Environmental frameworks of sustainable development in the Russian Federation (on the example of the Voronezh region)

N Kharchenko*, E Moiseeva and N Prochorova

Department of Ecology, Forest Protection and Forest Hunting, Faculty of Forestry, Voronezh State University of Forest and Technologies named after G.F. Morozov, 8 Timiryazeva street, 394087, Voronezh, Russia

*E-mail: forest.vrn@gmail.com

Abstract. Wildlife preservation and protection is a necessary condition for the implementation of sustainable development. It is a determining factor in the possibility of continued human existence as a species at the present stage of biosphere development. The reduction of natural ecosystems’ territories, and, as a result of this, the reduction of their biodiversity, negatively affects the quality of life of different regions and of humanity as a whole. One of the ways to optimize the environment, preserve natural ecosystems and improve the quality of human environment is creation of ecological frameworks of the regions. Shipov Forest, Tellerman Forest, Khopersky Reserve, Voronezh State Nature Reserve named after V.M. Peskov, a forest-green zone of the city of Voronezh (currently under construction) will be the main centers of the ecological framework of the Voronezh region. At the same time, there are 244 specially protected natural territories of regional and local subordination in the Voronezh region. They belong to different areas of protected territories, categories and profiles. When creating an ecological framework, these territories are included into ecological framework, thereby expanding its territory and strengthen its environment-forming functions.

1. Introduction
Destruction of the human environment is one of the most important problems of our time, as a result of its’ own human activities. Constant reduction of the territories of natural ecosystems and their biodiversity negatively affects the quality of life in different regions and of humanity as a whole.

Wildlife conservation and protection is a necessary condition for the implementation of sustainable development and the determining factor in the possibility of the continued human existence as a species.

Permanent reduction of natural or little disturbed by the anthropogenic activity territories is constantly happening in the Russian Federation. First of all, it is connected with the processes of urbanization; since currently, more than a half of the world's population is urban dwellers. Modern approaches to the development of nature management in the Russian Federation are focused on the formation of sustainable development system in the region. The term “sustainable development” means the development of society in which human living conditions improve, and the environmental impact remains within the economic capacity of the biosphere, so that the natural basis for humanity functioning is not destroyed [1]. One of the ways to optimize the state of the environment, maintain natural ecosystems and implement the concept of sustainable development is to create ecological frameworks of the regions. The basis of ecological frameworks should be specially protected areas of different
importance and forests [2]. Thus, the ecological framework of the region should include, in the first place, the territory in which forests dominate, because forest ecosystems perform a number of important bioclimatic and environment-forming functions [3].

The possibilities of sustainable territorial development in recent years have not been discussed without taking into account the issues of ecological balance of the regional ecosystems. Existing approaches to maintaining ecological balance at the level of municipalities do not provide the necessary level of ecosystem protection, have a low efficiency of the restoration function. That is why the study of the features of the formation of the ecological framework is so important [4].

The stages of formation and structure of ecological frameworks will vary greatly depending on the natural conditions of the subjects. However, most authors believe that the development of the ecological framework should be based on the existing system of specially protected natural territories [5-7].

Voronezh region is located in the central part of the East European Plain. All forests of the Voronezh region belong to protective forests. They are to be developed in order to preserve environmentally-forming, water-protective, protective, sanitary-hygienic, health-improving and other useful functions with the simultaneous use of forest resources, provided that this use is compatible with the intended purpose of the protective forests and useful features of their implementation. However, in recent decades, the forest area in the region has been steadily declining, primarily as a result of anthropogenic factors. In this regard, the formation of the ecological framework in the territory of the Voronezh region is an integral part of the sustainable development of the region and the country as a whole. The development of principles and criteria for creating the ecological framework of the region is necessary for the conservation of forest ecosystems.

Ecological frameworks are a set of ecosystems with an individual nature management regime for each site. They form spatially organized infrastructure. It maintains the ecological stability of the territory, preventing biodiversity loss and landscape degradation. The ecological framework should include the most active and ecologically interconnected spatial elements (rivers and river valleys, forests, etc.), on which the environment sustainability of the given territory depends [8].

