Studies on the Problems of Sustainable Development and School Ecological Monitoring of Water Reservoirs

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Abstract

In order to realize the strategy of the world community in the field of education for sustainable development, the D. Mendeleev University of Chemical Technology of Russia and non-profit organization Love Russia (Great Britain) organized for schoolchildren the teaching of the fundamentals of sustainable development problems and of river water and air quality ecological monitoring. The pupils of more than 50 schools, boarding schools and social rehabilitation centers for minors were involved in practical ecological monitoring within 2004–2007, who have monitored water in the Kasimov, Shilovo, Spassk Districts of the Ryazan Region and investigated more than 150 objects within a 200 km wide corridor lengthways the Oka River. The results obtained in the investigation were considered as a part of ecological audit and discussed from the standpoint of a practical example of the social responsibility of humans for the processes occurring in the biosphere. A positive experience of the lessons concerning the studies on the problems of sustainable development and carrying out ecological monitoring of wild nature allows the authors to propose these courses as a compulsory regional component of the school education process.

Key words: education, sustainable development, ecology, monitoring

INTRODUCTION

In April, 2008 the Executive committee of UNESCO has unanimously accepted the resolution for supporting the IUPAC initiative to have the year 2011 designated as International Year of Chemistry. This event should emphasize the importance of chemical sciences in solving the problems concerning sustainable development of biosphere, in supplying mankind with clear water, foodstuffs and energy, in mitigating the consequences of climatic changes. It is noted in the resolution of UNESCO that economic successes of the world community, health of mankind, quality of people's life of and rigorous vital activity of biosphere are directly connected with the progress in chemistry and with the development of sustainable development science.

Academician V. A. Koptyug, the founder of the journal "Chemistry for Sustainable Development" repeatedly emphasized the following: the major component of sustainable development consists in forming a new moral ideal of a person who changes one's own needs on a voluntary basis and takes upon oneself all the responsibility for living conditions of other people and of all the species of living creatures on the Earth. Just this concept underlies the resolution of the UNO which have declared the period from 2005 to 2014 to be the decade of education for sustainable development. March, eighteenth, 2005 the Strategy of United Europe in the field of education for sustainable development has been accepted, which assumes the further implementation of theoretical and practical training directed on formation of the

social responsibility of young generation for man-caused processes occurring in biosphere, into school and university courses.

Earlier [1] the journal "Chemistry for Sustainable Development" presented a description of the experience of the D. Mendeleev University of Chemical Technology of Russia (UCTR) where the recommendation of the world community that studying of the problems of sustainable development should be organized within the framework of a separate common course of university education has been for the first time realized. Since 2001 lectures are being read within the framework of such courses as "The problems of sustainable development", "Analysis and management of man-caused hazards" to the students of all the faculties of the UCTR, training games are being held concerning the newest educational subjects those are based on the interdisciplinary and system approach to studying the basic problems of the interaction between humans and environment from the standpoint of the principles of sustainable development. In addition, seminars, extension courses for teachers are organized on a regular basis, educational films are created and shown where such concepts are considered as stability and instability of dynamic systems, biosphere as dynamic system, its physical and chemical characteristics; the basic laws of ecology; the information about resources, man-caused impact on the biosphere, about the management of environment quality; modern trends in the processes of globalization; economic, sociopolitical and ethical problems of sustainable development.

Within the framework of the realization of the world community strategy in the field of the education for sustainable development the UCTR and the non-profit organization Love Russia (Great Britain) have started teaching theoretical bases of the problems of sustainable development not only for university students, but also for schoolchildren. Moreover, they have organized a practical ecological monitoring of river water and of air quality with the participation of schoolchildren of the Ryazan Region [2].

Russian schoolchildren, as a rule, study carefully enough the theoretical base of natural science, exact sciences and the humanities within the framework of the state educational program. At the same time the use of the theoretical knowledge obtained at physics, chemistry, mathematics lessons and at practical training anticipating the excursions to observe wildlife are realized only in rare cases. There are no such subjects as ecology and sustainable development at the overwhelming majority of the Russian schools. The technique of conducting the lessons in "Bases of ecology" held at all the Russian schools in 1995–1998, has been recognized unsuccessful, thus in this connection after 1998 this subject has disappeared from the school programs.

