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Biodiversity Conservation: From Ecosystem to the Ecosystem Approach[1]

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Abstract—The possibility of implementing 12 principles of the ecosystem approach is considered with regard to the results of meetings of the Conference of the Parties to the Convention on Biological Diversity (CBD) and recent international forums. The importance of these principles for achieving the main goals of the CBD is shown, and the role of biosphere reserves in solving urgent problems of biodiversity conservation and sustainable development in adjoining territories of subjects of the Russian Federation is discussed.

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Over the past few decades, global environmental changes caused by human activities have become an urgent problem, which has attracted more attention to ecology, the science of interactions between organisms and the environment. Many key ecological terms may be encountered not only in the scientific literature but also in political statements, at business forums, and in the mass media.

As a result of this enhanced attention to ecology, it is increasingly often viewed as a generalized system of knowledge on nature and the laws of its development. Therefore, environmental issues considered in ecological terms are often beyond the scope of ecology as a life science, which draws, in our opinion, unreasonably harsh criticism from some geologists (Zverev, 2003).

Undoubtedly, the UNESCO Man and the Biosphere (MAB) intergovernmental program has made a contribution to raising ecological awareness and increasing the social significance of ecology. In the early 1970s, MAB resumed studies on different types of ecosystems that had started in the framework of the International Biological Program (IBP), having amended the IBP agenda: anthropogenic impact on ecosystem was paid more attention, and humans were considered an integral part of some ecosystem types and the whole biosphere. We believe that this tendency, as well as the principles of the ecosystem approach, corroborates the social value of the noosphere concept that was put forward by Academician Vernadsky (1989). The noosphere determines the state of the biosphere if human activity in transforming the environment begins to play the decisive role in biospheric processes. Therefore, the increasing responsibility of humans for biosphere evolution should be the focus of attention at all levels of everyday life all over the world.

Participants of the United Nations Conference on Environment and Development (UNCED), also known as Earth Summit, held in Rio de Janeiro in 1992, emphasized that preservation of biodiversity has become a necessary condition for sustainable economic development. The Convention on Biological Diversity (CBD) was one of the most important documents adopted at the summit (*Convention*…, 1995). Priority tasks were set as soon as the first meetings of the parties to CBD, increasingly much attention being paid to preservation of not only individual species and their populations but also whole ecosystems.

The term "ecosystem" was coined by Tansley (1935), who defined it as a relatively stable system comprising a community of living organisms and their environment. Later, Odum (1975) redefined ecosystem as a unity comprising all organisms (i.e., the community) in a given area and interacting with the physical environment in such a way that the energy flow creates a distinct trophic structure, species diversity, and substance cycles within the system. Evans (1956) presented additional grounds for ecosystem to be the main subject of ecological studies. The history of various approaches to ecosystem study and of the formation of

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Table 1. Principles of the ecosystem approach adopted at the Fifth Meeting of the Conference of the Parties to CBD (*From Policy*…, 2000)

No.	Principle of the approach
1	The objectives of management of land, water, and living resources are a matter of societal choice
2	Management should be decentralized to the lowest appropriate level
3	Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems
4	Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management program should: (a) reduce those market distortions that adversely affect biological diversity; (b) align incentives to promote biodiversity conservation and sustainable use; (c) internalize costs and benefits in the given ecosystem to the greatest extent feasible.
5	Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach
6	Ecosystems must be managed within the limits of their functioning
7	The ecosystem approach should be undertaken on the appropriate spatial and temporal scales
8	Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term
9	Management must recognize that change is inevitable
10	The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity
11	The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations, and practices
12	The ecosystem approach should involve all relevant sectors of society and scientific disciplines

this line of research in various scientific schools has been comprehensively covered in the literature (McIntosh, 1985; O'Neill et al., 1986; Golley, 1991, 1993; di Castri, 1991; Solbrig, 1991; Likens, 1992; etc.). Russian publications more frequently mention the biogeocenosis concept proposed by Academician Sukachev (1943) and further developed by his disciples and followers. The fundamental difference of biogeocenosis from ecosystem is that the former is characterized by strictly definable parameters within a specific landscape, and no additional boundaries can be drawn within a biogeocenosis (Sukachev, 1949).

