

AN INTEGRAL MODEL OF SUSTAINABLE FOREST MANAGEMENT IN THE CONTEXT OF NATURAL CAPITAL THEORY

ІНТЕГРАЛЬНА МОДЕЛЬ СТАЛОГО ЛІСОВОГО ГОСПОДАРСТВА В КОНТЕКСТІ ТЕОРІЇ ПРИРОДНОГО КАПІТАЛУ

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Formation of the sustainable development concept was influenced by many economic theories, but most often it is interpreted as an idea of capital preservation in the works of environmental economists [3, 15, 18, 19]. The key to understanding these ideas is a notion that support of a certain prosperity level now and in the future is identified as the preservation of human capital which consists of natural, human and man-made capital.

Forest management as well as the whole sphere of natural resources usage reflects the type, direction and dynamics of human interaction with the environment. At the turn of the millennium understanding of the fact that forest is an environmental foundation for natural landscapes and the primary stabilizing element of their sustainable development has become a crucial component of the strategy of environmental survival of humanity. This in turn caused a number of different concepts, theories and trends of forest management development to emerge as well as prompted the need to reevaluate fundamental principles and approaches of forest production development.

Theory of natural capital is one of the most effective methodological tools for researching the transformation processes in the field of forest management relations, and utilizing possibilities for their aggregation and generalization in order to develop an integrated concept of sustainable forest management.

The difficulties and shortcomings of forest management transition towards the principles of sustainable development, reformation of public administration and modernization of the forestry sector of economy are covered by the fundamental and applied research conducted by Y.Koval, E.Mishenin, I.Antonenko, I.Lytsura, Y.Tunytsya, I.Synyakevych, O.Furdychko, A.Deyneka and others.

In the works of O.Veklych, L.Hryniv, N.Malyuga, I.Zamula, L.Melnyk, L.Maksymiv, I.Synyakevych, the theory of natural capital serves as a theoretical and methodological foundation for transition to the principles of ecologically sustainable management of natural resources [1; 2; 6-9]. In particular, one of the key research directions is to include natural capital into the national accounts system and to consider the value contribution of ecosystem goods and services for the biosphere and for assimilative capacity of the environment.

Despite a wide range of research conducted on the value estimation of forest ecosystems in the system of relations between production and transformation of forest management into sustainable development principles, formation of an integrated model of sustainable forestry in the context of natural capital theory is highly relevant.

Research purpose – analyzing and summarizing the theory, concepts and models of forest management transition to sustainable development principles, searching for an integrated management model adapted to Ukrainian conditions and features in the context of natural capital theory.

The main condition for sustainable development in its most general form is to use only an “interest” on natural capital. This condition is further extended and detailed in such terms as weak, strong and critical sustainability.

According to D. Pearce and G. Atkinson, sustainability of an economic system is achieved when: the share of savings is greater than the total level of natural and man-made capital depreciation; capital volume is stable over time; consumption per capita does not decrease over time [19]. Moreover, support of the sustainable level of aggregate capital can be achieved by partial or complete transformation of natural capital into man-made, assuming a high level of their substitution, is called weak sustainability.

On the contrary to “weak sustainability” there is a “strong environmental sustainability”, which implies that no reduction of natural capital can be compensated by any increase in man-made capital. In other words, it is impossible to substitute two types of capital, meaning reduce environmental quality by increasing production and consumption.

The different categories of asymmetric approaches led to the formation of a different direction of ecological sustainability – critical, which allows for a partial substitution of different types of capital and therefore to some extent determines the ecological corridor within which the process of economic development may take place. Thus, solving different issues of sustainable development is associated with deciding what should be the minimum amount of natural capital required to maintain sustainable levels of natural and human life and how man-made capital can substitute non-renewable natural capital and degraded environment [2].

Methodological basis of traditional forest management is formed on the principle of non-exhaustive, continuous and uninterrupted forest usage, which is called “sustainable harvesting” in the Western literature.

