Ensuring sustainable development of forestry in the Russian Federation

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Abstract. The study is dedicated to the pressing issues of sustainable development of Russia's forestry. The relevance of the study is substantiated by the importance of understanding sustainability as a new paradigm for the development of society and the uniqueness of forests as an ecosystem resource. The purpose of the study is to justify a set of measures to ensure sustainable development of forestry at the mega- and macrolevels, while taking into account the economic, environmental and social aspects of this process. The present study used international and Russian research data and publications, and regulatory documents. Based on the provisions of the Concept of Sustainable Development of Forestry and other international and national regulatory documents, we present the results of the analysis and the rationale for the proposed measures to ensure the sustainable development of the forest complex of the Russian Federation in the following areas: reforestation and afforestation; forest conservation and protection; monitoring, inventory and assessment of forests; public administration, services and support; forest exploitation; and forest education and science. The study identified problems of sustainable development of the forestry sector of the Russian Federation that require immediate attention. We provide characteristics of some digital solutions in the forestry of the Russian Federation. We have also analyzed the effectiveness of tools for assessing the status and for inventory of forest resources of the Russian Federation, and presented a comprehensive rationale for digitalization of forestry. We have analysed in detail the level of the development of forestry education and science and proposed the ways for further improvement.

1. Introduction

In recent years, there has been increasing interest in sustainable development issues from the Russia's research community. The idea of sustainable development is reflected in the concept and principles of general development of the economy, proclaimed at the UN World Conference in Rio de Janeiro in 1992, at the Summit of RIO-92 +10 (2002) and the XVIII World Congress of Accountants in Kuala Lumpur in 2010.

For the first time, the concept of "sustainable development" was defined at the global level as the conceptual basis of UN projects aimed at protecting the natural environment. The theoretical foundations of sustainable development as a new paradigm for the development of civilization were developed by V Vernadsky, P Teilhard de Chardin, and others. The concept of "sustainable development" was formulated by the Prime Minister of Norway G H Brundland in 1987 and presented in the report of the International Commission on Environment and Development "Our Common Future". According to this definition, sustainable development must satisfy the needs of modernity,

while not compromising the ability of future generations to meet their own needs. It should be noted that this definition proclaims intensive growth as the basis for sustainable development, being the exact opposite of the paradigm of economic growth, which provides for only quantitative changes and ignores social and environmental problems.

The phrase "sustainable development" conveys three notions of equal value: "economy – nature – society". A sustainable development of the system as a whole can be achieved only when an optimal combination of all three factors is obtained.

Given that forest is a unique resource and the most productive ecosystem, which harbours 80% of the diversity of all plants and animals on Earth, the role of forests in the transition to sustainable development can hardly be overestimated. Forestry provides multiple economic, social and environmental benefits. However, at present, forests are under increased pressure from agriculture, energy production, and other spheres of material production. This creates a number of problems associated with the rational use of forest resources. In connection with the above, it is extremely important to develop a set of measures aimed at ensuring sustainable development of forestry, both at the global and national levels, in order to achieve a high level of satisfaction of economic interests without compromising social and environmental aspects.

2. Methods and Materials
The methodology of the research presented was adopted from the available national and international publications in the field of sustainable development, systems theory and system analysis. We used regulatory acts in the field of sustainable development, forest management, digital economy, official materials of the Federal Forestry Agency of the Russian Federation, reports of international organizations, periodicals and Internet resources, as well as the results of our own research as sources of information for the present study.

We used the systemic and integrated approaches, combined with analysis, synthesis, deduction and induction, generalization and comparison, and a tabular method.

3. Results and Discussion
The concept of sustainable development of forestry was proclaimed at the UN International Conference on Environment and Development, held in Rio de Janeiro on June 3-14, 1992. The main provisions of this concept were reflected in the program documents "Agenda 21" and "Forest Principles". The postulates of sustainable forestry development set forth in the documents were not fundamentally new and revolutionary, since certain steps in this direction were taken earlier, e.g. in 1972, at the Seventh World Congress on Forests in Buenos Aires; in 1990, at a conference of European Ministers in Strasbourg; and at other conferences and forums.

