and other factors.

3.2. Trends and projections of carbon sinks in forests

Russian forests have served as a significant net carbon sink over the past decades, though the magnitude of this sink has shown high temporal and spatial variability. This variability is primarily driven by interannual changes in seasonal weather patterns and the impact of natural disturbances. Estimates of the carbon sink vary widely, ranging from 150–200 Mt C per year as reported in official submissions to the UNFCCC, to over 600 Mt C per year according to independent scientific assessments. These differences are largely due to varying definitions of land area and differing representations of ecosystem processes and disturbances in the analyses.

The Russian system for classifying forest-related land is quite complex. Official forest inventories focus solely on land managed by state forest authorities, known as the state forest fund. As a result, forest resource assessments using different methodologies yield varying estimates of forested areas and carbon removals in forest ecosystems. For example, assessments based on satellite imagery do not differentiate between state forest fund land and other lands with forest cover. This discrepancy contributes to significant differences between official, inventory-based data and other assessments regarding forest area. Additionally, caution is advised when using data from the State Forest Registry, as a significant portion of it is outdated. According to the Registry, about 50% of Russian forests have not been inventoried in over 30 years.

The official reporting on carbon removals and emissions in forest sector in Russia is done under the National Inventory Submissions of the UNFCCC. Russia has been regularly providing detailed data on the inventories, distinguishing between the managed (693 Mha) and unmanaged (204 Mha) forests, as required by the IPCC guidelines.

Each type of land use related to forest sector has been inventoried with respect to two main categories: 1) forest land remaining forest land, and 2) land converted to forest land. Table 1 presents the detailed data on each land use subcategory (as of 2022).

Table 1. The breakdown of forest land area in Russia, 2022.

Land-use category	Total area (kha)
Total forest land	896983
1. Forest land remaining forest land	775621
managed forest land	665968
unmanaged forest land	83823
managed forest land (protected areas)	20092
managed forest land (lands for defense)	4075

managed forest land (urban forests)	1157
reserve forest managed by RUSAL company	505
2. Land converted to forest land	121362
2.1 Cropland converted to forest land	1426
antierosion plantation	429
field-protective plantation	183
antierosion plantation before 1990	367
field-protective plantation before 1990	447
2.2 Grassland converted to forest land (natural forest expansion)	2630
2.3 Wetlands converted to forest land	NO
2.4 Settlements converted to forest land	NO
2.5 Other land converted to forest land (natural forest expansion)	117306

Source: Russian Federation. UNFCCC National Inventory Submission, 2023.

Net removals of greenhouse gases in the forest sector significantly increased from 1990 to 2009, rising from 235 to 754 MtCO₂e per year (Figure 5). This trend was primarily driven by a sharp decline in wood harvesting during the socio-economic crisis of the 1990s in Russia, the collapse of the planned socialist economic model, turbulent reforms in the ownership of industrial assets, ineffective forest resource management, and the degradation of forestry-related infrastructure, including forest roads and other support systems.

Large areas of abandoned agricultural land, estimated at 48-56 Mha¹⁴, naturally became forested. Some regions experienced forest growth due to ineffective land management practices. While natural and artificial afforestation and reforestation activities did occur, they were implemented at a very modest rate. This was primarily due to a lack of funding, inadequate regulation, and the absence of incentives for forestry companies to engage in these activities, despite their commitments to plant trees, which they rarely fulfilled.

However, from 2009 to 2021, net carbon removals by forests declined by 17%, dropping from 754 to 614 MtCO₂e per year. The primary factors contributing to this decrease include the increased

¹⁴ Kotlyakov, V.M. and Luri, D.I. (ed.) 2012 *Izmenenie prirodnoj sredy Rossii v XX veke* [Changing the natural environment of Russia in the XX century] Russian Academy of Science, Geography Institute: 402 p.

frequency and scale of wildfires, the spread of forest diseases, more frequent windstorms and other natural and anthropogenic impacts, and a rise in wood harvesting to meet both domestic demands and export needs.