Its practical reflection was a deterministic in its essence model of a normal forest, which implied the presence of equal shares of stands of all age classes at a forest management unit. Implementing the ideas of a normal forest is mainly related to correspondence between spatial and temporal aspects of forest management, in particular it is impossible for the volume of wood removed to exceed the average growth rate. Such way of organization in forest management production coincides with the basic condition for natural capital preservation, and in its essence it is a **single-purpose forest management**.

Later the ideas of permanent and sustainable use of wood have been transferred to all forest resources and their useful properties in order to meet

the environmental, economic and social needs of the society now and in the future [5]. They may be referred to as **multi-purpose forest management**. However, if the first model implied maximizing revenues from the use of main resource – wood, the following model implied maximizing economic benefits from all forest resources and their useful properties. In this case the condition for preserving natural capital (forest) has been enhanced by environmental and social constraints in forest management.

At the same time forest management has witnessed the implementation of a theory of maximizing the expected value of the land,

In the context of analyzing concepts, approaches and models of forest management development, methodological tools have been enriched by such concepts as substitutional and critical natural capital. Forest management of Ukraine is characterized by a gradual, but unjustified transformation of critical natural capital into substitutional. Formation of an integrated model of sustainable forest management is an urgent issue, for which a conceptual functional scheme has been developed in this article.

У контексті аналізу концепцій, підходів і моделей розвитку лісового господарства, методологічний інструментарій збагачено поняттями субституційного і критичного природного капіталу. Лісове господарство України характеризується поступовою, але не виправданою, трансформацією критичного природного капіталу у субституційний. Нагальним є формування інтегральної моделі сталого лісового господарства, концептуальна схема функціонування якої була сформульована в статті.

implementation of which allows a full depletion of forest ecosystems' natural resources given their high opportunity cost [12]. Time inconsistency of the effect and expenses that caused it requires considering time in forest management. Solving the task of finding rotation period based on maximizing present land value provides for full or partial substitution of natural capital into man-made, which coincides with the notion of weak sustainability. Forest management based on the criterion of maximizing land value is called **economically efficient forest management**.

The expansion of the global ecological crisis caused, in particular, by predatory forest destruction as well as by development of holistic and synergetic theory of building relationships between society and nature, led to the transformation of classical principles of sustainable and non-exhaustive forest management to the basis of sustainable development. The impetus for this were the conference in Rio de Janeiro on Environment and Development (1992), international conventions, agreements and initiatives on environmental protection, biodiversity preservation, forest protection and sustainable use of forest resources. The main challenge for the future development of forest management is the need to meet growing needs in both raw materials, including wood resources, and environment-generating functions of forests.

Formalizing the provisions of the sustainable forestry concept has been complicated by a very broad and comprehensive list of sustainable development principles. The Declaration of the Conference in Rio formulated 27 principles [20]. At the same conference there were separately prepared 15 forest principles which have not received an official status [17].

Framework principles of sustainable forest management concept led to the formation of different models of forest management, all or some aspects of which fully or partially meet the key characteristics of sustainable development. It would be appropriate to distinguish at least three models of forest management: **adaptive forest management, sustainable forest management and ecosystem approach to forest management**.

Adaptive forest management means "a dynamic approach to forest management in which the effects of treatments and decisions are continually monitored and used, along with research results, to modify management on a continuing basis to ensure that objectives are being met" [14]. This is a continuous process of evaluating the effectiveness of forest management and adjusting management decisions with regard to the new circumstances. It includes the following stages: planning; preparing forest management guidelines, directives and measures for their implementation; monitoring (collecting information about the results); evaluating achievement of goals and objectives; adjusting plans, guidelines and activities; reporting to stakeholders and society.

This model should not be assessed with the methodological tools of natural capital. At the same time it is distinguished by the ability to adapt training system and decision-taking process to permanent changes in the inner relations within the structure of natural objects and external factors.