At the global level, forest is recognized as the most important primary resource. It serves as the basis for many goods and services, the value of which multiplies as they move along the processing chain. In addition, forestry is a source of improved food security.

More than 20% of the world's total forest area is located in the Russian Federation. This is considerably more than in the countries with the developed forestry and forest industry, such as the USA, Canada, China, Sweden and Finland. However, in Russia this valuable resource has not been used rationally. "Russia's share in the global timber market reaches only 3%, and more than half of the exports are products of low processing - round timber and sawn timber: our country holds 16% of the world roundwood market, and 18% of the sawn timber market (second place in the world after Canada), but it occupies one of the last places in the structure of world exports of high value-added forest products (for example, the share of Russian pulp exports is 4%) "[1].

The contribution of the forest sector to the country's GDP is estimated at 0.5%. For comparison, in Canada the forest sector provides 4% (21.8 billion USD) of the GDP , and in Sweden, 2.9% (13.8 billion USD). This requires a review of the principles and approaches to the forest management system and ways for further development of forestry. One of the main problems of the Russia's forestry is the extensive forest management model, which is based on the harvesting of ripe wood from

predominantly natural forests and reforestation according to the "what has been cut down should be replaced" scheme.

In order to implement the Concept of the transition of the Russian Federation to sustainable development, approved by Decree of the President of the Russian Federation of 04.01.1996 No. 440 [2], Decree of the Government of the Russian Federation of 05.08.1996 No. 559 "On the development of a draft state strategy for sustainable development of the Russian Federation" [3] , in fulfillment of Russia's international obligations and the decisions of the UN Conference on the Environment and Development (Rio de Janeiro, 1992) regarding sustainable forest management (Forest Principles, Agenda 21), decisions of the XIX Special Session of General Assembly of the United Nations (New York, 1997) the following strategic policy documents have been developed and adopted: the Forest Code of the Russian Federation [4], the Strategy for the Development of the Forest Complex of the Russian Federation until 2030 [5], and the Forecast for the Development of the Russian Forest Sector up to 2030 [6]. The main problems that adversely affect the sustainable development of the Russia's forestry industry and therefore require an urgent action include: low specific productivity of timber removal; low efficiency of reforestation, conservation and protection of forests; out-of-date information on forest resources; excessive administrative barriers; illegal logging and trafficking of wood; imperfect regulatory framework of the forest complex; low level of personnel, scientific and technical support for the industry, to name just a few. According to the Accounts Chamber of the Russian Federation, in 2013–2017 the area of forest fires increased 3.2 times, the area forests affected by pests and diseases, 2.6 times, and that of illegal logging, 1.5 times.

Sustainable development of the forestry sector of the Russian Federation involves permanent qualitative changes based on specific targets and carried out on a long-term and cost-effective basis between people, society, the state and forest ecosystems. In the framework of such development, periodical removals of forest products take place in various ways, taking into account the assimilation potential of ecosystems, which does not lead to degradation of the values (market and non-market) of a forest as a whole, as well as of individual species living in it.

The main objective of the sustainable development of forestry is to ensure conservation of forests as part of landscapes and the most valuable resource of the Russian Federation through an integrated, rational and balanced use of the functions and properties of forests on the basis of maintaining biodiversity and forest productivity in a state acceptable for forest ecosystems and society.

Sustainable development of forestry in the Russian Federation, in our opinion, should be ensured in such areas as: 1) reforestation and afforestation; 2) conservation and protection of forests; 3) monitoring, inventory and assessment of forests; 4) public administration, services and provision; 5) forest management; 6) forest education and science.

These areas will make it possible to cover all components of sustainable development (economic, social and environmental), significantly increase the efficiency of forestry and contribute to achieving the goals stipulated by the Strategy for the Development of the Forestry Complex of the Russian Federation until 2030, approved by Decree of the Government of the Russian Federation No. 1989-p dated 20.09.2018. The Strategy demands an increase in the share of the forest complex in the GDP to 1%; an increase in the number of employees up to 820 thousand people, and an increase in tax revenues to budgets of various levels up to 189 billion rubles [5].

