Sustainable development of the timber complex: ecological and economic foundations

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Abstract. The forest management system established in Russia in recent years is characterized by a number of problems, including economic ones. The article reveals conceptual theoretical and methodological provisions for the development of sustainable forest management based on the formation of an appropriate environmental and economic mechanism. The essence of sustainable forest management should be considered in the context of economic, environmental, social and international aspects, taking into account the formation of effective multipurpose use of forest resources, as well as the strengthening of the environmental component in the development of forestry. The ecological-economic mechanism of sustainable forest management is proposed to be considered as a set of resources and methods of their connection in the process of economic, environmental and social forest management through the effective management of forestry activities. The main principles of the formation of the ecological-economic mechanism of sustainable forest management are outlined. Thus, the scattered views on the environmental-economic mechanism of sustainable forest management determine the need to streamline the existing economic methods of forest management, improve the efficiency of forestry activities and develop tools to obtain different types of effects: economic, environmental and social.

1. Introduction

The increase in global environmental problems, the emergence of local crises and accidents of man-made origin, the threat to the survival of humanity have led to the need to reconsider the ways of further development of civilization. Today, ensuring the sustainable development of mankind is the most significant problem facing the world community [1-3]. The regulation of sustainable development in the field of environment and forestry is a central topic. At the same time, the various legal documents issued by legislative bodies and executive regulations adopted by forestry and environmental officials are often not harmonious [4,5]. Sustainable development is a development path that must be based primarily on sustaining the expanded reproduction of productive capacity, human resources and the environment over the long term. It is known that, as a result of long research by the scientific world community, sustainable development is based on a balance between three
closely interlinked system elements: the economy, the social sphere and the environment. The importance of the timber industry in the country’s economy is determined by the fact that, under current conditions, there is no area of the economy where timber and its products do not play a significant role.

The timber complex occupies an important place in the country’s economy, comprising forestry and timber harvesting and processing industries. It plays a significant role in the socio-economic development of many regions and determines the country’s export position in world markets. The main element of the timber complex is forestry. It is an activity to regulate the use of forests and includes forest accounting, forest reproduction, protection and conservation, and control of use in the region. The composition of the timber complex by economic activity is shown in figure 1.

Figure 1. Composition of the timber complex by economic activity in the Russian Federation.

Conventionally, the timber industry can be divided into two integrated groups. The first group can include lumber production and mechanical processing (e.g. furniture production) and the second group includes pulp and paper industry and wood chemistry. Timber complex products are widely used in many industries, construction, agriculture, engineering, printing, trade and medicine. The production and consumption volumes of furniture and paperboard products have a direct impact on the social and cultural development of society.

The basis for the development of the timber complex is the forest resources. These are the forests of a certain area, which are used or can be used to meet any needs of society. In recent decades, the forest products market has seen an increased focus on the environmental aspects of forest product manufacturing. Such trends call for objective and open communication among its participants about the impacts on forest ecosystems, the origin of the timber, production conditions, requirements for exploitation and utilisation, and the like.

However, there are a number of problems related to the lack of transparency and trust among stakeholders, the limited use of modern marketing tools, the slow pace of transformation processes in the forest sector. Environmental issues need to be mainstreamed to regulate and address marketing activities in line with the concept of sustainable development.

Sustainable development is the process of ensuring the functioning of the territorial system with specified parameters under certain conditions during the required period of time, which leads to the harmonization of production factors and improvement of the quality of life of modern and subsequent generations under conditions of preservation and gradual creation of the integrity of the environment [6,7]. Rational use of natural resources is essentially equivalent to the concept of “reproduction of natural resources”, which is interpreted as a triune process: restoration (protection), exploitation, recycling of natural substances.
Experience has shown that the problem of sustainable forest management with the aim of conserving forest ecosystems cannot be solved by restricting and tightening forest use, up to and including exclusion from use (Protected Areas). To solve the problems of timber complex development it is necessary to implement a set of measures aimed at improving and developing the regulatory framework in the field of timber complex and forest management, forest management, inter-agency and interregional coordination in the field of forest relations, increasing the efficiency of activities for the use, conservation, protection and reproduction of forests, scientific and personnel provision of timber complex and expanding the participation of the Russian Federation in international cooperation in the field of forest complex. The mechanism for the establishment of sustainable forest management combines the following main blocks: the system of property relations (national features with their correction for regional specifics); the system of economic interests “about” the environmental and economic process in the timber complex; the system of market instruments (free pricing, competition, development of financial and credit sphere, including taxation); the system of state regulation (federal, regional and municipal level).