Currently, there are many points of view on the composition and structure of the ecological framework. The core of the ecological framework consists of centers or nodes (according to the majority of authors). These are territories that perform environment-forming functions, affecting adjacent territories, maintain ecological balance. They ensure biodiversity preservation of the whole complex of living organisms. In addition to the nodal sections (centers), the ecological framework structure should include areas of ecological restoration, buffer zones and transport corridors, green park zones around large populated areas. The territories of ecological restoration are of particular importance as a part of ecological framework, since these areas are heavily modified by anthropogenic influences. Their resistance to external influences is greatly weakened. Their inclusion in the framework entails the establishment of a special regime for the use of natural resources and the restoration of their environmental sustainability.

Transport corridors are the main routes of material-energy exchange between the nodes, thanks to which the exchange of living organisms between the nodes of the ecological framework is maintained. Forest belts are located between the fields where various crops are grown. These are the transport corridors of the ecological framework. Forest park green belts are zones with limited use of natural resources and other economic activities, including the territories in which forests are located and the territories of the green fund within the boundaries of urban settlements that are adjacent to these forests constituting a single natural ecological system.

Sir Ebenezer Howard (1850-1928) from Great Britain first proposed the concept of green belts. Howard used green belts in urban greening plans to separate residential and industrial areas. The Green Belt concept was officially proposed to the Greater London Regional Planning Committee in 1935. Since then, this concept has been adopted by many countries in Europe and Asia. The Beijing Green Belt was created in 1956 and has an area of over 12,300 km². The area of the "green belt" of the city of Seattle is 1,450 km², Toronto - 7,300 km², Frankfurt - 80 km² [9]. Forest park green belts play an important role in biodiversity conservation, rational environmental management, and improving the
quality of life of urban agglomeration populations. Such green belts should be an integral part of the ecological framework of the region.

The main problem of creating ecological frameworks is a significant reduction in the territories of natural ecosystems [10]. In the Russian Federation, forest cover percentage decreased from 69% to 40% according to the Federal Forestry Agency. Annual forest fires that destroy thousands of ha of forest in different regions and uncontrolled logging without reforestation are the main reasons for this.

In connection with the foregoing, the development of methods and methodology for the formation of ecological skeletons is an important task of modern ecology and related sciences.

The aim of this work is to clarify the selection criteria for territories to be included in the cores of the ecological framework of the Voronezh region.

2. Methodology
The Voronezh Region is located in the central part of the East European Plain, in the basin of the middle reaches of the Don River, at the borders of the forest-steppe and steppe zones. The territory of the region is 52,200 km². The Voronezh region is the third largest region in the Central Federal District. The total area of forests in the Voronezh Region was 506,000 ha in January 1, 2017. The area of forest land is 464,600 ha in the territory of the Voronezh region. The forest cover of the region is 8.1%, which makes it possible to attribute it to sparsely wooded areas [11].

All forests of the Voronezh region are classified as protective forests in accordance with the forest classification introduced by the Forest Code of the Russian Federation. These forests are subjected to development in order to preserve environment-forming, water protection, protective, sanitary and hygienic, recreational and other useful functions. The use of the forest resources in these forests is compatible with the intended purposes of protective forests and their useful functions.

Voronezh is located on the banks of the Voronezh River, 12 kilometers from its confluence with the Don. The population of the city of Voronezh is 1.058.547 people as of January 1, 2018. Agglomeration with a population of over 1,300,000 people was formed around the city of Voronezh. This agglomeration has a significant impact on adjacent ecosystems.

Quercus robur L. and Pinus sylvestris L. are the priority forest-forming species of the forests of the Voronezh region. Populus L., Alnus L., Betula L., Acer platanoides L. and Tilia L. also participate in forest formation as well. Pine forests are the most productive. The structures of the current age do not allow organizing the stable use of coniferous and oak tree stands (the prevalence of young stands and an insignificant proportion of mature stands).