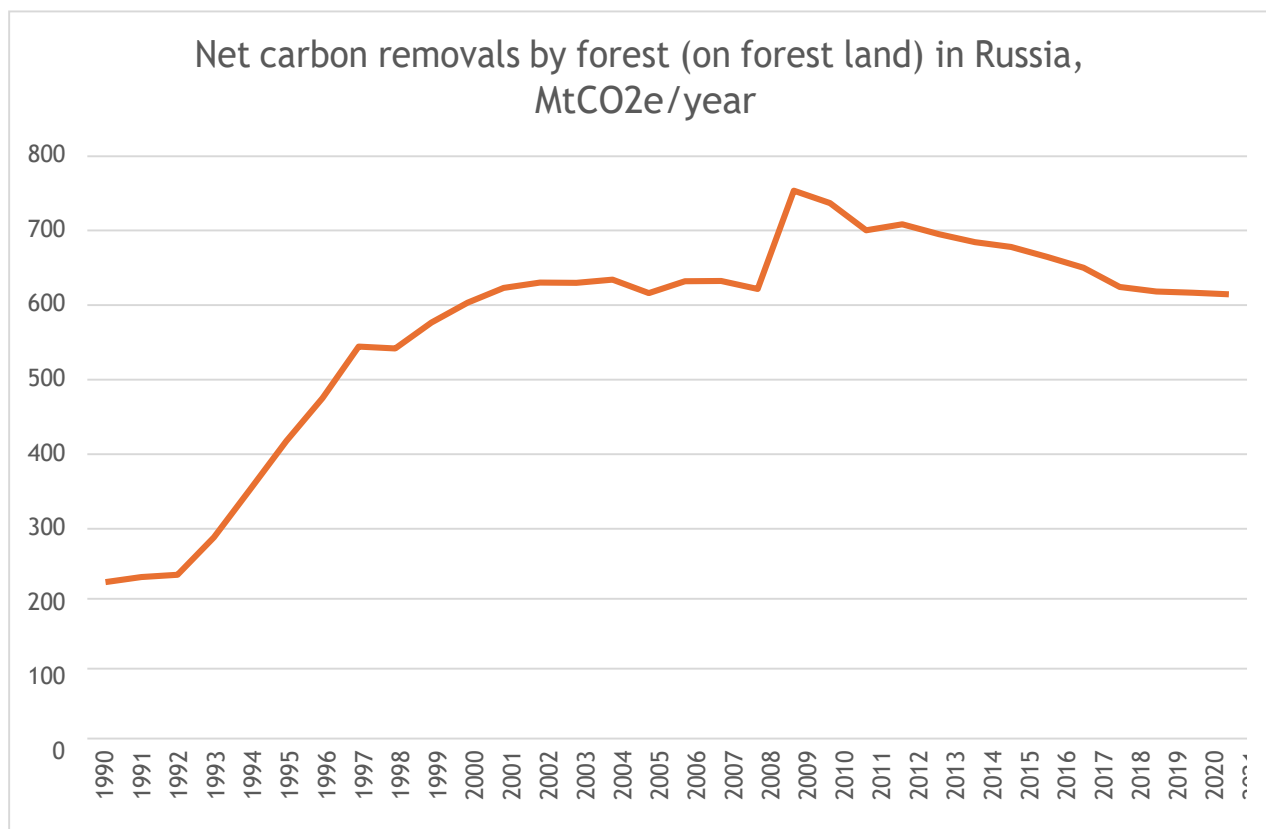


Figure 5. Annual net carbon removals by Russian forests (on the territory of forest land). Source: Russian Federation. UNFCCC National Inventory Submission, 2023. <https://unfccc.int/documents/631716>

3.2. Trends and projections of carbon sinks in forests

There are several categories of drivers influencing the forest sector in Russia, each playing a significant role in both the near and long-term future. Some of these drivers are directly linked to the effects of Russia's 2022 invasion of Ukraine, while others may be indirectly related, though the extent of their connection is determine.

The directly linked drivers include as follows:

- **Economic sanctions:** The sanctions imposed on Russia have led to reduced access to advanced technologies and international expertise, which can impact forest management practices, including fire control, reforestation, and sustainable harvesting.
- **Resource reallocation:** The redirection of government resources toward military efforts reduces funding and attention for forest management and conservation, potentially leading to increased vulnerability to disturbances like wildfires and pests.

- **Financial transactions:** The growing risks of secondary sanctions on banks and other financial institutions have emerged as significant obstacles for exporting wood products to China and other countries, as well as for importing essential equipment, materials, IT services, and more. Delays or outright bans on transactions in Chinese Yuan, Indian Rupees, and other currencies are disrupting normal trade flows and negatively impacting forestry companies, hindering their ability to operate effectively in the market.
- **Transport and logistics problems:** Railway transportation in the eastern direction, now the primary transit route for exporting wood products, has become increasingly problematic. Strong competition with other influential sectors, such as oil, coal, metals, and fertilizers, as well as the transport of military equipment, has created significant and growing barriers for wood product exports. This competition for limited railway capacity poses a substantial challenge for the forestry sector, further complicating its ability to access and maintain international markets.
- **Divestment:** Foreign investors, shareholders, partners, clients, international certification organizations (such as FSC), and audit firms have all withdrawn from Russia, divested from its forestry businesses, and canceled their partnerships. These actions will have long-lasting consequences, including restricted cooperation, diminished trust, and significant reputational damage.

