

## Forest Ecosystem Services in the System of Sustainable Forest Use of Sparsely Forested Regions of Russia

N.N. Kharchenko, S.S. Morkovina, D.Y. Kapitonov and O.S. Lisova  
Voronezh State University of Forest Engineering, Voronezh, Russia

**Abstract:** Ecosystem functions of forests include such ecosystem services and normal favorable water regime of rivers, containment of surface erosion, population's health protection and many irreplaceable productive benefits of forest. Due to the fact that ecosystem functions of forests ensure the quality of environment not only at national but regional and local (landscape) levels, the study of potential of protection forests is performed from the position of the most direct or indirect satisfaction of population's needs. Analysis of practice of forest use of sparsely forested regions shows that conduct of forestry in protection forests does not fully ensure the support for their targeted protection functions. For the purpose of improving the situation, the main directions for perfection of normative and legal regulations and use of protection forests are offered. It is determined that despite the use of forests of sparsely forested area for logging, entrepreneurs are also interested in organization of hunting farms and recreation activities. It is proved that recreation use of the forests has clear public character a large part is presented for provision of scientific and educational and research activities, therefore, ecosystem services in sparsely forested region do exist. The state of forest ecosystems of sparsely forested region aggravates due to increase of anthropogenic load. Thus, efforts of publics and regional authorities should be aimed at stimulation of the processes of ecosystem services budgeting. It would be possible to preserve forest ecosystems of sparsely forested region only by means of additional financing, including from provision of ecosystem services.

**Key words:** Protection forests, ecosystem functions of forests, sustainable forest use, ecosystem services, hunting, provision

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### INTRODUCTION

Forest fund of Russia is a strategic resource for the country. Russian forests, depending on territorial location are conventionally divided into two groups: forests of dense forest, sparse forest and medium forest regions which cover the Central, Volga, Ural, Southern and North Caucasus Federal Districts. Despite the fact that these regions account for 15.4% of the country's territory, 16.7% of forested area and 28.8% of annual average growth of timber, 68.5% of the country's population lives in these regions and 2/3 of the total industrial and agrarian production and trade turnover of the country are concentrated here. Moreover, these regions are in the center of internal forest use.

In sparsely forested and medium forested regions, the need for the main forest products, timber and other products formed in the process of living activities of forest ecosystems is high. The concept of sustainable management of forests which determined the direction of development of modern forest economy, contains the principles of multi-purpose forest use, based on the

balance of economic, ecological and social components. At that, large attention is paid to rational use of non-timber resources and ecosystem services, provided by the forest.

The academician Pisarenko and Strakhov (2008) states that effectiveness of forestry grows with transition from the use of forests as a resource to responsible management of forests. He emphasizes the latter is based on ecosystems forestry, viewed not only and not so much as a means of receiving profit but performed within forest ecosystems. In this regard, forests play a decisive role, performing complex functions. There are the following functions of forests (Hanemann, 2002):

- Climate regulating
- Water protecting and water regulating (regulation of water regime of rivers, lakes and other water objects, hydrological regime of catch lands, protection of river banks, etc)
- Protective (protection of soil from erosion in agriculture, protection of objects and territories from negative influence of transport, etc)

- Sanitary and hygienic and recreational (creation of favorable micro-climate in cities, green zones and areas of resort's sanitary protection)
- Recreational (recreational volume of territory, preservation of natural environment of historical and cultural monuments, recreation, tourism)
- Special (preservation of unique nature complexes and valuable types of flora and fauna within them)

All these functions of forests refer to the ecosystem. Boyd and Banzhaf (2007), see the ecosystem functions as biological, chemical and physical interaction between components of the ecosystems (surface waters, ocean, various types of vegetation, species) which are intermediary products. According to Daily (1997), ecosystem services are conditions and processes through which nature ecosystems and types allow supporting and ensuring population's humankind. At the same time, forest ecosystems are complex, closely interconnected and have non-linear character of interaction with consumers of ecosystem services in time scale (Chee, 2004).