Most modern ecologists use the term ecosystem, rather than biogeocenosis, making necessary corrections for its spatial boundaries. In addition, the word "ecosystem" is more widely used because it sounds acceptable in different languages. The recent monograph *Functional Ecology* (Kerzhentsev, 2006) contains numerous case studies on the structures and functions of ecosystems; this monograph may be useful for specialists participating in ecosystem studies, in particular, in biosphere reserves. Below, we will consider CBD recommendations on the application of the ecosystem approach to biodiversity conservation.

The ecosystem approach was discussed and recommended for implementation at the Second Ordinary Meeting of the Conference of the Parties to CBD held in Jakarta in 1995. It is believed that the ecosystem approach may be used to guarantee the achievement of three CBD goals, namely, the preservation, sustainable use, and equitable distribution of all benefits from the use of genetic resources. In June 2001, the Russian National Forum was held in Moscow, where all stakeholders discussed, and agreed upon, the main objectives of the National Strategy and Action Plan (*Natsional'naya strategiya*…, 2001; *Natsional'nyi plan*…, 2001). These documents, which were intended to play an important role in the implementation of CBD principles in Russia, emphasized that biodiversity preservation requires both the population/species and ecosystem approaches, with the hierarchical structure of the animate matter taken into account. It should be admitted, however, that little has been done for actually implementing the ecosystem approach into various projects and activities in the years that have passed since the National Forum, which has induced us to look at the experience of other countries.

After the Second Ordinary Meeting of the Conference of the Parties to CBD, the implementation of the ecosystem approach has been repeatedly discussed, mainly at meetings of the Subsidiary Body for Scientific, Technical, and Technological Advice (SBSTTA) to CBD. The characteristic features of this approach (why it is important for CBD and what is necessary for

its implementation) were most comprehensively considered at a meeting in Lilongwe, the capital of Malawi, more than 10 years ago (January, 1998). Discussions at this meeting, attended by experts from different countries and international organizations, resulted in formulation of 12 principles (Table 1). Afterwards, they were comprehensively discussed at several international conferences (*Proceedings*…, 1999; *Report*…, 1999, 2003, 2004; etc.) and, at the Fifth Meeting of the Conference of the Parties to CBD in Nairobi in 2000, recommended for use in all countries that signed CBD (*From Policy*…, 2000).

Close examination of the 12 principles shows that most of them should be implemented in the economic context, and others are important for agencies mainly dealing with the use, rather than preservation, of biodiversity. For ecology, where ecosystems have been the main subject for many decades, principles 5–7 are of special interest; however, implementation of the other nine principles also requires assistance and advice from ecologists. We regret to say that, not only in Russia but also in many other countries, many important decisions concerning biodiversity conservation and nature protection are made without direct participation of ecologists. The reasons for this situation are various; however, now that preserving the biosphere as the human habitat has become a priority problem, urgent measures must be taken before it is too late. This will require active participation of ecologists and a considerable contribution of fundamental science of ecology into practice. We hope that this review of international experience in implementing CBD recommendations will be useful for extending in-depth ecological studies necessary for biodiversity conservation in Russia.

At the Fifth Meeting of the Conference of the Parties to CBD in Nairobi, the MAB/UNESCO Secretariat publicized an illustrated booklet describing the implementation of the 12 principles of the ecosystem approach in the World Network of Biosphere Reserves (UNESCO…, 2000). In this booklet, the results of studies started in the framework of the UNESCO MAB program as early as 1972 are used to analyze the functioning of different types of ecosystems in individual biosphere reserves. Examples of the use of this knowledge for maintaining the key species in ecosystems and restoring deteriorated ecosystems are given. It is also noted that "Annals of Nature" kept in Russian state reserves for many years are important for estimating trends in ecosystem development under conditions of global change. The experience of European and South American countries that have managed to improve the efficiency of ecosystem protection by organizing cross-border biosphere reserves and coordination of efforts on the basis of agreements on cooperation is emphasized.