The next model of sustainable forest management is a direct consequence of implementing the ideas of sustainable development into forest management by forming a system of criteria and indicators which are to assess the type and direction of forest management transformation as well as effectiveness of implementing sustainable development principles. Among eight initiatives and processes of developing and implementing criteria and indicators for sustainable forest management, that cover over 150 countries, we should distinguish activities within the framework of ministry conferences on forest protection in Europe [16]. Despite the differences in climatic and socio-economic conditions of forest management, all initiatives have in common the following areas: extent of forest resources; biological diversity; forest health and vitality; productive functions of forest resources; protective functions of forest resources; socio-economic functions; legal, policy and institutional framework [22].

Even though model of sustainable forest management does not detail the principles of sustainable forest management, it is more consistent with the concept of critical sustainability, when there is a possibility to transform natural capital into man-made, but not below a certain limit which indicates inevitable destructive changes in the environment.

An *ecosystem approach* was formulated at the Convention on Biological Diversity [4] as a way of interaction with ecosystems and their use, which

guarantees protection, maintenance and, where appropriate, restoration of biological diversity – from genetic and species level to a group level.

It provides a long-term conservation of forest functions at all spatial levels of organization and finding ways to support (within ecological limits) diversity in using forest landscape. In other words, the ecosystem approach focuses primarily on what remains after using resources and not on what can be extracted without harming ecosystems. The ecosystem approach aims at preserving the composition, structure and functions of forest ecosystems at all levels of spatial and temporal organization [13].

Priority of preserving forest ecosystems is an evidence of its compliance with the concept of strong sustainability, and therefore restrictions on forest use which disable substitution between the two types of capital (natural and man-made), meaning reducing environmental quality while increasing production and consumption of forest products.

It would be wrong to believe that the principle of substitution is completely unsuitable for a strong environmental sustainability. It is impossible to imagine the development of a complex natural system which would not be accompanied by stochastic changes that may be identified as the degradation of the environment. Moreover, there are many examples where intensification of use and thus amortization one type of natural capital helps to reduce load, meaning to restore the ecological capacity and productive ability of the other one.

Therefore, a retrospective analysis of forest management development suggests rethinking of the role and value of forests – from merely wood provision to the global factor of ecological safety and a source of essential goods for humans. This goes along with the need to provide forest as natural capital with various properties, and hence distinguishing several types of natural capital is appropriate. It is proposed to distinguish such types of natural capital: *substitutional and critical*.

Substitutional natural capital is proposed to refer to such natural resources and related environmental conditions that inherently generate a continuous stream of goods for the biosphere and human needs, the economic effect from transforming into other types of capital or degradation of which would exceed the current and expected ecological loss in the future. An example of substitutional natural capital can be artificially created forest cenosis: commercial forests and forest plantation. These forests serve mainly for raw material functions and, therefore, in the case of their complete transformation into other types of capital, other functions, such as environmental, social and ecosystem, will be placed solely on critical natural capital.

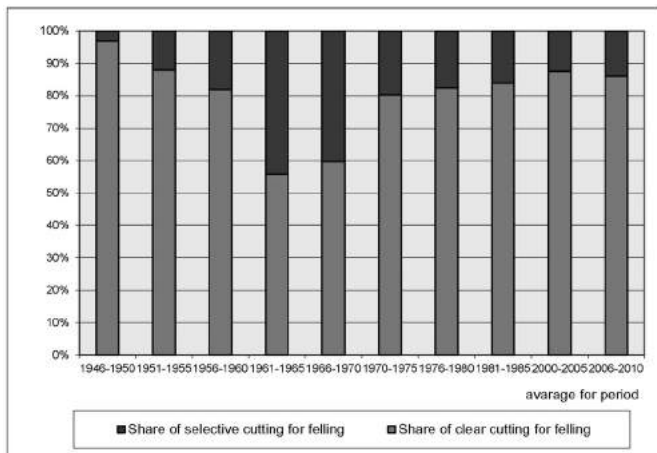
Critical natural capital is proposed to refer to such natural resources and related environmental conditions that tend to generate a continuous stream of goods for the biosphere and human needs now and in the future, transformation into other types of capital or deterioration of which cannot be compensated by other types of capital, and socio-economic and ecological effects of which lead to a narrowing of ecological parameters of ecosystem functioning at the global, regional and local levels, as well as prevent multiple directions of their development. Thus, critical natural capital can consist of natural forests that face minimal human interference and perform important ecological and social functions. According to the functional classification such forests include mainly forests of environmental, scientific, historical and cultural significance, as well as some recreational and protection forests [11].