Ecosystem function of forests consists of such ecosystem services as normal favorable river regime, containment of surface erosion, population's health protection and many irreplaceable product benefits of forests.

Costanza *et al.* (1997) estimate the total cost of all forest ecosystem services at \$33 trillion per year. Due to the fact that ecosystem functions of forests ensure the quality of environment not only at national but regional and local (landscape) levels, it's necessary to study the whole potential of forests from the position of the most direct or indirect satisfaction of population's needs.

## **MATERIALS AND METHODS**

This study performs the analysis of ecosystem services of forests of sparsely forested regions. At the first stage, the evaluation of organization of forest use in forests of sparsely forested area is given. Then, according to methodological recommendations, identification of ecosystem services in view of forests of various categories is performed and possibilities for determination of their economic values are shown in Bobylev and Zakharov (2009).

The study is based on the hypothesis that changes in the ecosystems are reflected at the human's welfare and therefore, determine the demand.

Before the conduct of economic evaluation, the materials of forest planning at a regional level were

studied which allowed for determination of ecosystem services provided by forest ecosystems and the circle of consumers of ecological goods. Depending on the type of a good (consumer or non-consumer, direct or indirect), corresponding methods of economic evaluation of ecosystem services of forests are used.

One of the main approaches to complex evaluation of services provided by forest ecosystems is concept of General Economic Value (GEV).

This concept gives cost estimate to all the three functions of nature capital. GEV includes two main components: cost use or consumer cost and cost of non-use. Cost of use consists of direct cost of the use, indirect cost of use and cost of postponed alternative.

Cost use allows evaluating two out of three functions of nature capital provision with resources and ecosystem services. Cost of direct use is cost of extracted types of use natural resources, raw materials, etc. Secondly, this includes cost of non-recoverable types of use: recreation, education, scientific research, transport, etc. Cost of indirect use gives evaluation to ecosystem services turnover of items, regulation of climate and water balance, assimilation of waste areal of various species, etc.

Cost of postponed alternative is related to the future use of natural good. This type of cost is hardly evaluated, as it's related to potential use of the resources in future, so, there appears an issue on appearance of new variants of use or determination of new features. Therefore, cost of postponed alternative could be outlined only with approximate estimate by correcting the sum of costs of direct and indirect use. The cost of non-use is the cost of esthetic services of nature. Usually, the cost of non-use includes cost of existence and sometimes, cost of inheritance (Tsibulnikova and Pospelova, 2011).

Here, the cost of nature as is reflected and the profits of the society from the knowledge that the benefit or service exist also, a range of cultural functions of nature could be included here.

For the purpose of evaluation of separate elements of total economic value, various approaches are used, including market prices, cost methods, methods of conventional estimate, methods of production functions, method of replacing goods, methods of hedonistic pricing and methods of "readiness to pay" and transport costs.

## **RESULTS AND DISCUSSION**

Forest fund of sparsely forested regions is represented mostly by protective forests. In a wide sense, all forests have protective features as they participate in accumulation of organic substance, enrichment of

atmosphere with oxygen, regulation of flow, climatic conditions, protection of soils, water sources, etc. (Prokhorov, 1982).

In modern forest science, the term “protective forests” means natural and artificial forest plants, melioration and environmental-forming features of which are used for protection of various objects from natural and anthropogenic influences. That’s why study of these attributes of forest plants becomes more topical with globalization of economy and growing rates of forest use. At that, socio-ecological significance of forest protection often exceeds their economic value.

According to the Program “Evaluation of ecosystems at the edge of a millennium” of Millennium Ecosystem Assessment (MEA), protective forests can provide the following ecosystem services:

Firstly supporting character, related to soil-forming, photosynthesis and turnover of fertilizer elements; Secondly, regulation of climate, elements’ cycles, water quality, processing of human activities waste, etc.; Thirdly, providing services-provision with food, water, timber, etc.; fourthly, cultural services, aimed at satisfaction of recreational, esthetic and mental needs.