There is a clear tendency to reduce the oak area in the forest fund. This is due to the drying process of oak forests, which is cyclical in its nature. Over the past 100 years, three waves of the most intense dieback of oaks (1895–1911, 1928–1945, 1964–1983) have been observed, which are caused by a complex of adverse environmental factors and climatic changes. Pine forests are the second largest forest formation in the Voronezh region. They are characterized by the predominance of artificial plantations.

There are several large forest areas in the Voronezh region. Shipov Forest is the largest island oak forest in the Black Earth region. It is classified as a particularly valuable forest. Thanks to regenerative felling, young oak plantings appear in the new areas of Shipov Forest. Late-growing form of oak is the dominant species here, which is characterized by straightness and high quality wood. Its area is 32 ha. The forest is widespread along the right upland bank of the Oseredka River, from Pavlovsk to Buturlinovka. Two wide forest beams cut it into the First and Second Ship Groves and the State Cottage. The predominant species of the first tier is oak. There are Norway maple, linden, and mountain elm in the second tier. The undergrowth is dominated by maple and hazel. Grass cover is represented by acacia, odoriferous woodruff, European wild ginger, and sedge. Wide old stripes of artificial oak forests of the Stone Steppe are especially noteworthy. Here, undergrowth and grass covers are structure characteristic of natural oak forests.

The Tellerman Forest is one of the oldest forests in our country. It is a world-famous natural monument with a long history of nature management, the main feature of which is the long-term conservation of the forest area in combination with multiple selective and clear cutting and oak planting.
Most of the forest area (about 75%) is a typical upland oak forest. The total length of the forest is about 65 km; the width varies from 3 to 16 km. The forest area is over 382 km².

Khopersky State Nature Reserve was founded with the aim of developing methods for conservation, restoration and rational use of the natural ecological systems of the Khoper Valley, as well as conservation and restoration of the Russian muskrat population. It is located in the south-eastern part of the Oksko-Don lowland, in the Khoper River valley. The territory is located in the eastern part of the Voronezh region within the three administrative regions: Novokhopersky, Povorinsky and Gribanovsky (figure 1). The territory of the reserve, with a length of 50 km along the Khoper River, from north to south, has a total area of 16.2 ha. 80% of the reserve’s area is covered with forests, among which floodplain and upland oak forests of 80–100 years old prevail.

Voronezh State Nature Biosphere Reserve named after V.M. Peskov occupies the northern half of the Usman pine forest at the junction of the Lipetsk and Voronezh regions. It is a unique natural complex with a rich variety of flora and fauna [9].

The following methods were used during research to justify the need to create an ecological framework for the Voronezh region and to develop a methodology for its creation. These are methods for collecting and processing data by field methods, methods for assessing the environmental parameters of forest ecosystems; empirical generalization, method of prioritization for the development of assessment criteria for forest areas to include them in the ecological framework.

3. Results and discussion

During the research, the current composition of the dominant species of hardy-shrub and herbaceous vegetation of the main types of the Voronezh region was clarified.

Dry pine forests form on convex watersheds. There are serious pine stands having 3–4 bonitet grade and medium density. Herbaceous layers are steppe and pine forest-steppe grasses: *Stipa pennata* L., *Festuca valesiaca* (Hask.) Gaudin, *Koeleria* Pers. Often there are plants growing on sandy soils: *Helichrysum arenarium* Moench, *Sedum acre* L., *Thymus* L. On the terraces and on weakly convex watersheds, pine forests are developed, which are located on even or slightly wavy, medium-elevated positions with a water table at a depth of 2.5-3.5 meters. The stand here is closed. Pine is dominated by 3 classes of quality indicator, but sometimes *Betula pendula* L can be also found. There is no undergrowth in such forests *Chimaphila umbellate* (L.), *Pyrola secunda* L., *Veronica officinalis* L., *Silene vulgaris* (Moench.) Carcke., *Calamagrostis epigeios* (L.) Roth are found in hardy-shrub forest. The ground cover is mosses.

