NATURAL RESOURCES AS A BASIS FOR SUSTAINABLE DEVELOPMENT: BIORESOURCES - RUSSIA

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Contents

Summary

The state of Russian biological resources is analyzed as an important indicator of biological security and sustainable development. Quantitative and qualitative parameters of plant and animal resources are considered for forest, swamp, tundra, steppe ecosystems and water basins. Management strategies should be based on complex assessment of the most important biological resources and a well developed ecological monitoring system providing appraisal of natural and human impacts.

Russia supports a greater area of forest than any other country in the world. Extensive territories of boreal forests with unique undisturbed ecosystems have uniquely important significance for conservation of biodiversity and sustainability of the biosphere. Rational forest use should be based on improvement of forest management, long-term forecast of forest fund dynamics, improvement of forest fire protection and defense from pests and diseases.

Non-forest areas are occupied by meadow, steppe, semi-desert, desert, tundra and swamp ecosystems. At present many natural complexes are being subjected to strong anthropogenic impact. Steppe communities retained as relics of previous extensive areas in southern Russia are largely degraded. The scale of tundra degradation has increased due to development of natural resources in the Arctic. Forest and swamp complexes in Western Siberia have suffered environmental harm as a result of development of the oil and gas industry.

Russia has unique animal resources, and their conservation, reproduction and exploitation raise complex issues. Stocks of wild animals determine not only natural processes, but the very basis for survival of some ethnic groups—those historically connected with game animals. Aquatic biological resources of Russia satisfy society needs, but their use isn't full and rational sometimes. Decreases of some important fishery stocks, for example sturgeon, salmon and carp have been caused by exceeding catch norms and poaching. The biological resources of Russia are capable of fully satisfying the needs of society because of their size and diversity, providing the ecological functions can be preserved. New legislation is required as a basis for rational management of nature.

1. Introduction

The ecological security of the country and its sustainable development depends to a great extent on the levels of use and conservation of biological resources, represented by populations, species and living communities. Their intensive use in agriculture, forestry, hunting and trapping, and the medical-biological and pharmaceutical industries is increasing every year.

Biological resources as the basis for life-support and sustainable development of humankind are inexhaustible if their direct and indirect use doesn't destroy their regeneration potential and reduce biological diversity—the main depository of genetic information. So the usage of biological resources must be adequately combined with their conservation and restoration. It is important to realize that the value of biological resources is determined not just by their utility to humans. Each plant or animal biological resource is an important element of the natural environment, providing stability to the ecological functions of the biosphere, and aesthetic value to landscapes. Thus it is necessary to have a clear concept of rational nature management, combining resource and ecological components and reflecting structural changes of the modern socio-economic situation in Russia. Management strategies should be based on complex assessment of the state of the main biological resources and development of a monitoring system to provide assessment of the negative consequences of anthropogenic impact. To increase the productivity of biological resources new plant

and animal species should be researched and brought into productive use. Modern highly efficient biological technologies should be developed, and biological methods of protecting crops from pests and diseases should be improved. As Russia has great resource potential, especially in the less-developed regions, the conservation of the genetic resources of wild nature and their efficient use are considered issues of global significance.

2. Biological Resources of Plant Origin

The plant resources of the Russian Federation are of great value as the key to the natural renewal resource base required for the transition of the country, and its separate regions, onto a course of ecologically sustainable development.

The vegetation of the 1700 million ha of Russia's Land Fund is very diverse, mainly as a result of the wide climatic, geological and altitudinal variation. The primary productivity (stores of plant material and its annual production) is the most sensitive integral parameter of ecosystem state. The change of living phytomass is determined mainly by zonal distribution. The highest storage of biomass (more than 200 t ha^{-1}) is recorded in forest regions with natural predominance of climax communities, e.g. in the southern taiga, broad-leaved and coniferous/broad-leaved forests of European Russia, the Caucasus and the Southern Far East. At the same time in the northern regions with widespread water-logging and permafrost this parameter is much less, being only 1.6 to 2.0 t ha^{-1} within Arctic archipelagos. Living phytomass in arid regions of southern Russia does not exceed 8 t ha^{-1}. The natural biota of Russia as a whole is a unique resource producing 20 tons of organic matter per hectare annually on average, forest ecosystems producing the main mass. Within the territory of Russia vegetation communities produce as much as 230 tons of living biomass calculating per capita per year.

There are three main centers of floristic richness within Russia: the Northern Caucasus, Sayan-Altai mountains and Primorye (Southern Far East). The high biological diversity of mountain territories is a result of the great differentiation of habitats represented.