The indirectly related drivers, among others, include:

- **Climate change impacts:** Ongoing climate change, which intensifies natural disturbances like wildfires, pests, and diseases, continues to affect the carbon sequestration capacity of forests. While not directly related to the war, broader geopolitical instability may hinder international climate cooperation and reduce funding for climate resilience efforts in Russia. Consequently, Russia's commitments under the Paris Agreement, especially the goal of enhancing carbon sequestration in forest ecosystems by 2050 and beyond, are likely to remain unfulfilled due to insufficient political will and resources. Additionally, as climate change impacts escalate, Russia's stagnating economy, deteriorating infrastructure, declining demographics, and degrading labor force quality are expected to exacerbate the negative effects on the forest sector.
- **Environmental and natural resource policy shifts:** Despite the Russian government's numerous declarations of initiatives to enhance environmental protection and promote sustainable natural resource use in recent decades, progress has been minimal. The adoption of the Forest Code in 2006, for instance, had severe consequences for forest ecosystems, as it led to the abandonment of many regulatory mechanisms that supported environmentally responsible harvesting and forest management practices. Given the current economic stagnation, declining revenues, reliance on wood product exports, and ongoing social instability, there is little expectation that the government or forest businesses will shift away from their "wild resource usage" approach in the near future. The impacts of the conflict in Ukraine will likely have enduring effects on Russia's forest sector.

The factors influencing the carbon sequestration capacity of Russian forests are identified below.

Wood harvesting

The scale of wood harvesting for both domestic consumption and export impacts the carbon sequestration capacity, with higher harvesting rates reducing the forests' ability to absorb carbon.

The Russian government has been trying to stimulate forest sector's growth to substantially increase its share in GDP from the current 0.7%. Not much has been reached in this respect in the last three decades, despite rich forest resources in the country.

The government's current strategic target is to increase wood harvesting from 183 million cubic meters (Mm³) in 2023 to 286 Mm³ by 2030, representing a 55% increase (see Figure 6). This significant rise would place a considerable additional burden on forest ecosystems, as clear-cutting remains the predominant harvesting method in Russia. This approach often leads to long-term degradation of ecosystems, as reforestation efforts are rarely conducted in line with sustainability requirements, if they are carried out at all.

In a more pessimistic scenario, the government predicts that harvesting levels might remain close to current volumes. However, this could mean that forestry companies may need to expand into new forest areas with more valuable wood resources, thereby intensifying their impact on natural ecosystems. Such expansion could increase the risks of anthropogenic effects and potentially lead to more frequent forest fires.

Forest wildfires, diseases and other disturbances

The frequency, intensity, and extent of wildfires play a significant role, as does the effectiveness of policies and measures aimed at controlling and preventing these fires. Other factors such as forest diseases, windfalls, and various anthropogenic impacts (e.g., pollution, land-use changes) disrupt forest ecosystems and reduce their carbon sequestration capabilities.

Over the past 40 years, Russia has experienced a significant warming trend, with an average decadal temperature increase of 0.61°C, approximately 2.5 times the global average. Concurrently, an overall intensification of the hydrological cycle has been observed, with average precipitation across Russia increasing by 2.2 mm per month per decade, particularly in the Central Far East. However, a slight decrease in precipitation has been noted in central and southern European Russia. The frequency of extreme events and hydrological hazards has nearly tripled between 2000 and 2018.