Relatively poor forest species grow on sandy soil with loams, but it is richer than a pine forest, where there is only one dominant pine species. In such forests, soil nutrients are activated due to the warm climate. Forest communities have a complex composition, dominated by the pine of the second bonitet class. Trees belonging to the first quality class are also found. *Prunus fruticosa* Pall., *Rubus* L., *Cytisus* L make the undergrowth. The tier of herbs is dominated by cereals: *Calamagrostis epigejos* (L.) Roth., *Poa nemoralis* L., *Poa pratensis* L., *Brachypodium pinnatum* (L) Beauv., *Silene nutans* L., *Inula helenium* L., *Polygonatum odoratum* (Mill.), *Dracocephalum ryschiana* L., *Fragaria vesca* L., *Campanula persicifolia* L., *Convallaria* L., *Peucedanum officinale* L., *Veronica* L Coniferous and deciduous species grow in mixed forests. Such forests are formed on low relief areas. In such forests, pine has the first or second grade quality indicator. *Betula Pendula* L. and *Betula pubescens* Ehrh. grow successfully in such forests. Bilberries and lingonberries are found in a tier of herbaceous plants and small shrubs. These plants are rare for the Voronezh region.

According to the state forest register, as of January, 1 2019, the region is dominated by a hard-leaved group of species, accounting for 56% of the land, covered with forest vegetation. Coniferous stands occupy 26%, and soft-leaved stands – 17%. Other species and shrubs occupy 1.0%. The predominant species is oak – 48.0% (short-stemmed oak – 28.0%; long-stemmed oak – 20.0%). According to age groups, oak is distributed as follows on the forest fund lands: young growth – 13%, middle-aged – 36%, ripening – 17%, ripe and overripe – 34%, including overripe – 12%.
In coniferous stands the following species prevail: middle-aged – 66%; in hard-leaved stands middle-aged stands take 40%, and in soft-leaved, mature and overripe stands take 34%.

The upland oak forests are zonal forests of the European forest-steppe. Oak forests are common on the high right banks of the rivers and on drained floodplains. The main areas of the Voronezh forests are located in river valleys, most of the forests on the terraces are cut down. In the Don Valley, the forest cover is low. Forests were preserved on the terraces of Voronezh (Usman forest), Khopra (Khopersky reserve, Tellerman massif, Novokhopersky forestry), Bityuga (Khrenovsky forest). Upland oak forests occupy the watersheds and slopes of the valleys of medium and large rivers. Of the large massifs of oak forests in the Chernozem region, the Shipov forest in the Osered forest basin and the Tallerman grove in the Khopra basin have been preserved. Bayrack oak forests, widely distributed along the erosion-beam network, are of great water protection and anti-erosion value. The uneven arrangement complicates the protection and management of these forests.

In ash-lime oak forests, the grass cover is diverse. Plants prevailing here are typical for European oak forests and European shadow broad-leaved forests. Before the leaves bloom, the *Scilla siberica* L., *Corydalis Halleri* Wild. begins to bloom, they are replaced by *Anemone ranunculoides* L, *Ficaria verna* Huds., as well as *Asarum europaeum* L. and *Carex pilosa* Scop. With the onset of the summer period, *Aegopódium podagrária* L. and *Carex pilosa* Scop., *Asperula odorata* L., *Poligonatum multiflorum* L., *Pulmonaria obscura* Dum., *Lathyrus vernus* (L.) Bernh., *Viola mirabilis* L. are predominant. Often, aspen forests develop in place of oak groves, sometimes ash, maple or linden predominate.

The raised sections of the high floodplain are occupied by floodplain oak forests. They are blackberry oak on dark gray loamy soils formed on river sediments. The prevailing stand is 1–2 grades of bonitet. Oak dominates, there is elm, ash, small-leaved linden. In the undergrowth there is a *Rosa canina* L. and *Frangula alnus* Mill. Of the herbaceous plants, floodplain oak forests are characterized by *Convallaria majalis* L., *Stachys palustris* L., *Galium boreale* L., *Galium rubioides* L., *Thalictrum minus* L., *Scutellaria galericulata* L., *Urtica dioica* L., *Lycopus europaeus* L.