The status of wild flora and plant communities provides the basis for information about rare and vanishing species requiring protection. Assessments of these species have been carried out and the information presented as regional lists in the Russia's Red Data Books, along with regional Red Data books. The RF Red Data Book contains data on about 533 floral species in need of protection. There are 440 species (80%) of angiosperms, 11 species of gymnosperms, 10 fern species, 4 clubmoss species, 22 moss species, 29 lichen species and 17 species of fungi. Species requiring protection over the entire country had priority for inclusion in the Red Data Book.

Among 400 rare species within the flora of northwest European Russia, 140 species are requiring immediate protective measures. Other plants needing protection include 500 species in the Non-Chernozem zone, 375 species in Saratov oblast, and 188 species in Krasnodar Territory (including 127 species on the Black Sea shore). In recent years some species have disappeared, for example royal fern (*Osmunda regalis*)

which grew on the Black Sea Shore, and the cinquefoil (*Potentilla volgarica*) from Middle Povolzhye. Unique plant communities can be found not only in the Caucasus but also in the Caspian region, Transbaikalia, and the Pacific coast.

Within the northern part of Western and Eastern Siberia the plant species composition is less varied because of the lack of refuges for relics and endemic species of Tertiary flora. The relatively poor species diversity in boreal ecosystems is compensated by the considerable intraspecific variation in the main forest forming tree species. The relatively small number of species does not result in any decrease of natural ecosystem resistance because it is supported by diversity of forms and local adaptation. Biodiversity research and conservation measures in this region includes specific tasks such as forest seed zoning and establishing plantations of highly productive forest stands from seeds of different origin, providing form diversity.
The vegetation cover of Russia is dominated by forests. Non-forested land includes meadows, steppe, semi-desert and desert communities, plus tundra and swamp ecosystems. The plant resources of these natural biomes represent great national wealth, which are also of global significance.

2.1. Forest Vegetation

Russia has a larger area of forest than any other country in the world. It holds more than one fifth (22%) of the world's forest area and standing volume (Figure 1). Russian forests perform very important environmental and protective functions. They include 60% of the world's boreal forests. The extensive areas of virgin boreal forests with unique ecosystems undisturbed by human activity play an extremely important role in conservation of biological diversity and stability of the biosphere as a whole.

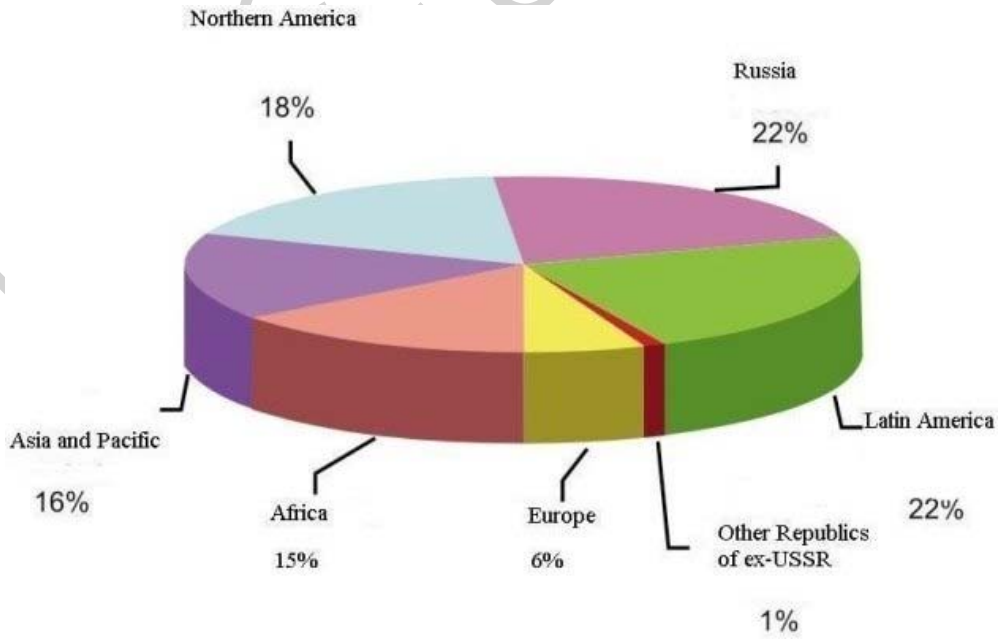

Figure 1. Distribution of forest lands over world regions.

The Forest Fund of Russia is represented by diverse forest vegetation in combination

with shrub thickets, swamps and meadows. The forest vegetation can be divided into three more-or-less geographically discrete (zonal) types: 1) boreal coniferous forests accompanied by swamps and meadows; 2) mixed coniferous and broad-leaved forests with their corresponding zonal swamp and meadow types, and 3) deciduous forests to the south of the dark coniferous taiga area.