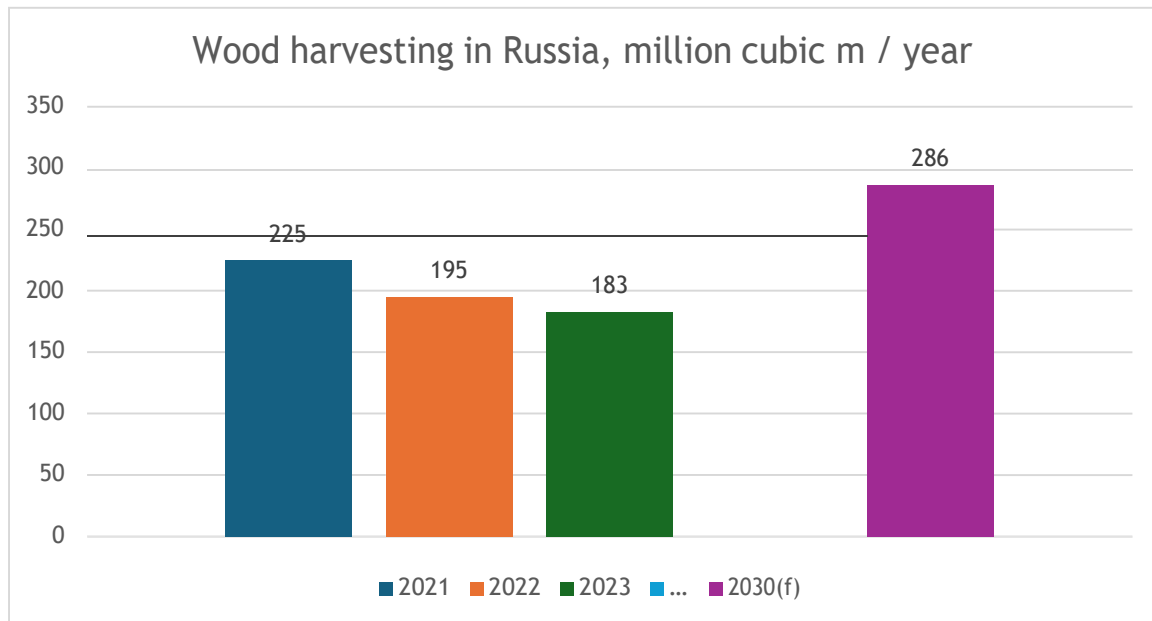


Figure 6. Dynamics of wood harvesting in Russia in 2021-2023 and the governmental target for 2030 (“Strategic scenario”). Source: Rosstat, LesEGAIS, WhatWood, “Strategy of development of the forest complex of Russian Federation by 2030”.

Future climate projections consistently show a continuation of these warming trends across all scenarios, both in the medium term (2036–2065) and long term (2070–2099). Cumulative precipitation is expected to continue increasing on average, particularly in Siberia, while decreases are projected for Southern European Russia. However, climate variability and the occurrence of extreme events are likely to intensify, especially in central and far eastern regions.

These changes suggest an increased risk and intensity of forest disturbances, leading to greater carbon release and disruptions in the steady flow of forest resources. As a result, adapting to these disturbance risks is crucial for the sustainability of Russian forests and the forest sector, with an urgent need for enhanced forest restoration efforts following disturbances.

While disturbances may accelerate forest changes, they also present opportunities for adaptation, such as adjusting species composition to better suit the changing climate. However, the decline in the area of productive forests, along with the impact of disturbances on the quality and quantity of harvested wood and the lack of regeneration of commercially valuable tree species, poses significant challenges to the Russian forest sector.

To address these challenges, substantial improvements are needed in the current forest management system, including the development of a more reliable and operational forest inventory and monitoring system, as well as more effective forest protection measures under future disturbance regimes. Adaptation measures must also be tailored to regional specificities, with particular attention to the southern ecotone between forest and arid zones, which is especially vulnerable to climate change impacts.

However, there is significant doubt that these urgent improvements in policies and measures will materialize in Russia in the short- to medium-term future. For instance, the failure to effectively

implement the Climate Doctrine of the Russian Federation (2009) and the National Adaptation Plan by 2025 (2023) highlights the ineffectiveness of the country's climate policy.

Reforestation and afforestation

The scope and effectiveness of reforestation and afforestation efforts are crucial in maintaining and enhancing the carbon absorption potential of forests. These activities help replenish and expand forest cover, contributing to long-term carbon sequestration.

Forest fund land that is temporarily not covered by forest vegetation due to logging or natural disturbances (such as fires or diseases) is primarily regenerating naturally. According to forest inventory data, over 30 million hectares in Russia require reforestation, yet artificial reforestation efforts annually cover less than 1% of this area (Proderevo, 2018). Natural regeneration often favors deciduous species like birch and aspen, which replace coniferous evergreen species such as spruce and fir. To maintain or increase the share of species that are in demand by the forest sector for wood production, more active restoration efforts are needed.

In order to enhance effectiveness of forest restoration measures, some operational changes should be incorporated into forest management instructions, thinning and reforestation guidelines, and similar documents. All regulatory documents at the federal level should undergo an audit to identify and revise the sections most pertinent to reforestation and afforestation measures. However, in the current context, such enhancement is not considered as feasible.

Utilization of forest resources

The efficiency with which forest resources, particularly biomass, are utilized can also affect carbon sequestration. Reducing waste in wood harvesting and processing, along with promoting the reuse and recycling of wood products, can enhance the overall carbon storage capacity of forest ecosystems.