Three regional meetings (in South Africa, South America, and Southeast Asia) were held in 2000 to discuss the results of 26 pilot projects on achieving the CBD goals on the basis of the Malawi principles of the ecosystem approach. The Commission on Ecosystem Management (CEM) of the International Union for Conservation of Nature (IUCN) has played an important role in summarizing the results obtained. Supported by the CBD Secretariat, it published special reviews on the subject (*Ecosystem*…, 2000; Smith and Maltby, 2003; Shepherd, 2004). At several conferences held in Germany, further development of the ecosystem approach under different socioeconomic and environmental conditions was discussed and international debates were critically reviewed (Hartje et al., 2003). For example, a program for management of forests (which cover almost one-third of the total area of Germany) was based on all 12 principles of the ecosystem approach (Hausler and Scherer-Lorenzen, 2001). It was noted that the principles are defined so generally that they are difficult to interpret; nevertheless, the authors believed that the ecosystem approach, even in the form recommended by CBD, could be useful for ecological optimization of sustainable forest management in Germany. In the framework of the National Forest Program, many owners of forested estates may support this approach, which will be useful for achieving the goals of sustainable development. This experience is obviously interesting in terms of forest management in Russia, where economic reforms cause substantial changes and sustainable forest use is one of the objectives.

Paulsch et al. (2003) considered the compatibility of the ecosystem approach principles with the goals of the Alpine Convention in Germany. As in the case of the estimation of the applicability of this approach to forest ecosystems (Hausler and Scherer-Lorenzen, 2001), it was noted that some principles were defined too "theoretically," which interferes with using them in practice. For example, CBD (some of the parties to which are European countries) emphasizes the importance of principle 3, according to which the actual and potential effects of an ecosystem on adjacent areas should be taken into account. This condition is clearly defined in CBD; however, it is not met in some countries that signed CBD, because effective monitoring systems do not allow complete implementation of the principle. We believe that not only principle 3 but also other principles of the ecosystem approach included in CBD must help in conservation and sustainable use of biodiversity in highland areas.

In this connection, the experience of the Alpine Convention as a model of the practical use of the ecosystem approach principles is very attractive for Russia. Russia borders on many Eurasian mountain areas characterized by the highest biodiversity parameters; however, the corresponding conventions (primarily, the Caucasian and Altaic ones) have not yet been signed. Most likely the implementation of CBD recommendations on the ecosystem approach will help to speed up the signing of such agreements, which are important for preservation and sustainable use of biological resources in mountain regions along the borders.

Management of aquatic ecosystems and conservation of water resources are also among the priorities. The international community has recognized that the problem of global potable water deficit may be exacerbated within a few years. Global water consumption has increased by a factor of six over the past 100 years, and it is expected to double by the year 2050. A workshop on the application of the ecosystem approach to the management of inland water systems and their biodiversity was held in the framework of the Tenth Global Biodiversity Forum in Bratislava in May 1998 (*Report*…, 1998). Although the participants supported this approach, it was suggested that the CBD Secretariat prepare a manual that CBD member states could use for developing their national and regional strategies and action plans. In connection with the necessity of training specialists and developing programs for implementation of the ecosystem approach, the participants of the forum asked the CBD Secretariat to inform the Global Environment Facility (GEF) about the necessity to allocate additional resources specially for the conservation and sustainable use of the biodiversity of aquatic ecosystems.

Examples of good practice in using the ecosystem approach for managing aquatic ecosystems are noteworthy. The European Union (EU) has developed the Water Framework Directive (WFD) whose goal is to improve the qualitative parameters of freshwater ecosystems and, hence, ecosystem services within 15 years. Hartje and Klaphake (2006) believe that, although this directive exemplifies an implicit use of the ecosystem approach to only one type of ecosystem, it makes it possible to judge the possibility of applying it to other ecosystem types at both national and international levels.

Successful use of this approach will require changes in administrative and legal structures before planning of activities even in a single river basin if it is located in more than one EU country. This is why the ecosystem approach to water resource management developed by the EU is difficult to use in the EU itself, and even more so in other regions, taking into consideration the specificity of environmental policy, administrative traditions, and differences in economic development. Hartje and Klaphake (2006) cite another example: the water ecosystems of the basins of seven large rivers in the United States are being conserved, restored, and sustainably used owing to the ecosystem approach. An important prerequisite of this good practice is that the United States Federal budget allocates funds for the use of the ecosystem approach. Probably, other countries could also achieve more success in this field if sufficient funds were allocated for such activities.