Voronezh Oblast is among sparsely forested territories of Russia and its forest relate to the category of protection which are to be used for the purpose of preservation of environmental-forming, water protection, protection, sanitary and hygienic, recreational and other functions of forests with simultaneous use of forests under the condition that this use is compatible with targeted purpose of forest protection and performed useful functions. Forests of Voronezh Oblast do not possess substantial raw material resources and perform protective, nature protective and ecological functions.

The Oblasts’s conifer forests account for 30% of the forested areas. All of these forests are located in the central and Southern parts of the Oblast, adjacent to inhabited localities.

Areas of existing categories of forests are shown in diagram of Fig. 1. In view of peculiarities of the legal regime of protection of forests of Voronezh Oblast, the latter are represented by the following categories:

#### **Forests located at special protected nature territories:**

This category includes forests on territories of state national reserves Voronezh biosphere and Khoper which perform the functions of preservation of genebank purity of flora and fauna population of the central forest steppe in natural nature complexes.

**Forests located in water protection areas:** Forests located in water protection areas perform the functions of

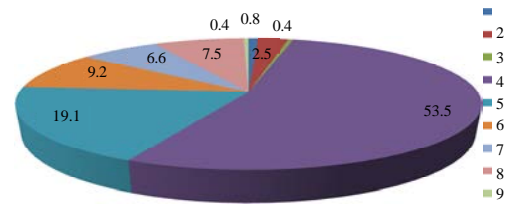


Fig. 1: Distribution of forest area for the targeted purpose (legend: 1- state forests; 2) Forests with scientific or historical value; 3) Natural landmarks; 4) Especially valuable forest areas; 5) Anti-erosion forests; 6) Forbidden stripes of forests spawning stripes of forests; 7) Forests of green zones of communities and economic objects; 8) Forests located on protected nature territories and 9) Especially, valuable forest areas)

prevention of pollution, infestation and sedimentation of water objects and depletion of their waters as well as preservation of habitat of water biological resources and other objects of animal and vegetation world.

#### **Forests that perform the functions of protection of natural and other objects:**

Firstly, protective stripes of forests, located along railroad ways of general use and highways. These protective stripes of forests protect roads from snow drifts and erosion influence of wind and wind. The area of this category of protection forests constitutes 4.9% of total area of forests. Secondly, green zones that perform sanitary and hygienic functions and create optimal conditions for population’s recreation. The area of green zone constitutes 5.4% of the total area, distributed according to the targeted purpose. Thirdly, valuable forests are represented by state protective forest stripes 0.8%, spawning grounds 6.6%, anti-erosion forests 20.0%, forests located in forest steppe zones and steppes 47.6%, forests with scientific or historical values 7.1%.

The forest fund of Voronezh Oblast is dominated by hard-wooded broadleaved trees which constitutes 52.6% of areas covered by forest vegetation, conifer trees account for 28.5% and soft-wooded broadleaf trees for 17.6%. Other trees and bushes account for 1.3%.

Softwoods are dominated by middle-aged forest crops (68.9%), hard-wooded broadleaved trees also by middle-aged (39.3%) and the group of soft-wooded broadleaf trees mature stand and old-growth timber (40.1%). Around 50% of planting of Voronezh Oblast has artificial origin. A large part is planted on territories taken from agricultural use. These characteristics of forest fund influence organization of forest use and ecosystem services.