3.1. Monitoring, inventory and assessment of forests, and forest exploitation
The transition from an extensive forest management model to an intensive one began in 2017. The process is characterized by an increasing volume of forest-related activities, which in turn demands an increase in the complexity of the management system, also due to the use of modern digital technologies, for solving planning problems, accounting for results and forecasting returns from forestry events.

The main area of development of the national economy of the Russian Federation is currently the digitalization of all its sectors, including the forest complex. However, without detracting from the importance of the digital transformation of the industry, it should be noted that the process should be

accompanied by unification of forest resource assessments. Only in this case, the digitalization of forestry will be most effective.

The main tool for assessing the status and inventory of forest resources in the Russian Federation are State Forest Inventory and the state forest register, which do not contain reliable information, and the automated information system "State Forest Register" worth 185 million rubles, which is not used much. The lack of a uniformly agreed strategy for the digital transformation of forestry is the main reason for the lack of coordination between the federal and regional governments. This leads to an unreasonable increase in software and hardware solutions, excessive costs and a decrease in the efficiency of the use of engineering solutions in state forestry management. In addition, existing regulations are poorly synchronized with key documents in the field of the digital economy, for example, with the Development Strategy for the Information Technology Industry in the Russian Federation for 2014–2020 and for the long term until 2025 [7], the Federal project "Digital State Administration", the national program "Digital Economy of the Russian Federation"[8] and others. Obviously, in modern conditions, digitalization is an objective necessity, which has no alternative, so there is a need to develop and adopt a strategy and / or program for the digital transformation of forestry.

For example, Russia has not developed a unified approach to the creation of a state system for determining the volume of round timber. To combat the so-called "black loggers", the Unified State Automated Information System (EGAIS) was introduced for tracing timber from the place of harvesting to the actual export point from the customs territory of the Russian Federation, linking the logger and the buyer; however, not a single illegal logging has been detected with the help of this system. In addition, now the number of supporting documents required for the transportation of round timber by road has increased significantly (from two to forty), which creates additional costs for law-abiding loggers.

To ensure sustainable development of the Russia's forestry sector through digitalization, it is necessary, first of all, to bring all the data provided by various services and bodies to a single form through the use of common inventory methods.

If not solved, the following problem will impede the sustainable development of forestry. It is the need to assess the forest resource in its entirety (wood biomass, resin, birch bark, mushrooms, berries, seeds, etc.). Moreover, it is important to take into account its territorial availability and the resources required for harvesting, in order to predict the income from the use of this kind of resource. However, of the total forest resource, only wood is currently estimated. According to experts, inventory of timber alone significantly narrows the income base of forestry; for example, as a result of processing spruce needles, one can get additional products in the form of carotene paste with the value of 1.2–2.25 million rubles per hectare, which is more than three times the cost of wood obtained from the same area [9].

Several forest monitoring information systems and services have been created at the federal level, including a unified state automated system for timber resource assessments and transactions (LesEGAIS), a remote monitoring information system of the Federal Forestry Agency (ISDM-Rosleskhoz), and a fire hazard monitoring unit and an interactive map "Forests of Russia". Several regions implemented their own systems; however, they are based on outdated information and methods of its processing, and therefore require modernization. All information of commercial value is concentrated in forestry units, often in a form of paper maps. The share of forest inventory materials formed over the past 10 years amounted to only 3.2% (about 18 million hectares). Data on more than 70% of forests (397.9 million hectares) were last updated more than 20 years ago. Information from the State Forest Register and the Unified State Register of Real Estate on the Lands of the Forest Fund diverge by 257 million hectares. In such circumstances, bureaucracy flourishes, which affects, for example, the timing of the allocation of forest plots (currently 235 days).

The absence of a unified geographic information system containing up-to-date and relevant information on the availability and condition of forest resources, which would also ensure constant updating, leads to a significant decrease in the efficiency and effectiveness of decision-making in

terms of ensuring sustainable development of forestry. According to experts, the creation of such a system would reduce losses and improve the quality of raw materials, as well as expand the planning horizon to 5-10 years.