As environmental problems increase, forests are no longer perceived by humanity only as a factor of production. They are becoming an important factor for the sustainability of the socio-economic development of countries and territories. In this context, scientists and practitioners have turned their attention to the integrated use of the forest as a recreational resource and as the basis for the conservation of the natural environment.

Different policy documents of the country formulate integrated approaches to forest management. The trend is set by the global community, but has not yet been systematically implemented in the structure of nature management in our country. Domestic scientists pay sufficient attention to the concept of multi-purpose forest management; they point to the need to preserve forest productivity, its ecological and recreational value, relying on the “post-industrial forest” paradigm.

The state, as the main owner of the forest, is responsible for resource conservation. The main disadvantage of state forest management in Russia is high centralization, which hinders effective interaction between state bodies and entrepreneurs [8]. The timber complex appears to be a polycentric system, which complicates its management system, as there are many target parameters and many management centres, which ultimately determines the final efficiency of the management process.

Despite the relevance of the problem of ensuring self-sufficient development and the scientific achievements in this area both in Russia and abroad, domestic science has accumulated little research that considers the ecologization of production as one of the main factors. Ecologization of production in modern economic conditions contributes to the achievement of sustainable development of ecological-economic systems. The debatability and low degree of development of a number of issues, high theoretical and practical significance of the problem under study predetermine the purpose of this study.

The purpose of this study is to systematise the theoretical foundations for the formation of sustainable development of the timber complex and to substantiate the mechanism of environmental and economic management of forests based on the principles of sustainable forest management.

2. Methodology
The theoretical and methodological basis of the study was based on the fundamental provisions of classical and modern economic and management theories, the theory of management and sustainable development of socio-economic systems, including environmental and economic systems, theoretical and applied concepts of state regulation of the economy and ecologisation of production, and provisions on the development of environmental management.

The systematization of theoretical provisions and the development on their basis of the methodology of formation of sustainable development of enterprises of the Russian timber complex became possible through the integrated use of empirical and theoretical methods, levels of knowledge, including a systematic approach, methods of induction and deduction, comparison and analogy.

A variety of research methods and techniques were used in the work:
− general scientific and special methods of cognition: structural-logical method – to build the general structure of the study;
− historical-logical method – to systematise and study the evolution of the content of environmental concepts in the context of global environmental problems;
− comparative method – to study the methodological apparatus for assessing the effectiveness of the processes of ecologization of the world economy system;
− content analysis and bibliographic method – to study current trends in environmental and economic sustainability;
− historical approach – to identify strategic priorities for the development of mechanisms of interaction between economic, social and ecological components of ecological-economic systems of different hierarchical levels;
− graphical method – to visualise the results of the research;
− scientific generalization – to substantiate the conclusions of the study.

The information-empirical base of the study is based on scientific sources in the form of data and information from books and monographs, articles of industry and specialized scientific journals, scientific reports and reports on research work, scientific conferences and seminars; statistical sources in the form of domestic and foreign statistical materials; state, regional and departmental statistics reports; materials of various organizations, foundations, institutions; statistical reports, internal regulatory documents, projects, plans and concepts of environmental and economic programs of individual economic entities of the timber complex; official documents in the form of laws, legislation and other regulations, including resolutions, instructions, reports and projects.

The theory and methodology for solving environmental and economic problems have been developed in studies by both foreign and domestic scientists.