To some extent this division is consistent with the classification of natural capital on wild (natural) and produced (cultivate) assets [6].

Development of forestry in Ukraine was influenced by all of the above concepts and models. Thus, lack of balanced forest management policy, inadequate financial and economic mechanism, institutional structures that are weak and not ready to implement innovative development strategies have caused errors in the organization of forest production and in the formation of agricultural approach to forest management: «planting – harvesting.» An evidence of such approach is a dynamic ratio of clear and selective cutting for felling over more than half a century period (Figure 1). This trend has a more anthropogenic rather than a natural origin. Share of selective cutting for felling ranges from 5 to 20 per cent, except for 1960's. Despite the significant growth of multi-purpose forest areas (for protection, recreation, conservation, etc.), forest management technology remains undivided. A large number of

Fig. 1. Ratio between clear and selective cutting for felling based on cutting area

Рис. 1. Співвідношення суцільних і вибіркового рубок головного користування за площею



environmentally oriented cutting in 1960's does not match the rate of natural regeneration for the analyzed period.

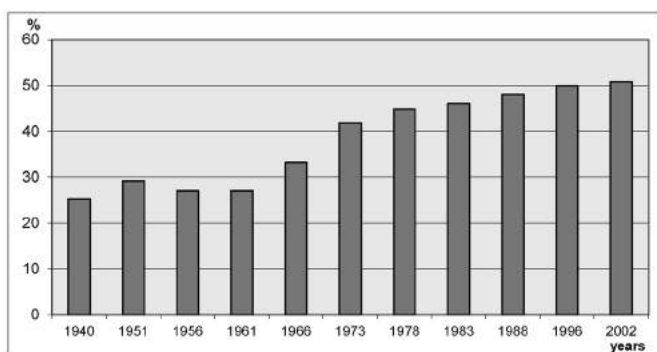
During the indicated period has also significantly changed, nearly doubled, the ratio of wood, received from cutting for felling (in commercial forests) to intermediate and other cutting correspond with forestry management – from 0,83:0,17 in 1950's to 0,44:0,56 in the first decade of this century. This indirectly points at the reorientation of wood extraction from commercial forests on to the whole forest fund, regardless of the functional purpose of forests. An additional evidence of this can be the dynamics of intermediate cutting ratios and other cutting related to forest management. If the proportion of sanitary cutting in the early 1950's averaged 35%, over the period 2006-2010 it he has reached 66%.

Thus, despite the general decrease in the intensity of forest use from 125% to 57% (load on forest ecosystems) over the analyzed period, the anthropogenic load on forests has shifted from mature commercial forests to the vast majority of other forests with different functions and age groups.

Another consequence of a false forest management strategy is the gradual transformation of critical natural capital into substitutional by replacing natural forests with those of artificial origin. During the period from 1940 to 2002 the share of forest plants has increased from 25 to more than 50 per cent (Figure 2). According to research of S.Popovych [10], such a change of multi-dominant natural forests to derivative single-dominant plants with unstable coenocultural structure caused the degradation of ecological relationships, simplification of coenocultural structure, poorer floristic composition and disappearance of some rare species.

As a result, according to the FAO/ECE forest classification by the level of disturbance, the largest share in Ukraine have the semi-natural forests – 95.3%, forest plantations – 4.1%, while undisturbed by man forests in Ukraine account for only 0.6% [21].

Fig. 2. Dynamics of the share of artificial forests
Рис. 2. Динаміка частки лісів штучного походження



Therefore, underestimating the potential of forest production intensification on lands that are no longer used for agricultural purposes, based on theoretical provisions of maximizing the land value, has caused formation of the forest sector of economy with its distinct feature of transforming critical natural capital into substitutional natural capital.