Table 1: Volume of forest fund use for the types of use

Types of forest use	Measuring unit	Yearly value		
		2011	2012	2013
Production of timber:	Thousand m <sup>3</sup>	500.3	538.5	1,244.59
Including in mature stand	Thousand m <sup>3</sup>	90.0	114.4	228.8
Production of non-timber forest resources	Hectares	-	-	-
Production of food and medicine resources	Hectares	-	-	-
Conduct of activities in the hunting sphere	Hectares	17,680.8	19,646.0	19,746.0
Agriculture	Hectares	230.0	366.0	524.0
R&D and educational activities	Hectares	30,902.0	30,902.0	30,902.0
Recreational activities	Hectares	657.0	770.0	865.0
Growing forest fruit, berry and decorative plants	Hectares	-	-	-
Study and extraction of mineral resources	Hectares	123.8	168.9	183.9
Construction and exploitation of artificial water objects and waterworks	Hectares	14.5	15.0	15.0
Construction, reconstruction and exploitation of linear objects	Hectares	25.0	143.0	143.0
Conduct of religious activities	Hectares	49.0	65.0	70.0

Table 2: Possible types of forest use and ecosystem services in view of forests' purposes

Targeted purpose of forests	Type of ecosystem services	Non-timber resources	Food and medicine resources	Hunting					Creation of forest plantations	Extraction of minerals	Liner objects	Creation of timber processing infrastructure	Growing fruit, berry, decorative and other plants
				Economy	Amateur	R&D	Recreation	Agriculture					
Protective Q													
Protective stripes along roads	S, R, P	Ps	O	O	Ps	B	P	B	F	O	Ps	F	O
Green areas	S, C	O	O	F	F	Ps	P	O	F	F	Ps	F	
Valuable	C	O	O	F	F	P	Ps	O	F	F	O	F	
GZLP	S, P	Ps	Ps	F	P	Ps	Ps	O	F	Ps	O	F	Ps
Anti-erosion	R	Ps	Ps	P	Ps	Ps	Ps	O	F	Ps	O	F	Ps
Located in	S, R	Ps	Ps	Ps	Ps	Ps	Ps	A	F	Ps	O	F	Ps
Steppe regions													
With scientific or historical value	S, C	O	O	O	O	P	Ps	F	F	F	O	F	O
Water protection zones and spawning grounds	S, R	Ps	Ps	Ps	Ps	Ps	Ps	O	F	O	O	F	O

Types of forest use: P Priority type of forest use, Ps Possible type of forest use, O Undesired type of forest use, F Forbidden type of forest use. Types of ecosystem services: S Supporting, R Regulating, P Providing, C Cultural

The data for the types of use of forests of Voronezh Oblast is given in Table 1. Nine of the top-priority types of use of protection forests are distinguished on the territory of Voronezh Oblast. Analysis of the table shows that the dominating types of use of protection forests are timber production and conduct of recreational activities which corresponds to division of forests according to targeted use and accordingly, possible types of forests use. Total volume of forests use consists of entrepreneurial use with provision of forest plots and without provision of forest plots on a free basis. In this treatment, the sphere of forests use is expands and is presented by all types possible in forest protection.

Distribution of recreational activities into entrepreneurial and public consists in the following: conduct of recreational activities which is entrepreneurial activities, constitutes 3, 354.8 ha or 4.9% of the priority or 0.8% of the total area of forest divisions.

It should be noted that the structure of forest use in sparsely forested region changes very slightly in dynamics. The main part of forests are used for timber production; entrepreneurs are also interested in organization of hunting farms and recreational activities.

At the same time, recreational use of the Oblast's forests has a clear public character a large part is provided

for R&D and educational activities and therefore, ecosystem services do exist in sparsely forested regions. As a result of analysis of forest plans, we substantiated top-priority types of forest use in view of targeted purpose of forests and determined possible types of ecosystem services (Table 2). Protective forests of sparsely forested area, despite their targeted purpose, perform supporting functions, being a green basis of territories. In some cases, they provide regulating ecosystem and cultural and educational services especially in the areas of forest fund, transferred to the unlimited use for scientific and educational purposes.

As for providing ecosystem services, it should be noted that their significance for sparsely forested territories is not so high. This is shown by underdevelopment of such types of forest use as production and gathering of non-timber forest resources (stumps, elm, bark, brushwood, woody forage, moss, forest cover, reed, cane and similar forest resources), harvesting of forest resources and gathering medical plants.