The concept of sustainable development has guided environmental research and become a development paradigm since it appeared in the Brundtland Report in 1987 (WCED, 1987). Since the Rio Earth Summit, the concept has become universally accepted and has been incorporated into international treaties and national constitutions and laws in many countries around the world. It has also been used in issues related to business, agricultural production, industry and urban development and has provided the conceptual basis for theoretical approaches such as green economy (and circular economy [9].

The term “sustainable development” became popular after the United Nation’s Conference on Environment and Development held in Rio de Janeiro in 1992. The Brundtland Commission Report (World Commission on Environment and Development, 1987) made a major contribution by stressing the importance of sustainable development and providing the most frequently quoted definition [10,11].

The starting point for the formation of the theory is the ethical idea of sustainability. It is based on a commitment to future generations and assumes intergenerational equity. In terms of specific resources and services (e.g. freshwater, atmosphere as a carbon sink, a wide variety of ecosystems), it is clear that further growth at this rate of use is unsustainable. The problems on Earth are manifold: underdevelopment, poverty, drought and famine, environmental depletion, waste, unsustainable use of resources, etc.

The goal of Sustainable Development is to solve these problems and to create a situation that will last for all present and future generations, which is known as inter- and intra-generational justice. Sustainable development concerns everyone, it affects every country in the world, all firms, all regions, all cities and all households. Sustainable development is an anthropocentric concept because people are at the centre of concerns. It is also a normative concept. The concept has three main pillars: social, economic and environmental aspects (figure 2).
The economic component is more fluid, while the environmental and social components are relatively conservative. However, they are all interlinked and together create sustainable development goals (figure 3).

**Figure 2.** Interaction of the main components of sustainable development*.

*Source: Prokopyev M and Vitukhin A, 2020 [12].

**Figure 3.** Key sustainable development challenges in socio-environmental-economic interactions.
Thus, Mikulčić H, Wang X, Duić N and Dewil R believe that the integration of energy, water and ecological systems is important in the concept of sustainable development, as they represent the basic life needs of humanity [13].

Fraser J argues to achieve the UN Sustainable Development Goals, an economic governance strategy – “creating shared value” for business is needed [14]. According to Corsi A, Pagani R, Kovaleski J and Silva V, a sustainable development strategy should aim at achieving social development – improving health, quality of life and poverty alleviation [15]. Wong R points to the relationship between a sustainable development strategy and skillful coordination, which is responsive and neutral [16,17].

Domestic scholars distinguish the following approaches in the study of sustainability:

- in the framework of the neoclassical theory – sustainability is characterised as a non-decreasing per capita consumption that depends on a non-negative change over time in the size of the capital stock;
- conservatism approach defines sustainable development as the maximum that can be achieved without reducing a nation’s natural capital assets;
- ecological-economic approach is based on the need to reconcile strict limits on environmental quality with social and economic needs.

In Russia, the open discussion of sustainable development issues dates only to the mid-1990s. In 1996 the first Concept for the Transition of the Russian Federation to Sustainable Development was adopted. In this document, the public authorities justified for the first time the need to balance socio-economic objectives and the problems of preserving a favourable environment and natural resource potential in order to meet the needs of present and future generations of people.

It must guarantee the survival of the country's population and the preservation of the environment. The transition to sustainable development implies a gradual restoration of natural ecosystems to a level that ensures environmental sustainability. But it cannot be achieved by maintaining past stereotypes of thinking that disregard the possibilities of the biosphere and generate irresponsible attitudes among citizens and legal entities towards the environment and environmental security.

Currently, the entire world community is trying to solve the problem of sustainable development and to find mechanisms of purposeful global management of this process. The study of various aspects of environmental management within the concept of sustainable development was carried out by such authors as Bobylev S [18,19].

Studies by researchers such as Anopchenko T, Denisov V, Ilyichev V, Tarasova L, Cheshev A and others are devoted to the problems of providing effective management of ecological-economic interaction [20,21]. Approaches to improvement of methodology of analysis and evaluation of negative impact of technogenic and anthropogenic factors on qualitative parameters of environment are presented in studies of Rozin M, Svechkarev V, Novoseltseva L, Ivanov A and Tumakova Z [22], Tereshina N and Sorokina A [23]. The most adequate conceptual scheme of modelling and analysis of sustainable development management processes of territories, taking into account the interests of the active agents involved, is provided by the theory of active systems (Burkov V, Novikov D, Shchepkin A and others) [24-26].