The reasonable approach to divide natural capital (on critical and substitutional) finds its confirmation in the existence and development of the opposing models of forest management, methodological principles of which are consistent with respective categories of natural capital. Thus, we can conclude that it is impossible to apply only one of the models of forest management. Only a combination of concepts, models and areas of forest management development, that take into account the pace of market transformations and systems of governmental regulations, will ensure its modernization on the basis of sustainable development, or in other words will ensure the preservation and maintenance of natural capital.

It is urgent to distinguish a forest management model that would contain the key provisions of various models of forest production in order to balance the economic, social and environmental benefits. Due to its content, this forest management model is *integral and makes up a system of relations of social production, which ensures production of forest raw materials as well as ecological and ecosystem services to meet the needs of present and future generations in the light of constant changes of natural and social systems*. The main condition for the functioning of this model is ensuring reproduction of substitutional capital as well as protecting and preserving critical natural capital.

The vast majority of private goods and services (wood) is proposed within the framework of economically efficient forest management, while the production of environmental and ecosystem services should be made using models that imply ecosystem approaches of forest management. The relationship between components of an integrated forest management model, types of capital and wealth produced is depicted in the **fig. 3**.

The implementation of an integrated model of forest management considering permanent changes in the natural and social systems seems possible based on the theoretical provisions of adaptive management. The model contains three components that are related to the forests' forms of ownership. First one – based on the state forest ownership, it allows to consider a wide range of stakeholders' interests in resources and useful properties offered by forests for society needs, as well as to consider preservation of other functions in order to provide mainly environmental and ecosystem services and, therefore, implies implementing an ecosystem approach in forestry.

Lack of market for a vast majority of produced services causes the use of direct budgetary financing for forestry activities or leads to establishment of an adequate system of tax breaks and economic incentives. The second model component is based on community property on forests, focused mainly on meeting the needs of local communities. In this case the most suitable is a multi-purpose forest management, which would provide production of mainly environmental services and raw material resources. The third component is associated with the development of the private forest management institute according to which

Fig. 3. Conceptual diagram of relations between components of an integrated model of forest management, types of capital and produced goods

Рис. 3. Концептуальна схема зв'язку між складовими інтегральної моделі лісового господарства, видами капіталу та продукованими благами

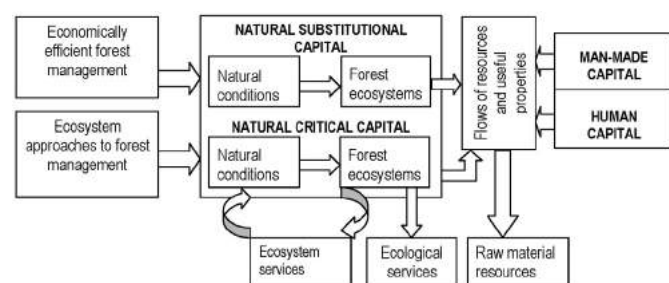
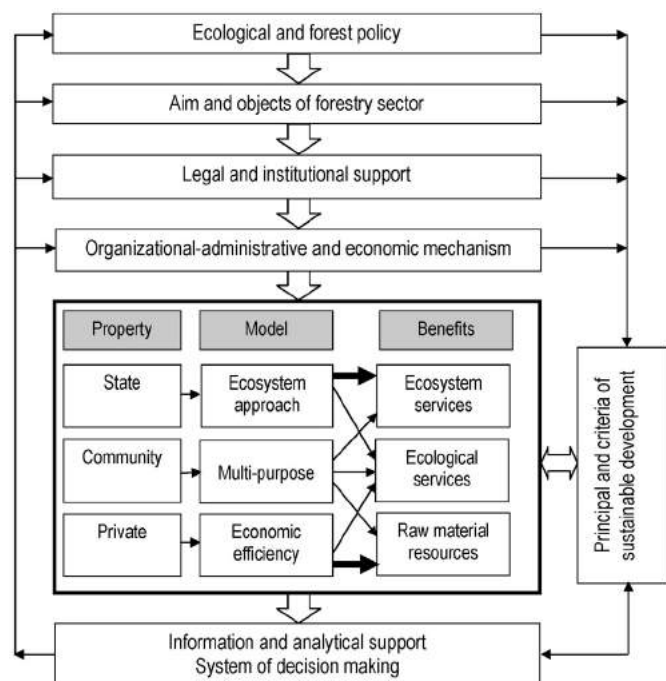