There are numerous opportunities for efficiency improvements, such as more resource-efficient wood sourcing, which includes better practices in harvesting, storage, and transportation of raw materials, as well as more efficient production processes. These improvements can significantly enhance the efficiency of utilizing harvested materials. Additionally, there is great potential in increasing the use of industrial side streams—materials that were previously discarded as waste—thereby further optimizing resource use.

For instance, according to the recent estimates, approximately 75 to 127 million cubic meters of wood waste is generated annually in Russia.¹⁵ The economic potential of woody biomass resources in the country is estimated to be between 45 and 90 million cubic meters.¹⁶ Utilization of the wood waste and other wasted biomass, as well as implementation of bioeconomy solutions for reducing carbon footprint of industries (e.g. wooden buildings, innovative wood-based materials) could reduce GHG emissions in Russia substantially.¹⁷

¹⁵ Marchenko, O.; Solomin, S.; Shamanskiy, V.; Donskoy, I. Evaluation of the Effectiveness of Joint Use of Wood and Other Renewable Energy Sources in the Baikal Region. *Appl. Sci.* 2022, 12, 1254. <https://doi.org/10.3390/app12031254>

¹⁶ Marchenko, O.V.; Solomin, S.V.; Kozlov, A.N. Possibilities of Use of Wood Wastes in the Power Industry of Russia. *Ecol. Ind. Russ.* 2019, 23, 17–21. (In Russian)

¹⁷ Safonov G. et al. (2022) Potential Role of Bioenergy in Decarbonizing Russia's Economy. *Economic Policy* 17(6), 2022. DOI: 10.18288/1994-5124-2022-6-90-111

Forest management systems in Russia should be re-evaluated to promote actively managed forests with long-term sustainability goals. Developing bioeconomy markets linked with the circular economy could help to establish a new economic foundation, moving away from the traditional linear economy model.

Projections of carbon sequestration by 2050

There are several studies attempting to build scenarios of net carbon removals in forest ecosystems in Russia based on analysis of various factors, such as the intensity of wood harvesting, climate change impacts, forest management.

Figure 7 illustrates the dynamics of net carbon removals by scenarios of wood harvesting, prepared using two forestry models – Canadian model CBM-CFS3 calibrated for Russian data and Russian regional forestry model ROBUL (Zamolodchikov D., Grabovsky V., 2014). The following scenarios were considered in that study:

Scenario 1. Fast growth of timber cutting in 2010-2050, which corresponds to the observed growth of wood harvesting in the period of 2010-2021 with the decline in 2022 and recovery onwards.

Scenario 2. Long term moderate growth of timber cutting in Russia, which corresponds to the strategic scenario of the Strategy of development of the forest complex of Russian Federation by 2030.