Among foreign authors, whose works are devoted to the issues of sustainable development and problems associated with the transition to it should be noted Brundtland G [27], Meadows D [28], Randers J [29], Forrester J [30], Tinbergen J [31].

The study of sustainable development of the forest industry, the formation of its economic, social, environmental problems in market conditions, the foundations of management and implementation of forest policy are devoted to the works of foreign scientists, such as Martins I [32], Baumgartner R [33], Bennich T [34], Hurditch W [35], Howes M [36], Dai L and etc. [37], Kazana B [38].

Scientific developments of domestic and foreign scientists are of constructive theoretical, conceptual and practical importance. They are characterized by the breadth and validity of scientific provisions for solving the problems of sustainable spatial development of forestry. At the same time, the formation of modern continuous forest space requires a deeper study of forest resource potential as
a spatially formed object in relation to the subsystems of national (regional) economic (economic) space.

3. Results and discussion

Forestry production as a special branch of the economy has developed as a result of the use of natural forests. It forms the basis of timber complex and has its own characteristics:

− need for large production areas, which significantly exceed the requirements for the areas of other sectors;
− connection of the labour process with the biological processes of growth and development of woody plants;
− diversity of forest products and their usefulness;
− forest in forestry production is the subject and means of labour;
− seasonality of forestry works;
− organisation of forestry production is carried out taking into account the soil and climatic zones.

The specific features of timber complex are the environment-forming role of the forest as a component of the biosphere, the ability of the forest to regenerate naturally, the long duration of the production cycle of the economy, the zonal differences of forests, the complexity and dynamics of the relationships between the components of forest ecosystems, the uneven distribution of forests over the territory, the integrated and environmentally safe use of forest resources in the national economy. The organisation of timber complex aims to ensure forest management based on the principles of sustainable development, taking into account natural and economic conditions, the intended use, forest site conditions, the species composition of forests, as well as the functions they perform. The main directions of timber complex development are protective; protective-operational; operational-industrial; and industrial.

The lands of the forest fund on the territory of the Russian Federation constitute more than 65% of the total area of its land fund and almost ¼ of all forest resources of the planet. The timber complex of the Russian Federation is one of the world’s largest in terms of timber production. Strategic and current forest management plans are linked to the development of the global and national forestry sectors. In turn, this raises the issues of organizing their use and their protection, the economic, social and environmental feasibility of the development of the timber complex in the regions of the country. Achieving a certain balance between the use of forest land and the forests that grow on it is a problem that has been raised by scientists and researchers both in Soviet times and at present. These issues have become particularly acute in the period of ongoing economic reforms. Intensive, wasteful use of forest lands, non-compliance with sanitary and fire protection measures, squatting of forest lands (especially in water protection zones), unauthorized logging, and failure to carry out forest land reclamation have led to a deterioration of the ecological condition of forests and lands, and to enormous economic losses.

Numerous United Nations documents consider the concept of sustainable, socially beneficial, environmentally acceptable forest management, economically justified development of the timber complex. From these positions, the reform of the forest policy of the Russian Federation is being carried out. At the same time, there is a very important problem that is directly related to the way the state manages the lands of the forest fund and the forests that grow on them, as objects of federal state property rights.

The intensive timber complex model and its accompanying compulsory elements as a technical basis for reforms, as well as projects for the transfer of forest land to concessions and private ownership, meet considerable resistance. The problem of transferring forest land to other categories of land for more efficient use of the site, capable of preventing forest decline, becomes especially urgent in connection with the intensive use of forest land and, above all, for the development of various business projects. Against this background, the key contradiction in forest management continues to be the contradiction between environmental and economic priorities in the development of the timber
complex. At the heart of this situation is inefficient forest land management. The increasing role of the environmental factor in forest management processes is due to the trends of forest ecologization and the increasing importance of the socio-ecological functions of forest resources. This, in particular, requires the development of elements of environmental management in forestry, a mechanism for socially responsible forest management and the formation of an environmental-economic knowledge management system.