Tishkov and Petrova (2002) attracted attention to the important role of the ecosystem approach in biodiversity conservation at the regional and local levels in Russia. Tishkov (2003) was even more precise when advocating the use of the ecosystem approach to save the steppe biome, which is now disappearing from the face of the earth. At an international workshop in Germany, Shestakov (2003) discussed the possibility of using the ecosystem approach for achieving the CBD goals in Russia and noted that the main difficulties arose from the lack of proper legislative and financial support in the period of transition to a new economic policy. We analyzed the ecosystem approach principles (Table 1) as applied to the Volga River basin and the European population of the saiga living on the right bank of the Volga (Bol'shakov and Neronov, 2005; Neronov et al., 2005) and found a remarkable lack of interagency coordination, which prevents complete implementation of these principles under the given conditions.

Participants of the GEF project Conservation of Biological Diversity in Russia (*Proekt GEF*…, 2003), a separate component of which dealt with biodiversity conservation in Lake Baikal and the Baikal region, also encountered difficulties using the ecosystem approach. In this case, the ecosystem approach required, first, establishing a *system for coordination* of activities on biodiversity conservation between subjects of the Russian Federation, various agencies, and local stakeholder groups; second, adoption of a *unified policy* of biodiversity conservation throughout the Baikal region; third, *integrated use* of political, informational, economic, and legal tools for biodiversity conservation; and fourth, *due regard to essential specificity* of each subject of the Russian Federation in the region and each ecological zone of the Baikal natural area. Finally, one more characteristic feature of the ecosystem approach as applied to the given situation is the necessity of *engaging and uniting the civil society* of the region on the common platform of unified strategic principles of biodiversity conservation in the Baikal ecosystem. The results of the Baikal component in the fields listed above are described in detail elsewhere (*Obzor*…, 2002).

Between 2002 and 2007, the United Nations Environment Programme (UNEP) and GEF supported the project on an Integrated Ecological Approach to Conservation of Biological Diversity and Decreasing Habitat Fragmentation in Three Model Areas of the Russian Arctic (ECORA). Judging from the title, this project was also expected to use the ecosystem approach; however, we did not find any publications on the corresponding studies in the framework of the project or references to them on the project's website (http://www.grida.no/ecora/documents.aspx).

The Earth Summit on sustainable development in Johannesburg (2002) recognized the ecosystem approach to be one of the most important tools for sustainable development and struggle against poverty, which stimulated its further development and correction in the framework of CBD. This decision was partly provoked by ecosystem assessment at the turn of the millennium starting in 2000 on the initiative of the United Nations General Assembly. The results of the integrated assessment carried out by more than

Table 2. Ecosystem services (*Otsenka ekosistem*…, 2003)

Services		
supplying	regulatory	cultural
Resources produced or supplied by ecosystems	Benefit or advantage from the regulatory effect of ecosystem processes	Nonmaterial benefit from ecosystems
Food Fresh water Firewood Fiber Biochemical compounds Genetic resources	Climate regulation Protection against diseases Protection against floods Detoxification	Spiritual Recreational Esthetic Inspiring Educational Symbolic Communal
Maintaining		
Services maintaining life on the earth: (a) nutrient cycles; (b) soil formation; (c) pollination.		

4000 experts from different countries over five years were published in a multivolume series (*UNEP/GEF Project*…, 2005). The results demonstrating a considerable and almost ubiquitous decrease in various ecosystem services (Table 2) raised concern at many levels, especially in the countries where subglobal assessment was performed.