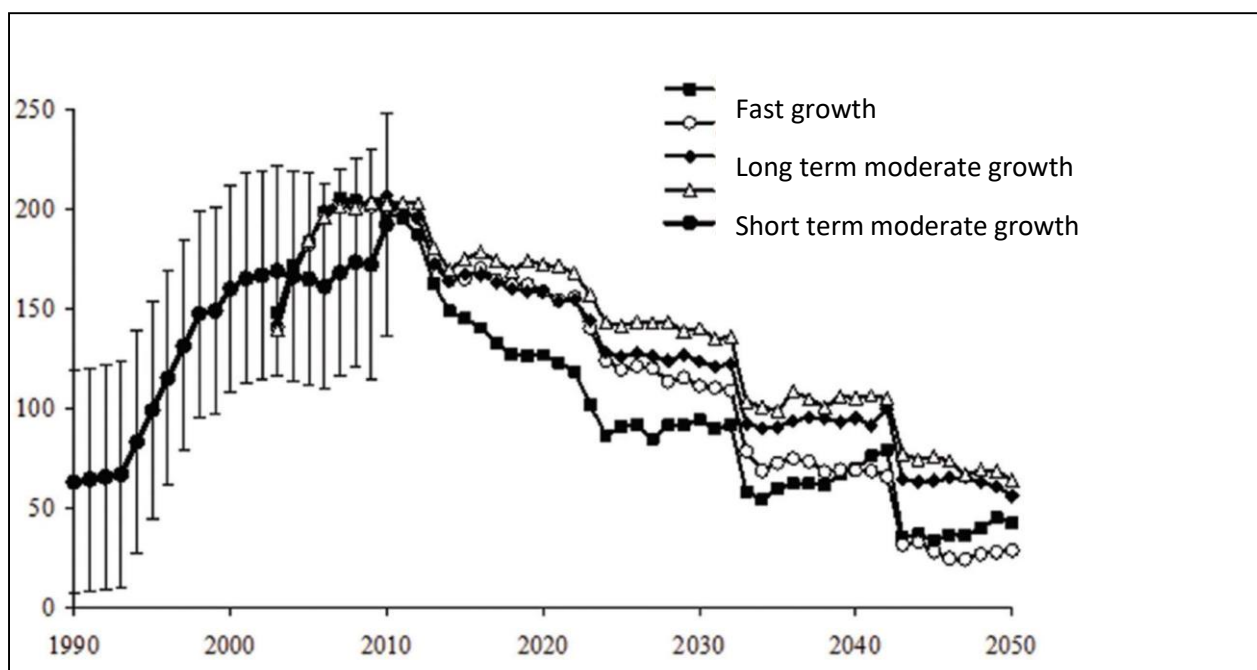


Figure 7. Projections of net carbon sequestration by Russian forests by scenarios of wood harvesting (based on CBM-CFS3 and ROBUL forestry models), MtC/year. Source: Zamolodchikov et al, 2013a.

Scenario 3. Short term moderate growth of timber cutting in Russia.

Scenario 4. Continued wood harvesting approximately at the levels of 2010.

The observed dynamics of net carbon removals in 2010-2020 well corresponds to the scenarios 2 and 3 of the long and short term moderate growth of wood harvesting. Net carbon removals in both these scenarios are projected to gradually decline by 2050: by 70% in scenario 3 and by about 85% in scenario

2. This means that the longer while of stable and moderate growth of wood harvesting will lead to substantial loss of carbon sequestration capacity of Russian forest even without consideration of climate change impacts.

Another study (Zamolodchikov et al., 2013b) was based on the regional forestry model ROBUL and considered the impacts of climate change on the net carbon removals by Russian forests until 2050. Figure 8 demonstrates the dynamics of net carbon sequestration for 4 scenarios:

Scenario 1. No meaningful climatic changes in Russia, which could affect forests.

Scenario 2. This scenario corresponds to IPCC A1B scenario¹⁸, assuming a very rapid economic growth in the world, global population peaking in mid-century and declining thereafter, and the rapid introduction of new and more efficient technologies, which would be well balanced across all energy sources.

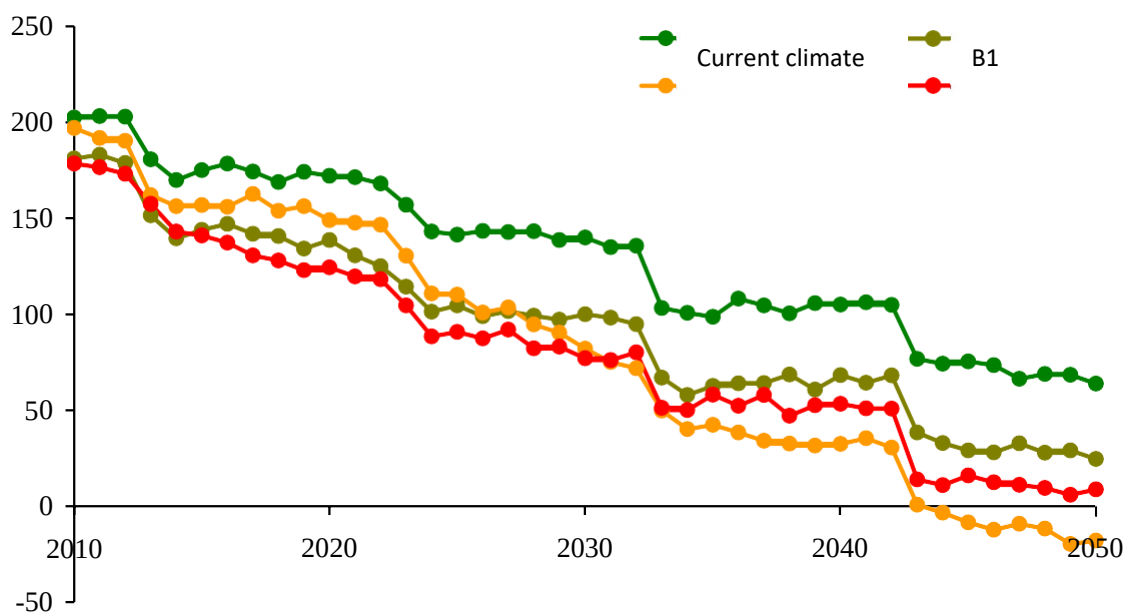


Figure 8. Projections of net carbon sequestration by Russian forests by climate change scenarios, MtC/year. Source: Zamolodchikov et al, 2013.