Fig. 4. **Conceptual diagram of an integrated model of sustainable forest management**
Рис. 4. **Концептуальна схема інтегральної моделі сталого лісового господарства**



economically effective forest management would provide a maximum return on invested capital and will respond quickly to the needs of forest markets (fig. 4).

If the first two components received their legal, institutional, financial and economic provision and support, the last one is still more of a declaration. At the same time, attracting investments and transition to an innovative way of development in forest management is related to the formation of plantation forests' networks for special purposes.

The system of adaptive management will play an important role, as it is becoming a driving force for aligning the legal and institutional spheres, organizational, managerial and economic mechanisms, the system of informational and analytical provision, monitoring and support for management decisions in accordance with the principles, criteria and indicators of sustainable development and with the changes that take place in politics, goals and tasks of forest production.

The main ideas

The theory of natural capital serves as a methodological tool for dealing with various concepts, approaches and models of forest management in the context of sustainable development.

It is appropriate to use not one, but several models of forest production, which together constitute an integrated model of sustainable forest management.

There is an urgent need to develop the institute of private forest management, functioning of which will distinguish substitutional natural capital that is to take off the economic burden on natural and semi-natural forests that serve mainly ecological and social functions.

New scientific findings

For the first time methodological tools of the natural capital theory were used for analyzing and processing concepts, approaches and models of forest management.

Definitions of substitutional and critical capital have been proposed on the example of forest ecosystems.

A conceptual functioning scheme was formed and drafted for an integrated model of sustainable forest management.

CONCLUSIONS

Forest management is a reflection of the transformation of social relations and human ideological beliefs about place and role of forests – from the

source of wood and other raw products to the determining factor of biosphere stabilization and the ecological safety of civilization.

The concept of sustainable development has provided additional impetus to the emergence of different models and directions for modernizing forest management. However, none of them fully covers all the principles of sustainable development.

Selecting models of forest management should be based on criteria of the natural capital theory and the conditions of strong, weak and critical sustainability. Therefore, it is proposed to distinguish the concepts of substitutional and critical natural capital.

Modern forest management that is experiencing impacts of various concepts and theories of economic development remains the dominant model of multi-purpose forest management, the failures in the implementation of which resulted in a gradual and irreversible transformation of critical natural capital into substitutional.

In the conditions of simultaneous growth of needs in raw material resources as well as in environmental and ecosystem services that are in conflict within a particular model, it is appropriate to combine and merge the individual models and adaptive management to form an integrated model of sustainable forestry.

Permanent changes in the natural and social systems cause the need for constant adaptation and improvement of the basic principles of forest production.