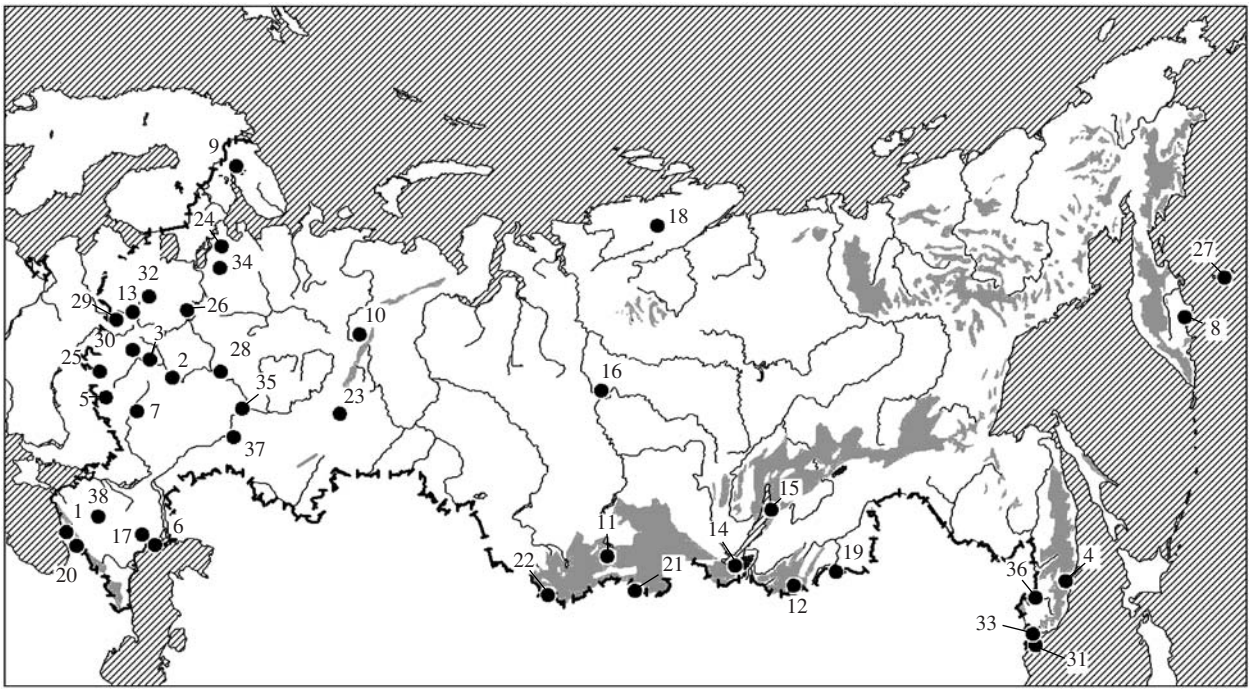
In Russia, this assessment, supported by the World Wildlife Fund (WWF), was made for the Altai–Sayan ecoregion (*Otsenka ekosistem*…, 2003); the methodologies developed in the course of this project may be used in other Russian regions. Certainly, this will require involvement of ecologists and support of both the Ministry of Natural Resources and Ecology of the Russian Federation and the authorities of the subjects of the Russian Federation that will decide to assess the state of "their own" ecosystems.

UNESCO, as well as other United Nations agencies, has incorporated the results of the ecosystem assessment at the turn of the millennium into its current activities, including the MAB program.

One example of due regard to recommendations of international organizations is Germany, where the ecosystem approach is being implemented into practice on a large scale (*The Ecosystem*…, 2006; *Full of Life,* 2005; Gundling, 2002). Primarily, all 14 German biosphere reserves serve as a basis for permanent environmental monitoring; conditions for wildlife preservation are ensured; and measures on raising ecological awareness and development of ecological tourism are made. Economic activities in biosphere reserves themselves are thought to play a special role, and a relatively large number of people live in many of the German biosphere reserves. It has been found that the ecosystem approach may ensure normal human–environment interactions and increase productivity in various branches of the economy. This is possible because the government substantially supports biosphere reserves. This support allows specialists managing biosphere reserves to strictly coordinate efforts towards implementation of some specific principles of the ecosystem approach and ensures free access to the necessary information, including that required for extending the intra- and interregional networks.