These zonal types include various classes of vegetation formations based on the dominant forest-forming tree species. Their floristic composition, structure, geographical distribution, ecological and geographical links are determined by the natural characteristics of the area: climate, geology and geomorphology, soils, hydrology, and the history of forest cover. The main types of forest vegetation within the taiga zone are the following: dark coniferous (*Abies spp., Picea spp., Pinus sibirica, P. koraiensis, P. Pumila*), light coniferous (*Pinus sylvestris, Larix spp*, etc.) and small-broadleaved (birch and aspen) forests. The latter type has a secondary character. These forests have appeared on the site of former coniferous forests. The main areas of dark coniferous forests are located in temperate cold and rather humid territories. These types are predominant in the western part of the taiga zone in Russia where the influence of humid Atlantic air masses is strong. Within the continental regions of Siberia extensive areas of dark coniferous forests are characteristic of mountain territories where air humidity increases as a consequence of vertical differentiation and regional climatic peculiarities. Such conditions and snow cover protection are favorable for the growth of a specific form of dark coniferous forest—thickets of dwarf Siberian pine communities which are classified as shrubs in the state forest fund inventory. They have a wide distribution in the belt below the timberline of the North-East mountain ridges.

Larch forests are widespread in regions of extremely continental climate and permafrost in Eastern Siberia and the Far East. They have local characteristics in Western Siberia and in the East Russian plain. In the southern mountains of Eastern Siberia they border the dry steppes of Central Asia, and in the northern regions they grade into forest-tundra. Pine forests are widespread over the whole forest zone, with a particularly even distribution in the western forest zone, as far as the Yenisei River. They are typical of alluvial plains, extensive areas forming on sandy river terraces. Unlike the dark coniferous forests, pine and larch forests penetrate into the steppe zone. Birch and aspen forests occur everywhere in the boreal zone. Normally they developed after coniferous forests had been affected by cutting, fires or pest invasions. In Eastern Siberia where larch forests predominate, birch and aspen forests occupy extensive areas of formerly burnt forest. Aspen is more characteristic of the southern regions, particularly on more nutrient-rich soils.

Within the territory of Russia the mixed coniferous and broad-leaved forests consist of two separate natural areas—one in the European part (the Russian plain) and the other in the Far East (Amur basin and Primorsky Territory). Woody vegetation of these regions is very diverse in composition, structure and productivity because they arose under different historical, ecological and geographical conditions. Within the Russian plain the dark coniferous forests are represented by a combination of coniferous and broad-leaved stands or by proper mixed forests. Large areas were occupied by these forests in the past but now they are mostly under agricultural and other usage.

Coniferous and broad-leaved forests of the Far East are influenced by the Pacific monsoon, which provides high air humidity. These are mountain forests mainly with a small number of tree species and dominated by Korean Pine (*Pinus koraiensis*), and various fir and spruce species. At present these forests are being subjected to intensive anthropogenic impact, which is changing their appearance, particularly by cutting and forest fires.

The deciduous forests in the southern part of the forest zone are represented by diverse broad-leaved forests with oak predominating within the Russian plain, and birch and aspen forests in the Western Siberian lowland. To the east of the Yenisei this belt is not clearly marked—there are forest-steppe small birch forests with meadow steppes in Central Siberia, and isolated broad-leaved forests with dominant Mongolian Oak (*Quercus mongolica*) in the southern part of the Far East.
Russian forests exert considerable influence on all natural processes in the biosphere. The most important ecological function is considered to be their regulation role in atmospheric composition, due to CO_2 binding during photosynthesis and carbon accumulation in wood, soils, and peat. These processes are of special importance in assessment of possible climate changes and balance of greenhouse gases in the forest ecosystems.

On a global scale Russian forests play an important role in accumulation of organic carbon (see Table 1). Most of the accumulated carbon consists of detrital remnants and their decomposition products. The store of soil carbon accumulated in Forest Fund lands is 172.4 Gt, while the carbon pool in phytomass is 34.3 Gt and its rate of deposition is 240 Mt per year. The average carbon stock in forest phytomass is 30.9 t ha^{-1} and the average deposition value 0.22 t ha^{-1}. For land entirely covered with forest these values are 44.5 t ha^{-1} and 0.32 t ha^{-1} per year. The main process providing high carbon sequestration capacity in boreal forests is ‘swamping’, or accumulation of peaty material under waterlogged conditions. The carbon store in peat and boggy soils is 114-118 Gt.