REFERENCES

1. O.Veklych. *Natural capital as a basic component of economic development of Ukraine* / O.Veklych, T.Yaheyeva // *Economy of Ukraine*. – 2004. – № 12. – P. 73-80.
2. Hryniv L.S. *Theoretical and methodological principles of forming an ecologically balanced economy: Thesis. Doctor of Economics: 08.08.01. / Hryniv Lidia Svyatoslavivna*. – Lviv, 2002. – 343 p.
3. Daly H. *Beyond growth. The Economics of sustainable development* / H.Daly, [Translation from English: Institute for Sustainable Development]. – K.: Intelsfera, 2000. – 312 p.
4. *Convention on Biological Diversity: The Law of Ukraine on November 29, 1994, № 257/94-VR Eelectronic resource*. – Retrieved from: http://zakon.rada.gov.ua/cgi-bin/laws/main.cgi?nreg=995_030.
5. *Forest management at the turn of XXI century* / [A.I.Isaev, S.G.Sinityn, V.I.Suhyy, I.V.Holovyhyn and others], ed. A.I.Isaev. – M.: Ecology, 1991. – T. I-II. – 334 p.
6. *Forest Policy: Theory and Practice: monograph* / [I.M.Synyakevych, I.P.Solovey, O.V.Vrublevska, A.M.Deineka and others], Ed. I.M.Synyakevych. – Lviv: Pyramid, 2008. – 612 p.
7. Maksymiv L.I. *Forests as part of natural capital: some approaches to expansion of the national wealth index* / L.I.Maksymiv // *Scientific paper UkrDLTU: Collection of scientific works*. – Lviv, 2004. – Vol. 14. 1. – P. 160-167.
8. Malyuga N.M. *Natural capital: identification and accounting* / N.M.Malyuga, I.V.Zamula // *Bulletin of Economic Sciences of Ukraine*. – 2010. – № 1. – P. 66-71.
9. Melnyk L.G. *Environmental economics and environmental management: [tutorial]* / L.G.Melnyk, M.K.Shapochka. – Sumy: University Book, 2005. – 759 p.
10. Popovych S.Y. *Synphitosozology of Ukrainian forests* / S.Y.Popovych. – K.: *Academperiodicals*, 2002. – 228 p.
11. *About introducing amendments to the Forest Code of Ukraine: Law of Ukraine from February 8, 2006, № 3404-IV* [Electronic resource]. – Retrieved from: <http://www.zakon1.rada.gov.ua/cgi-bin/laws/main.cgi>.
12. *Environmental economics and economics of natural resources. An introductory course: manual* [ed. A.A.Holuba, H.V.Safonov]. – Moscow: SU VSE, 2003. – 268 p.
13. *An ecosystem approach to forest management: Basic concepts and scientific basis. The Silva Forest Foundation*. [Electronic resource]. – Retrieved from: www.silvafor.org/assets/silva/PDF/Russian/SILVA-ECOAPP-1997-r.pdf.
14. *Adaptive Forest Management. Forest Encyclopedia Network* [Electronic resource]. – Retrieved from: <http://www.forestencyclopedia.net/p/p1286>.
15. Costanza R., Daly H. *Natural capital and sustainable development* // *Conservation Biology*, 1992. – 6. – P. 37-46.
16. *Ministerial Conference on the Protection of Forests in Europe* [Electronic resource]. – Retrieved from: http://www.foresteuropa.org/eng/What_we_work_for/Sustainable_Forest_Management/.
17. *Non-legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable development of All Types of Forests. Report of the United Nations Conference on Environment and Development. Annex III. A/CONF.151/26 (Vol. III)*. [Electronic resource]. – Retrieved from: <http://www.un.org/documents/ga/conf151/aconf15126-3annex3.htm>.
18. Pearce, D.W. *Economics of Natural Resources and the Environment* / D.W.Pearce, R.K.Turner. – London: Harvester Wheat sheaf, Hertfordshire, 1990. – 378 p.
19. Pearce D.W. *Measuring sustainable development*. In: D.Bromley (Editor) *Handbook of Environmental Economics* / D.W.Pearce, G.D.Atkinson. – London: Basil Blackwell, 1995. – P. 10-12.
20. *Rio Declaration on Environment and Development. Report of the United Nations Conference on Environment and Development. Annex I. A/CONF.151/26 (Vol. I)* <http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>.
21. *State of European's Forests 2007. The MCPFE report on sustainable forest management in Europe. Ministerial Conference the Protection of Forests in Europe. Warsaw: 2007. – 247 p.*
22. Wilkie M.L. *Sustainable Forest Management and the Ecosystem Approach: Two Concepts, One Goal. Forest Management Working Paper* / M.L.Wilkie, P.Holmgren, F.Castaneda. – Rome: Forestry Department. FAO, 2003 [Electronic resource]. – Retrieved from: www.fao.org/forestry/6417-0905522127db12a324c6991d0a53571fa.pdf.