In February 2008, the Third World Congress of Biosphere Reserves was held in Madrid. The congress adopted the Madrid Action Plan for the near future (http://www.unesco.org/mab/madrid/doc/E_MAP220408.pdf), a separate paragraph (14.1) of which assigned all biosphere reserves (a total of 531 in 105 countries) the task of wider use of the ecosystem approach for estimating the state of ecosystem services, conservation of biodiversity, and sustainable development. Finally, the Ninth Meeting of the Conference of the Parties to CBD was held in Bonn in May 2008. Its agenda included additional analysis of the results of ecosystem assessment at the turn of the millennium and data on the implementation of the ecosystem approach prepared at the 12th meeting of SBSTTA (Paris, July 2007). This analysis served as the basis for additional recommendations on implementing the ecosystem approach (http://www.cbd.int.sbstta/). Evaluation of the progress in implementing the adopted recommendations will require specific indicators of efficiency, additional scientific substantiation, and raising community awareness of the advantages of this approach for biodiversity conservation. It is obvious that new requirements can hardly be fulfilled unless specialized organizations or coordinating agencies at the national level are established, particularly as the deadline for achieving the millennium goal of restraining the growth of biodiversity losses is not far off (scheduled for 2010).

Today, there are 38 biosphere reserves in Russia (figure), all of which have relatively large "cores" with protected natural ecosystems. Some reserves have addi-



The network of Russian biosphere reserves. In the following list, the years of joining the UNESCO's World Network of Biosphere Reserves are indicated in parentheses after the name: (1) Kavkazskiy (1978), (2) Okskiy (1978), (3) Prioksko-Terrasnyi (1978); (4) Sikhote-Alinskiy (1978), (5) Tsentral'nochernozemnyi (1978), (6) Astrakhanskiy (1984), (7) Voronezhskiy (1984), (8) Kronotskii (1984), (9) Laplandskiy (1984), (10) Pechora–Ilychskiy (1984), (11) Sayano–Shushenskii (1984), (12) Sokhondinskiy (1984), (13) Tsentral'nolesnoy (1985), (14) Baikalskiy (1986), (15) Barguzinskiy (1986), (16) Tsentral'nosibirskiy (1986), (17) Chernye Zemli (1993), (18) Taimyrskiy (1995), (19) Daurskiy (1997), (20) Teberdinskiy (1997), (21) Ubsunurskaya Kotlovina (1997), (22) Katunskiy (2000), (23) Visimskiy (2001), (24) Vodlozerskiy (2001), (25) Nerussa–Desna Polesye, (26) Darvinskiy (2002), (27) Komandorskiy (2002), (28) Nizhegorodskoe Zavolzh'e (2002), (29) Smolenskoe Poozer'e (2002), (30) Ugra (2002), (31) Far Eastern Marine (2003), (32) Valdaiskiy (2004), (33) Kedrovaya Pad' (2004), (34) Kenozerskiy (2004), (35) Great Volzhsko–Kamskiy (2005), (36) Khankaiskiy (2005), (37) Middle Volga (2006), (38) Rostovskiy (2008).

tional, legally established zones for collaboration with residents of adjacent areas. Therefore, we think that the Ministry of Natural Resources and Ecology of the Russian Federation should assign the tasks of finalizing the methodologies for implementation of the ecosystem approach in different subjects of the Russian Federation and substantiation of the "efficiency indicators" to biosphere reserves. In this case, at least some of the biosphere reserves may actually become analytical, training, and information centers for sustainable development.

At the Ninth Meeting of the Conference of the Parties to CBD in Bonn in May 2008, it was suggested that new results of the efforts toward the conservation and sustainable use of biodiversity on the basis of the ecosystem approach should be publicized in the next CBD national reports (http://www.cbd.int/cop9/). The progress in implementing the Madrid Action Plan should also be regularly reported to UNESCO. Thus, specialists developing fundamental and applied aspects of ecology face difficult tasks. We believe that, to solve them successfully, it is necessary to restore and enhance, without delay, relationships of biosphere reserves and other types of specially protected natural areas with research institutes of the Russian Academy of Sciences, as well as universities and other higher educational institutions. Earlier, Tishkov (2007) put forward a similar proposal with reference to the principles of the ecosystem approach at the conference devoted to the 75th anniversary of the Central Forest Biosphere Reserve. We believe that this cooperation will finally make a considerable contribution to meeting the requirements of the Ecological Doctrine of the Russian Federation (2002) aimed at improving the quality of the environment and health of the population in Russia.

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