In the south of the Voronezh region, in the steppe zone, bayracks, which are extrazonal forests, are widespread along beams and overgrown ravines. The difference between the bayrack oak forests and the main types is the lower stand and sparse cuttings. There are meadow, meadow-steppe and weed plants, but the prevailing flora of ordinary oak forests.

The main centers for creating an ecological framework will be: Shipov forest, Tellerman forest, Khopersky reserve, Voronezh State Nature Biosphere Reserve named after V.M. Peskov, green park belt of Voronezh (currently under construction) (figure 1). At the same time, there are 244 specially protected natural territories of regional and local subordination on the territory of the Voronezh region. These territories have different types of the protected area, categories and profiles. When creating an ecological framework, they will enter into its structure, thereby allowing it to expand its territory and strengthen its environment-forming functions.

Location, configuration and size of the ecological framework are among the most important indicators of successful functioning. The location of forest areas is scattered in the Voronezh region. Only near the regional center (Voronezh) do massive forests surround the city with a semicircle from the northeast side (entering separate preserved islands into the urban area) and cover it with a discontinuous chain of small forest areas around the rest of the city's perimeter. In addition to the center, the ecological framework must include forest ecosystems and smaller territories. They perform the same functions, albeit on a smaller scale. For this, criteria for the selection of such forest areas was developed.

One of the most important issues that arise when creating ecological frameworks is the criteria for selecting territories that should be a part of it. We propose to use the following criteria for the selection of forest areas to include them in the regional ecological framework: first, the localization criterion; secondly, the type of plot; thirdly, the presence of burdens and restrictions.

The criterion “Localization of ecological framework sites” is the basis for including a site in the ecological framework, reflecting the distance of the site (proximity) from the other.
Figure 1. The location of the main nuclei for the formation of the ecological framework of the Voronezh region: – Forest green belt of Voronezh; – Voronezh State Nature Biosphere Reserve named after V.M. Peskov; – Tellerman forest; – Hopersky Reserve; – Shipov Forest (The Russian version of the map is available at: http://ulh.govvrn.ru/Shared Documents / Forest Plan of Voronezh Region.doc).

The criterion “Presence of encumbrances” is the basis for not including a site in the ecological framework. Sites of natural and artificial origin which are not included in the composition:
- Contaminated, with the presence of production and consumption waste on them, violations of the soil cover;
- Granted for placement of capital construction projects or land plots on which capital construction projects are located (including construction in progress);
- Plots for which an agreement has been concluded on the development of a built-up territory or an agreement on the integrated development of the territory;
- Plots, in accordance with the approved territorial planning documents and (or) territory planning documents, intended for placement of federal facilities, regional facilities or local facilities, or in respect of which a decision has been made to prepare documentation for territorial planning or to prepare documentation for territory layout;
- Plots indicated in the license for the use of subsoil or, in accordance with [12], application was submitted for the right to use the subsoil plot above which the land plot is located, a decision was made on a tender or auction for the right to use such a subsoil block, either a decision was made to provide such a subsoil block for use, or a mineral deposit located within the boundaries of the respective land
plot contains mineral reserves put on the state balance, or a subsoil block is included in the list of subsoil blocks of federal or local significance;
- Plots with subsoil plots located on them, included in the federal fund of subsoil plot reserve;
- Land reserved for state or municipal needs;
- Plots seized for state or municipal needs.

The criterion “Site Type” is the basis for including the site in the ecological framework, reflecting the origin of the site and its distinctive parameters: areas of natural origin, unique to the climatic conditions of the region; plots of natural origin, usual for the climatic conditions of the region; site of artificial origin that is unique to the climatic conditions of the region; site of artificial origin that is common to the climatic conditions of the region. The selected sites for inclusion in the ecological framework are sent to the authorized federal executive bodies.