Digitalization of forestry is extremely urgent due to the large area of forest in Russia (more than 880 ha), which makes their inventory, assessment of status and control using traditional methods extremely time-consuming. With the help of technological and system solutions based on neural networks and artificial intelligence, it is possible to simplify this procedure. It should be noted that the use of foreign computer systems in the forestry of the Russian Federation is limited by the fact that they are developed taking into account data on the forest stands characteristic of these countries.

Digitalization of forestry is envisaged by the state program "Digital Economy" [8], in accordance with which 30 projects should be implemented by 2025, including those in the forestry complex.

Russia is currently creating its own computer systems for forestry, capable of carrying out the most important tasks, from recording forest plot leases to forecasting the dynamics of forest fires and digital automatic monitoring of illegal logging. The characteristics of some digital solutions in the forestry sector of the Russian Federation are presented in table 1.

Table 1. Characteristics of digital solutions in the forestry of the Russian Federation.

Item	Type	Technologies used	Problems solved
"KEDR"	Space monitoring system for forests	Recurrent neural networks; machine intelligence; space and geographic information technologies	Automatic detection of forest cover changes; conservation of forest resources; automation of forestry operations
"Avers"	Forest Inventory System		
ATLAS VR	Virtual platform	Virtual reality technology	Monitoring and demonstration of changes in forestry; assessment of the economic efficiency of involving forests in economic process
Lesvostok.rf	Digital Forest Inventory Platform	Space and geographic information technologies; artificial intelligence; big data	Providing relevant information on forest plots; formation of forest plots, control of their development; evaluation of the effectiveness of woodworking projects
Smart forest	Information system	Space and geographic information technologies; artificial intelligence; big data	Providing open access information about the forest fund; formation of a register of participants in the processes; ensuring transparency of wood turnover; shorter reporting cycle on forest use

Following the example of European countries, in the Russian Federation a state policy on forestry informatization should be developed, as well as a methodological approach to creating a single digital platform, "Digital Forestry". This will ensure sustainable development of forest monitoring, inventory and assessment of forests, as well as forest utilization, based on the provision of complete, reliable and consistent data on the forests of the Russian Federation.

One of the important approaches to sustainable development of the forestry sector of the Russian Federation is voluntary forest certification according to the FSC scheme, which allows minimizing the risks of environmentally and socially irresponsible forest management, when the harvesting and processing of wood is illegal and carried out with violations of environmental and social norms [10]. Forest certificate guarantee that paper and paper products were produced without such violations.

Voluntary forest certification according to the FSC scheme covers all components of sustainable forestry development: the economic component ensures the legality of forest products; environmental, the absence of irreparable damage to nature in the process of harvesting forest products; and social, the absence of damage to local and indigenous people. In addition, the benefits of voluntary forest certification include the competitiveness of certified forest products in environmentally sensitive markets; fast return on investment in certification; and an increased degree of openness of forest relations and the quality of forest management in certified forests.

3.2. Forest conservation and protection
One of the acute problems of the Russia's forestry, which impedes its sustainable development, are forest fires. According to the Federal Forestry Agency, in 2019 about 1% of Russia's forest fund was lost. According to regional dispatch services, by the end of November 2019, 14 409 fires were registred, and the area damaged by fire was estimated at 10.078 million hectares. On top of the list were the Far East (5.9 million hectares in the Krasnoyarsk Territory and Irkutsk Region) and Siberian (4.1 million hectares in the Republic of Yakutia) federal districts. According to various estimates, the total damage from forest fires amounted to 70 billion rubles, when wood alone was considered. These figure does not take into account the loss of extremely valuable forest resources, Red Book listed animals and plants, etc. [11].

A promising area of forest conservation and protection is the development of methods and substances for extinguishing forest and underground peat fires. For the latter, an alternative to water is a special solution that, when interacting with fire, releases gas which fills the entire volume of the peat fire and extinguishes it. It also appears promising to use this solution for fireproof treatment of forests, because the substances that make up the solution have fertilizing properties. Similar technological solutions have been developed by St. Petersburg State Forest Technical University named after S. M. Kirov; unfortunately they have not receive proper attention from relevant ministries and state departments (Rosleskhoz, Ministry of Emergencies) [9].