The transition from nature management to sustainable nature management as a new socio-economic paradigm necessitates a more meaningful definition of the principles, directions and mechanisms for the formation of environmentally responsible forest management. We consider forest management as a social, material and spiritual system capable of self-development. It is created and developed through the involvement and use of the components of the forest resource potential, as well as the intellect and spirituality of society in order to create and harmonize living conditions, as well as to satisfy its interests and the needs of society, in accordance with the laws of functioning of forest ecosystems in the system of economic relations.

The ecologization of the timber complex is a way to implement the principles of achieving the parameters (criteria and indicators) of sustainable reproduction and use of forest resources and determines the need for the implementation and functioning of the ecologically-oriented forest management system. Based on the analysis and synthesis of existing views on the system of nature use and management, the following types of ecologically-oriented forest management can be distinguished: ecological management; ecosystem management; ecological-economic management.

We propose the following mechanism for the ecological-economic management of forests, based on the following components:

- principles of sustainable forest management, oriented towards achieving stability in a certain area of economic, environmental and social activities, interrelated, i.e. by affecting one of the areas of activity, each of the principles indirectly affects the others;
- monitoring the state of forest resources and their use on the basis of a system of ecological and social criteria and indicators for sustainable forest management;
- ecological and economic assessment of the value of forest resources, which allows to characterize not only the resource potential, but also the services and usefulness of the forest;
- legal regulation of forestry activities, which implies a differentiated approach to areas with different degree of forest cover;
- system of strategic and operational management of forestry activities aimed at the conservation and development of forest resources.

The economic mechanism of the sustainable forest management model consists primarily in the distribution of rent income from the intensification of forest use between the state, as the owner of the resource through the minimum value rates of standing timber (absolute rent), and the tenant (investor) who exploits the forest area (differential rent by position and fertility) (figure 4).

Thus, the reproduction of forest resources is ensured and the investment attractiveness of the industry is preserved. The application of intensive forest management increases the rent value of the forest and the volume of harvesting per unit area, thereby providing a guaranteed income to the state and the lessee and creating incentives for sustainable forest management.

Regarding the implementation of the foundations of the organizational mechanism of the sustainable forest management model, it is necessary to implement a fundamentally new zoning of the forest fund area based on the principles of landscape planning, to develop new regional standards for logging and reforestation with this in mind, and to form strategic forest plans. In addition, it is necessary to introduce compulsory certification of forest products, which will ensure a significant reduction in illegal logging. These measures will make it possible to form an optimal structure of the regional forest fund, to ensure its reproduction and protection.

The legal mechanism is a system of state regulatory measures. It is based on a pre-developed state policy, agreed and adopted at the federal and regional levels.
Sustainable development of the timber complex: an environmental and economic foundations

The system’s approach: the main lines of development

Economic: improving efficiency, final position, risk reduction, fair distribution of profits, assessing and realizing synergies

Production: renewal of fixed assets, new technologies, capacity utilization, re-engineering and restructuring, supply chain development

Organizational and managerial: development of organizational structures, centre models, self management, contractual relations, CRM certification, quality system, integration design

Innovation, investment and finance: consolidation, integration of investment projects, growth in processing, adaptive technologies, investment funds, IPOs, umbrella structures

Regulatory and institutional: development of laws, codes of conduct, contracts, organizational culture, legal business protection, infrastructure and infostructure

Socio-environmental: socially and environmentally responsible business, sustainable development principles, occupational health and safety, PR development, democratization, public scrutiny

Organizational and economic management mechanism

The strategy (priorities and guidelines) for the development of the forest sector of the economy:
− advanced development of timber processing;
− indicators, directions, milestones, factors and interinlncages (Balanced Scorecard – BSC)