	Carbon store, Gt C	
	Phytomass	**Soils**
Russia’s forests	34.4	172.4
World’s boreal forests	57	338
World’s forests	536	704
World’s terrestrial ecosystems (excluding agricultural lands)	654	1567

Sources: Isaev A.S., Korovin G.N. Carbon in Northern Eurasia Forests // Carbon cycle on the territory of Russia. – Moscow: Ministry of Science and Technology of the Russian Federation, 1999, - p. 165-201 (in Russian); Prentice I.C., Farquhar G.D., Fasham M.J.R., Goulden M.L., Heimann M., Jaramillo V.J., Kheshgi H.S., Le Quere C., Scholes R.J., Wallace D.W.R. The carbon cycle and atmospheric carbon dioxide // Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. – Houghton J.T., Ding Y., Griggs D.J., Noguer M., van der Linden P.J., Dai X., Maskell K., Johnson C.A. (Eds.) – Cambridge: Cambridge University Press, 2001. – p. 85-98.

Table 1. The carbon pool in terrestrial ecosystems

The resource and ecological potential of forests directly depends on their qualitative and quantitative characteristics and their distribution within the country. There are about 300 tree species and a great number of shrubs and lianas in Russian forests. However the main forest forming trees number not more then twenty species. Coniferous and hard-leaved forests are the most valuable and unique due to the tree species composition ("hard-leaved forests" is a term fixed in the Instruction on Forest Fund State Account for a determined list of broad-leaved tree species, the wood of which is harder than that of soft-leaved species). These forests form the most long-lasting and resistant ecosystems, providing a regulatory influence over natural processes including carbon sequestration.

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Biographical Sketches

Isaev Alexander Sergeevich is a Doctor of Biological Sciences, professor, and academician of the Russian Academy of Sciences. He is a specialist in the field of forest ecology, forest protection from pests and diseases, forest monitoring, resource and economic policy. He is the author of more than 250 scientific works (including 6 monographs) devoted to different problems of forestry. The fundamental researches for dynamics of forest pest number based on the phenomena theory for resistance of mobile ecological systems was completed under his leadership. An applied aspect of this theory is development of models for dynamics of forest insect populations, giving possibilities of prediction and regulation of pest numbers. He is one of the founders and leading executors of the program for satellite monitoring of Russian forests. The results of this works are widely used in forestry practice for assessment of Forest Funds and impact of various natural and anthropogenic factors on forest ecosystems.

For achievements connected with protection and rational use of forests he was awarded the Prize and Gold Medal of International Union of Forest Research Organizations (IUFRO), an Honorary Diploma of United Nations Environment Program (UNEP) (Global 500), and the Gold medal of RAS after academician V.N. Sukachev. He is a foreign member of the Bulgarian Academy of Sciences and an Honorary member of the American Society of Foresters.

- 1949-1954: Student of Leningrad Academy of Forestry;
- 1954-1960: Engineer of Moscow Forest Inventory Expedition;
- 1960-1988: Scientific researcher, Leader of Laboratory, Deputy Director, Director of the Institute for Forest and Wood, Siberian Division of Academy of Sciences of USSR;
- 1977-1988: Chairman of Krasnoyarsk Scientific Centre, SD AS USSR
- 1988-1991: Chairman of the State Committee on the Forest of USSR;
- 1991-1993: Chairman of Higher Ecological Council at Russian Supreme Soviet;
- Since 1978: Chairman of Scientific Council on the Forest, RAS;
- Since 1978: Editor-in-chief of magazine “Lesovedenye”.

Rybalsky Nikolay Grigorjevich is a Doctor of Biological Sciences, professor, and academician of Russian Ecological Academy. He is a specialist in the biology of soils, biotechnology, science of theory and practice of patenting and protection of copyright, and ecological safety.

He is the author of more than 130 scientific works devoted to different problems of ecology and nature management. He was leader or participant in the development and realization of state scientific technical programs: “Ecology of Russia” (1991-1992), “Conversion to Ecology” (1991-1993), and “Ecological Safety of Russia” (1993-1995). He is the leader of the “Biological Diversity” Section within the framework of State Scientific Technical Program.

- 1970-1975: student of Moscow State University after M.V. Lomonosov.
- 1975-1980: post-graduated education in Moscow State University.
- 1981-1990: senior researcher, leader of Sector for biotechnology and ecology, All-Union Scientific Research Institute of State Patent Expertise, State Committee for Inventions.
- 1991: head of Major Department of Nature, Ministry of Nature USSR
- 1992-1994: Deputy Minister of Ecology of Russia
- 1994-1997: General Director of Russian Ecological Federal Information Service, Ministry of Nature of Russia
- Since 1997: Director of National Information Agency «Natural Resources», Ministry of Nature Resources, RF.
- Director of National Selected Center INFOTERRA UNEP
- Deputy editor-in-chief of magazine «Use and Conservation of Natural Resources of Russia»
- Member of editorial board «Regional Ecology» magazine
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