Given the area of forest fires, it is necessary to create and universally implement digital solutions for monitoring forests and the rapid detection of forest and peat fires. An example of solving such problems is the "Forest Guard" stationary video surveillance system implemented in the Perm Territory. The system provides continuous monitoring of the forest fires in an area of 1.7 million hectares. In addition, a hardware-software complex for forest monitoring and early fire detection "Forest Watch" has been developed in Russia, which allows us to locate the sources of smoke and fire in a radius of 30 km.

3.3. Reforestation and afforestation
Measures contributing to the sustainable development of forestry in terms of reforestation and afforestation are the state forest pathological monitoring carried out by the Federal Forestry Agency "Roslesozashita"; sanitary and health measures (sanitary felling), creation of forest plantations; and assisted natural regeneration (scarification of the top soil layer) carried out by executive authorities.

3.4. Forest education and science
Forest education implies training for the forestry industry; it should cover all levels, from a comprehensive school to higher education institutions [12]. As an example, St. Petersburg State Forest Technical University named after S. M. Kirov insists on the introduction of the subject "Forest Pedagogy" in schools, within the framework of which it is planned to teach the basics of environmentally friendly attitude towards forests [9].

Seventy one Russian university currently provide education in "Technology of logging and wood processing industries" and "Forestry", which belong to the group 35.00.00 "Agriculture, Forestry and Fisheries". The number of students studying forestry is constantly decreasing: in 2019, at St. Petersburg State Forest Technical University named after S. M. Kirov, the number of students was 7.2

thousand, and in 2010, 14 thousand. For comparison, in the 1980th and 1990th the number of students was nearly 19.5 thousand [9].

All-Russia Institute for Advanced Studies for Leading Workers and Forestry Specialists (VIPKLH) implements training programs based on the use of new technologies. The institute opened a specialized computer class with a new GIS software "Panorama", which will help students master the use of geographic information technologies in forestry. Employees of forestry departments in federal districts, the Federal State Budget Institution Roslesinforg and state authorities of the RF constituent entities authorized in the field of forestry receive training at VIPKLH annually.

Despite positive trends, the following negative tendencies in forest education and science of the Russian Federation should be highlighted: insufficient funding for R&D; reduction in the number of research staff in forestry research institutes; aging work force; insufficient number of new and reprinted basic textbooks on forestry disciplines; lack of government subsidies for the maintenance of experimental forestry stations and botanical gardens, etc.

The research potential of universities and research institutes is enormous. They carry out research and development activities in areas that are important for ensuring sustainable development of the forestry of the Russian Federation: extinguishing techniques for forest and underground peat fires; methods of forest transport development and monitoring; environmentally friendly logging technologies; composite materials with high fire resistance and low phenol content; 3D prototyping, etc.

Further development of forest education and science should be based on: an increase in state funding; targeted training of specialists for forestry enterprises; increase in recruitment of operators of forestry machines (harvesters and forwarders); automation and digitalization of education and R&D; the creation of a scientific and educational complex that combines all areas of training in the forest sector; development and approval of an integrated program of forest science and education; creation of an open-access modern scientific and educational infrastructure; allocation of annual grants for the publication of modern basic textbooks on forestry disciplines based on approved plans; distribution of state orders between universities that train bachelors and masters in the field of "Forestry", according to the approved criteria; inclusion a section on forests in the draft state program of the Russian Federation "Scientific and Technological Development of the Russian Federation", and inclusion of the Federal Forestry Agency as a participant, etc.

4. Conclusions

A complex of institutional, organizational and managerial foundations of sustainable forestry development is currently being formed in the Russian Federation, which is aimed at using natural resources and preserving the environment while striving to obtain economic benefits from the exploitation of forest resources in such quantities that would ensure environmental sustainability of forests and their ecological and economic functions (protective, sanitary, health, resource).

The state policy of the Russian Federation should be aimed at the transition to an intensive model of forestry, which implies the use of modern methods of monitoring, assessment and inventory of forest resources, forest management, conservation and protection of forests, and reforestation. This will increase forest productivity and the economic return on forest use, as well as provide intangible benefits, social and environmental. Sustainable development of the forestry of the Russian Federation is most promising. It should be based on the experience of the world's leading countries that actively implement digital solutions in this area.

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