Economic methods: taxation, forestry payments in relation to investments in processing, investment funds, IPOs, Profit distribution mechanisms, economic evaluation of synergies and integration efficiency, staff incentives

Organizational methods: holdings, associations, processing centers, cluster, corporation, contractual relations, centre models, voluntary certification, megaproject, investment project package, project management, agreement system, lobbying

Legislative, institutional, support: corporate laws, property protection, codes of conduct, business culture and ethics, legal business protection skills, enforcement, umbrella structures, contract, contract institution, confidence building, IC image support

Information support: “electronisation” of all aspects of business, availability of information, monitoring of investment attractiveness of enterprises, regular evaluation of investment potential, objectivity of forest data, forest cadastre

Financial support: centralized financing of timber complex in order to ensure a balance of income and expenses; consolidation of funds: for the maintenance of environmental protection and restoration of depleted operational forests

**Figure 4.** Environmental and economic mechanism for sustainable forest management.
Forest legislation implements state forest policy through a package of normative legal acts, which are implemented, in turn, through relevant rules, guidelines and instructions regulating the specifics of forest management, taking into account the intended use of forests, natural and economic conditions. The financial and investment mechanism of the sustainable forest management model includes centralized forest financing to balance revenues and expenditures, as well as the consolidation of funds for the maintenance and rehabilitation of depleted commercial forests.

Thus, the ecological-economic mechanism of sustainable forest management is proposed to be considered as a set of resources and methods of their connection in the process of economic, ecological and social forest management through effective management of forestry activities. The main objectives of timber complex restructuring should be considered as improvement of forms of ownership of forests and forest lands; restructuring of financial support structure; development of infrastructure, including social and marketing; improvement of organizational structure of forest management. Public institutions and economic entities, despite often opposing orientations of their interests and functions, have similar institutional frameworks in the methodological aspect. This is an important factor in the development of institutional support for the protection, use and reproduction of forest resource potential (expansion of the forest area, increasing its productivity, increasing the forest resource base to meet the needs of consumers at the expense of their own resources and improving the overall environmental situation).

Currently, there is no comprehensive approach to the organization of sustainable management of the timber complex, the formation of its development goals, as well as the planning of forest conservation, protection, reproduction and use at the federal and regional levels. The formation of goals and priorities for the development of the timber complex is currently carried out in the absence of up-to-date information on the country’s forest resources. The organisation of the integrated use of forest resources at both federal and regional levels is based on a systematic approach. Forest management is viewed as a single system, taking into account the links between the various elements, as well as external links with other systems. The procedural nature of the system is expressed in the fact that it is in a continuous process of formation and acquisition of new properties. The state programs “Development of Forestry” and “Development of Industry and Improvement of its Competitiveness” do not correlate with each other [39,40]. Strategy 2030 also aims at achieving two separate objectives (in the field of forestry and in the field of forest industry) and does not take into account cross-sectoral issues, e.g. the focus of reforestation activities in areas of intensive forest use, where there are no forest resources but forest farms; the strengthening of control of forest use in areas of intensive use and development of the forest industry, etc. The parameters of the state forestry programs at the federal and regional levels are insufficiently consistent with the parameters of the strategic documents. The regional level does not fully decompose the goals, objectives and target indicators defined at the federal level in the state program “Development of Forestry”.

4. Conclusion
Thus, further improvement of theoretical and methodological approaches to forest land management, their rational use taking into account the positive historical experience in the country, including foreign, is one of the main elements of effective and sustainable development of timber complex, rational use and protection of forest land.

The priority direction of development of timber complex is the increase of production efficiency on the basis of improvement of its structure, intensification of production potential, achievements of scientific and technological progress, rational and complex use of forest resources. Of particular importance will be the improvement of quality, consumer properties and competitiveness of products, strengthening of export potential. The concept of sustainable forest management and development of timber complex is an integral ideology of rational use, reproduction and protection of forest resources. Timber complex is a specific form of a broader interpretation of sustainable forest management, forestry activities, and determines the organizational-economic and organizational-social forms of implementation of environmentally-oriented management.
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