Following the logic of the research and according to priority types of forest use, territories of forestries were redistributed in view of forest use and ecosystem services (Table 3).

Table 3: Summary result of distribution of territories of forestries for the functional zooming according to priority types of forest use (hectares)

Forestry	Area, hectares	Timber harvesting, hectares	Agriculture	Recreational activities			Construction and exploitation of linear objects	Construction and exploitation of reservoirs	R&D and educational	Geological study of activities	Religious activities minerals	Organization of hunting farms
				Rental agreements	Constantl	Public						
Anninskoye	19,282	14,706.2	743.0	-	-	3,582.2	-	-	-	-	-	222.9
Bobrovskoye	24,981	20,294.4	482.6	39.1	-	3,552.1	74.5	-	-	-	-	534.3
Boguchanskoye	11,147	8,404.7	593.8	14.1	-	1,876.6	57.5	-	-	-	-	194.0
Buturlinovskoye	23,551	22,355.0	231.1	7	-	807.6	0.3	-	-	-	-	150.0
Voronezh	26,803	18,992.3	335.0	671.7	-	6,225.1	146.0	-	-	-	2.0	250.0
Vorontsovskoye	15,662	1,3117.0	288	-	-	502.0	14.0	-	1740.0	-	-	1.0
Davydovskoye	22,161	18,007.8	443.8	3	-	3,594.2	-	14.5	-	-	-	49.0
Donskoye	16,225	13,196.0	648.1	231.5	-	2,082.2	65.0	-	-	-	-	1.2
Kalacheevskoye	27,212	24,238.9	748.3	3.8	-	1,911.9	23.1	-	-	-	-	286.0
Kantemirovskoye	6,337	5,982.0	16	0.6	-	320.4	3.0	-	-	-	-	15.0
Novosmanskoye	19,277	15,488.9	285.0	20.9	24.0	3,179.4	106.0	-	-	61.6	2.6	-
Novokhoperskoye	17,052	13,311.1	622.9	274.5	-	2,470.5	153.0	-	-	-	-	220.0
Ostrogzhskoye	20,568	18,478.8	309.0	6.0	-	1,648.4	120.0	-	-	-	4.0	-
Pavlovskoye	20,812	16,439.3	360.2	37.7	-	3,786.0	89.8	-	-	-	-	85.0
Peskovskoye	17,629	12,401.1	1,185.5	13	-	3,977.6	51.7	-	-	-	-	-
Rossoshanskoye	10,485	8,567.7	167.7	159.2	-	1,432.1	27.7	-	-	-	-	130.3
Savalskoye	17,074	14,495.8	315.6	18.5	-	1,967.9	46.0	-	-	-	-	229.7
Semilukskoye	1,8317	11,209.3	384.4	127.2	15.2	6,148.0	122.5	-	-	53.3	-	-
Somovskoye	9,166	-	59.0	316.0	13.2	7,404.3	134.3	-	1,036.2	-	44.4	-
Tellemenovskoye	40,281	31,349.1	977.0	491.6	-	5,681.8	59.0	-	1,708.0	8.90	-	-
Khrenovskoye	16,706	-	1.4	-	-	0.1	2.9	-	16,699.4	-	-	-
Ertalskoye	3,216	2,680.7	44.1	-	-	491.2	-	-	-	-	-	-
Progorodnoye	12,169	-	97.6	119.4	-	3,087.3	107.2	-	8,667.0	-	-	-
Total	416,113	303,716	9,339	2,554	52	65,729	1,403	14.0	29,850	123	53.0	2,368
Percentage	100	73.0	2.2	0.6	0.01	15.81	0.32	-	7.2	0.03	0.01	0.59

Analyzing the practice of forest use in protection forests of Voronezh Oblast, it is possible to distinguish the following regularities, peculiar for most of sparsely forested regions of the European part of Russia.