Scenario 3. This scenario corresponds to IPCC B1 scenario, assuming the same global population as in A1B scenario, but rapid changes in economic structures toward a service and information economy, reductions in material intensity, introduction of clean and resource efficient technologies.

Scenario 4. This scenario corresponds to IPCC A2 scenario, assuming a very heterogeneous world, continuously raising global population, regionally oriented economic development and fragmented and slow technological changes.

¹⁸ IPCC Special Report. Emission Scenarios. Summary for Policy Makers, 2000.

The observed dynamics of net carbon removals in 2010-2020 rather well corresponds to the scenario 2 (A1B) with the decline of net carbon removals by about 17%. All scenarios considering climate changes provide significant decline of net carbon removals, primarily due to the forest wildfires, aging of forests, impacts of insects and forest diseases, windstorms and other factors. In the most pessimistic scenario for the country (A1B), the Russian forests may become net carbon emitter in mid-2040s.

Combination of both factors (increase of wood harvesting and more intensive negative impacts of climate change) will highly likely lead to declining role of Russian forests as a global source of carbon removals from the atmosphere.

Conclusion

The socio-economic transformations in Russia after the full-scale invasion in Ukraine have fundamental implications for the Russian society and all sectors of the economy. The forest sector is one of them, being deeply affected by the losses of traditional export markets, rearrangement of the logistical and transportation systems, bans on the technological cooperation and access to foreign investments and finance.

In the short term, Russia retains a substantial base of natural resources, capital assets, production facilities, technologies, and other resources. Businesses are adapting to the evolving environment and, in timber industry, managed to recover from the drop of production and sales in 2022. The turn to the East (Asian markets) is considered as successful, even for the producers located in the Western part of Russia, primarily due to the strong support of the government. However, the costs of such support (e.g. subsidies for railway transportation) are rather significant, and may unlikely be sustained in the long while. The forest industries will face further exacerbating circumstances when the state support declines.

In the longer term, the consequences become increasingly concerning. With a diminishing natural resource base for cost-effective production, deteriorating technologies, crumbling infrastructure, high capital costs, and limited financial resources, the economy will face significant pressure. Socially, the situation is also problematic due to the worsening demographics, losses of people in the war, continuing brain drain, a decline in human and social capital, and a growing shortage of qualified workers. These factors collectively contribute to a fundamental shift towards an unfavorable environment for forest sector development, lack of access to large-scale and profitable markets, and falling behind global technological and development trends.

There are multiple additional aspects that should be taken into account when analyzing the perspective role of Russian forests in the global carbon cycle. There are many uncertainties, requiring in-depth investigations, including the quality of primary data, coverage of forest territories, opportunities for improvement of forest management, implementation of forest bioeconomy solutions for decarbonizing Russian economy, and others.

The long-term socio-economic consequences of the sanctions and other impacts on Russian economy after 2022 will adversely affect the state of forests in the long-term, including the quality of forest management, business practices of wood harvesting, technological basis for wood processing, application of the sustainability standards, and incentives for greening operations in forestry. Climate change impact will add negative disturbances on forests that would not be well coped by the poorly managed forest authorities and a lack of financial and other resources.