Work on the creation of the ecological framework of the region (at the regional level) should be implemented in stages. It is a subject to a certain algorithm of sequential actions. Firstly, the need for creating such a framework as a factor for maintaining and preserving ecosystems is scientifically substantiated. Secondly, the selection criteria and the procedure for establishing the boundaries of the ecological framework are scientifically found, taking into account the current forest, urban planning and land laws. Thirdly, the preparation of draft regulatory acts defining the legal regime of economic and other activities is made, including use, protection, protection and reproduction of forests included in the ecological framework. Fourth, the preparation of draft regulatory acts defining the legal regime of economic and other activities, including the use, protection, protection and reproduction of forests of the ecological framework.

Our studies enable to identify clear criteria for the inclusion of forest plots in the ecological framework of the region and develop an algorithm for its creation.

Conclusion
Analysis of the current state of different oak stands in the Voronezh region was carried out based on the research. Species composition of dominant species of tree and shrubbery and herbaceous vegetation was clarified. For the first time, “centers” for the formation of the region ecological framework were identified. An algorithm for the sequential actions necessary for its creation was developed. The criteria for the selection of forest areas for inclusion in the ecological framework were clarified. The proposed algorithm for creating an ecological framework can be used for the other regions of the Russian Federation.

The creation of ecological frameworks in the regions is undoubtedly one of the ways to optimize the environment. It contributes not only to the preservation of natural ecosystems, but also to improving the quality of the environment for humans. In the Voronezh region, there are several large forests that should become the centers (cores) of the future framework. The presence of a large number of specially protected natural areas of a smaller size will make the ecological framework more ranked and sustainable. The creation of a forest-green belt around the city of Voronezh will contribute to the enlargement and strengthening of the environment-forming function of the ecological framework of the Voronezh region and preservation of the biodiversity of the region, which is unique in its natural conditions.

References
[1] Chi Y E 2004 Ecological look at the assessment of ecosystem services. Biol. Conser. 120 549
[2] Lisova O S Grigoryevskaya A Ya, Yakimenko O V and Prokhorova N L 2016 Protected areas as the “core” of the recreational structure of the Voronezh city agglomeration Forestry Engineering Journal 1 549 doi: 10.12737/18731
[3] Boyd J and Banzhaf S 2007 What are ecosystem services? Ecol. Econ. 63 (2-3) 616
[4] Starokogeva L G 2017 Features of design of an ecological framework in areas of agricultural development of the Volgograd region. Econ Research and Development Journal, available at http://edrj.ru/article/02-11-2018 [in Russian]
[5] Latypova Z B and Omarov M K 2017 The formation of the ecological framework of the territory (for example, Pavlodar region) Problems of Regional Ecology 1 53

[6] Chibilev AA 2017 Experience and prospects for the formation of a natural-ecological framework in the regions of the steppe zone of European Russia. South of Russia: Ecology, Development 6 32 [in Russian]

[7] SemenchivaAV 2019 Problems of formation of the natural-ecological framework of the region. Bulletin of the Nizhny Novgorod Institute of Management 1 (51) 3

[8] Martynyuk AA and, Rafailov MK 2015 Methods of a functional cost analysis in strategic planning for the development of forestry in modern conditions. Forestry Engineering Journal 1 264 DOI: 10.12737/11284

[9] Razgulyaev V N 2010 Sustainable development: concepts and modern scientific and practical interpretation. Bulletin of Economic Integration 9 28

[10] Kharchenko N N, Morkovina S S, Kosichenko N E and Skrynnikova M V 2017 Methodological approach to creating a green forest park belt of urban agglomerations. Forestry Engineering Journal 4 122 Doi: 10.12737/article_5a3ef4403ea445.07775744

[11] Kalaev V N, Moiseeva E V and Nikolaev E A 2010 Conservation of biodiversity in the botanical gardens of the world. Bulletin of Voronezh State University: Geography. Geoecology 2 12 https://elibrary.ru/item.asp?id=15602255

[12] The Law of the Russian Federation of 02.21.1992 N 2395-1 (03 August 2018), available at https://sudact.ru/law/zakon-rf-ot-21021992-n-2395-1-o/