Middle-aged pinaceous forest stands of artificial origin which grow on poor dry (often beyond the climatic norms of the type) or on territories outside the agricultural use, created with crowded schemes (up to 15,000-20,000 items per hectare), subject to significant anthropogenic load (due to close proximity to inhabited communities) are influenced to pine fungus and needle-eating insects (Kharchenko *et al.*, 2010). This causes the necessity for development of the system of charging the fee for ecosystem services provided by these forest ecosystems.

In hardwoods, the situation is somewhat better but the state of mountain oak woods is rather dangerous. Degradation processes in them, due to increased share of coppice forests including due to selective cutting increase constantly. Limitation of coppice woods by croplands hinders their natural restoration and forest cultures of oak, for obtaining a positive result (in the form of complete stand), require constant costly care (Kharchenko *et al.*, 2009).

Thus, efforts of the public and regional authorities should be directed at stimulation of processes of budgeting of ecosystem services (Morkovina, 2014). Only due to additional attraction of assets, including from provision of ecosystem services, it would be possible to preserve forest ecosystems of sparsely forested regions.

Human welfare depends on the provided ecosystem services such as climate stabilization, air and water purification, formation of fecund soils and their protection

from erosion, turnover of nutriment, efficiency of natural societies, etc. All these and other natural blessings belong to society, having no obvious cost and not being the objects of market relations. Therefore, their reduction or loss are not evaluated in modern economic models, even with clear dependence of society on the quality and sufficiency of one or other ecosystem services.

The process of use of protection forests for the purpose of timber harvesting not supported by sufficient methodological and legal basis in modern natural and climatic conditions of sparsely forested regions, turns into low-profit, ineffective measure (in view of obligation of a forest user for cleaning of cutting areas and forest restoration) (Martynyuk and Rafailov, 2015).

In this situation, protective forests which play a colossal role in supporting ecological balance of regions, especially in forest-steppe zone become more vulnerable and need a scientifically substantiated sustainable management. An important role in this could belong to public-private partnership (Morkovina *et al.*, 2014).

As a measure for increase of economic effectiveness of protective forests management, it is necessary to implement into Russian Forest Law and law enforcement practice the notion of payment for ecosystem services and protection forests (UNO., 2014). At that, it is necessary to understand that payment for ecosystem services, according to the expression by Engel *et al.*, (2008) "is not a 'silver bullet' which could be used to solve any problem of environment protection" (Engel *et al.*, 2008). It is a tool adapted for solving a certain set of problems emerging during improper management of ecosystems as a result of concentration of attention in narrow limits of their resource functions.

## CONCLUSION

The above implies that sustainable management of protective forests should be separated as a special part of the forest law system. In the sparsely forested area of Russia, volume and regime of forest use should become a secondary value, dependent on the functional purpose of forests. All economic events on the territory of protection forests (from the moment of design of forest cultures to cutting of mature wood) should be governed by the single goal creation of forest biocoenosis that is maximally close as to structure and contents to the natural one with homeostasis and a full set of ecosystem functions.

The schemes of payment for ecological services, related to the forests are not a universal solution to the problem of environment protection. They are the means that supplements the ecological law, regulation and system of control and accounting. Determination of situations when implementation of payment for forest ecosystem services is more preferable than territorial protection of nature is not a simple task: there's a need for analysis of costs and profits and measuring of "political temperature" especially in view of large connection of the population of many regions to their forests.

Successful functioning of forest-related schemes of payment for ecosystem services directly depends on establishment of clear legislative and institutional frameworks as well as development of measures that ensure economic effectiveness of the process. Combination of several various services could allow reducing the operational costs.

As a rule, experimental projects are a good means of demonstrating the importance of payment for ecosystem services and the received results at that, it is necessary to provide monitoring of effectiveness of the scheme for receipt of investment support on a long-term basis.

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