Literature, information and data sources

- Akhapkin N.YU (2023) Russian economy under sanctions: dynamics and structural changes. Vestnik Instituta ekonomiki RAN, Issue 6, 2023, pp. 7-25 [in Russian].
- Bank of Russia (2024a), Monetary aggregates, April 2024. https://www.cbr.ru/eng/statistics/macro_itm/dkfs/monetary_agg/ [last accessed 24.08.2024].
- Bank of Russia (2024b), The dynamics of the official exchange rates https://www.cbr.ru/eng/currency_base/dynamics/ [last accessed 24.08.2024].
- Center for Strategic Studies (2022), Picture of foreign businesses, 2022 report [in Russian] <https://www.csr.ru/ru/research/kartina-inostrannogo-biznesa-uyti-nelzya-ostatsya/> [last accessed 24.08.2024].
- Donovan K., Nikoladze M. (2023) Global Sanctions Dashboard: What to do with sanctioned Russian assets, Atlantic Council <https://www.atlanticcouncil.org/blogs/econographics/global-sanctions-dashboard-what-to-do-with-sanctioned-russian-assets/> [last accessed 24.08.2024].
- European Council (2024), EU sanctions against Russia explained. <https://www.consilium.europa.eu/en/policies/sanctions/restrictive-measures-against-russia-over-ukraine/sanctions-against-russia-explained/> [last accessed 24.08.2024].
- Forbes (2023), Minfin plans to collect all windfall tax in 2023. 27.9.2023. <https://www.forbes.ru/finansy/497319-minfin-zaplaniroval-sobrat-ves-nalog-na-sverhpribyl-uzhe-v-2023-godu> [last accessed 24.08.2024].
- Interfax (2023), Russian president signs law on windfall tax. 4.8.2023 <https://interfax.com/newsroom/top-stories/93317/> [last accessed 24.08.2024].
- Interfax (2024), FNB declined by 1.47 trillion RUR in December 2023. 17.1.2024 [in Russian]. <https://www.interfax.ru/business/940594> [last accessed 24.08.2024].
- IPCC Special Report. Emission Scenarios. Summary for Policy Makers, 2000.
- Izvestia (2023), FT: About 2000 applications from foreign companies are waiting for approval to withdraw from Russia, 28.3.2023 [in Russian]. <https://iz.ru/1489922/2023-03-28/ft-okolo-2000-zaiavok-ot-inostrannykh-kompanii-zhdut-odobreniia-na-ukhod-iz-rossii> [last accessed 24.08.2024].
- Karpov A. (2022), Assessment of dependency of Russia from import of intermediate products, Bank of Russia, Series of reports on economic studies, #106, December 2022 [in Russian]. https://www.cbr.ru/Content/Document/File/144138/wp_106.pdf [last accessed 24.08.2024].
- Kotlyakov, V.M. and Luri, D.I. (ed.) 2012 Izmenenie prirodnoj sredy Rossii v XX veke [Changing the natural environment of Russia in the XX century] Russian Academy of Science, Geography Institute: 402 p.
- Levada Centre (2023) Assessment of income levels in Russia in 2023. <https://www.levada.ru/2023/07/18/otsenki-urovnya-dohoda-sredi-rossiyan-v-2023-godu/> [last accessed 24.08.2024].

- Marchenko, O.; Solomin, S.; Shamanskiy, V.; Donskoy, I. Evaluation of the Effectiveness of Joint Use of Wood and Other Renewable Energy Sources in the Baikal Region. *Appl. Sci.* 2022, 12, 1254. <https://doi.org/10.3390/app12031254>
- Marchenko, O.V.; Solomin, S.V.; Kozlov, A.N. Possibilities of Use of Wood Wastes in the Power Industry of Russia. *Ecol. Ind. Russ.* 2019, 23, 17–21. (In Russian)
- Ministry of Economic Development of Russia (2021) The forecast of longterm socio-economic development of Russian Federation until 2030. Adopted by the government of Russia on 06.10.2021 #2816-r.
- Ministry of Finance of Russia (2024b), Volumes of the state bonds by 21.3.2024 [in Russian]. https://minfin.gov.ru/ru/document?id_4=126517-obemy_razmeshchennykh_gosudarstvennykh_tsennyykh_bumag_po_sostoyaniyu_na_25.01.2024 [last accessed 24.08.2024].
- Ministry of Finance of Russia, Federal budget, 2024 <https://minfin.gov.ru/ru/statistics/fedbud> [last accessed 24.08.2024].
- Roslesinforg portal <https://roslesinforg.ru/>
- Rosstat (2023), Demographic forecast by 2046, 2023 report [in Russian]. <https://rosstat.gov.ru/folder/313/document/220709> [last accessed 24.08.2024].
- Russian Federation. UNFCCC National Inventory Submission, 2023. <https://unfccc.int/documents/631716>
- Russian foreign trade tracker dataset, 20.2.2024 <https://www.bruegel.org/dataset/russian-foreign-trade-tracker> [last accessed 24.08.2024].
- Shirmanova I. (2023), 800 thousand Russians might have left the country in 2022. 16.3.2023 [in Russian] <https://tochno.st/materials/rossiyan-mogli-pokinut-stranu-v-2022-godu> [last accessed 24.08.2024].
- TASS (2024), Minfin plans to attract 40 trillion RUR of population for investments in national economy, 21.12.2023 [in Russian]. <https://tass.ru/ekonomika/19602203> [last accessed 24.08.2024].
- UN (2022), World Population Prospects.
- Zamolodchikov D.G. et al. Carbon budget of managed forests in the Russian Federation in 1990-2050: Post-evaluation and forecasting. *Russ. Meteorol. Hydrol.* 38, 701-714 (2013a).
- Zamolodchikov D.G. et al. The impacts of fires and clear-cuts on the carbon balance of Russian forests. *Contemp. Probl. Ecol.* 6, 714-726 (2013b).
- ZN.UA (2023), A tax on Ruble devaluation is introduced in Russia, 22.9.2023 [in Russian]. <https://zn.ua/WORLD/v-rossii-vvodjat-naloh-na-devalvatsiju-rublja.html> [last accessed 24.08.2024].