Only at the secondary schools of Moscow, due to the enormous efforts of Corresponding Member of the RAS G. A. Yagodin, it was possible to revive teaching the bases of ecological knowledge at a new education level: an extremely important subject "Ecology of Moscow and sustainable development" has appeared among school courses. A "City experimental platform" has been created under the title of "Ecological education for the sake of sustainable development" in order to train school teachers conducting the lessons concerning the subject "The ecology of Moscow and sustainable development". This subject new for Moscow schools has become an obligatory one as a regional component of school education process.

Unfortunately, nowadays such a subject is taught only at schools of Moscow. Regional laws concerning ecological education are accepted in 13 subjects of the Russian Federation. However, at the overwhelming majority of the Russian schools there are no subjects considering the problems of ecology and sustainable development included in the programs at all, in spite of the fact that the United Nations declared the decade of 2005–2014 to be the Decade of education for sustainable development.

Against this background it is especially pleasant that the Administration of the Ryazan Region has agreed to begin a work concerning ecology and sustainable development with schoolchildren.

The work with schoolchildren has begun in 2004 in the Shilovo District (the Ryazan Region) according to the agreement with the head of the Administration of the District. The lessons are based on the practical use of scientific data obtained at school for observing natural processes, personal participation in ecolog-

ical monitoring as well as the formation of solicitous attitude to the natural environment, rather than on learning the rules and laws by rote. In all, schoolchildren of more than 50 schools, boarding schools and social rehabilitation centres for minors of the Ryazan Region have been involved in practical ecological monitoring within 2004–2007, by whose forces more than 150 objects were investigated.

Conducting open-air lessons concerning the monitoring of fresh-water flora and fauna, determining the quality of air with the use of simple and available equipment allows a teacher to cultivate in schoolchildren the skills of studying the environment those they could use both in their adult life and already today: on country sites, during their walks or travel. Such lessons promote in pupils the development of interest with respect to the processes proceeding in the biosphere, help them in paying attention to the beauty of the world where they live, as well as bring up the children to behave solicitously toward wildlife.

During the period of 2004–2007, air and water monitoring was carried out within a 200 km wide corridor lengthways the Oka River in the Kasimov, Shilovo, Spassk Districts of the Ryazan Region, the condition of eight rivers with regular navigation flowing across the land sites with a high population density and the sources of intense agricultural and industrial activity.

The results obtained are considered to be a part of ecological audit and discussed from the standpoint of a practical example with respect to the social responsibility of humans for the processes occurring in the biosphere [2].

The ecological audit includes the inspection of industrial, agricultural and household waste products, studying the populations of birds, butterflies, ladybirds as well as performing the phenological monitoring. The work started concerning the gathering of these data is supposed to be continued.

In the practical work with schoolchildren we used the experience gained in the Great Britain and approved by Simon Young, the Director of the British National Reserve on the Wight Island [3].

EXPERIMENTAL

For carrying out the monitoring of river water we used a bioindicator method based on the analysis of invertebrate inhabitants of fresh-water reservoirs. Invertebrate organisms those could be found out in the Russian fresh-water reservoirs are very similar to invertebrate inhabitants of the British rivers and lakes, therefore we have found possible to use the British key [4].

The equipment for carrying out the monitoring was simple enough and quite available: the British key [4], nets, magnifying glasses, trays, paper, pencils, rulers, cellophane film.

Before practical training we demonstrated educational films [5, 6] to the schoolchildren where it was told about the techniques of water and air monitoring, which techniques were developed by the Ecological Education Department of the Newtown British National Wildlife Reserve on the Wight Island and were adapted to the Russian conditions. Unfortunately, there are no equipment (DVD players, projectors, sound amplifiers) required for the demonstration of video films at many Russian schools.

The essence of practical work concerning water monitoring consisted in capturing inhabitants of fresh-water reservoirs and identification according to the keys. The water reservoirs were then labelled with corresponding values of biotic indices indicating the contamination level for the reservoir.

Almost all the schoolchildren participated in the practical work of ecological monitoring for the first time in their life. Schoolchildren worked in subgroups consisting of five or six persons; the biotic index was calculated according to ten-point scale in each subgroup. Further the results obtained in each separate subgroup, were processed in order to calculate the average values of biotic indices. All schoolchildren of a school took part in the practical works. Upon termination of the monitoring, stands with photos and reports on water-reservoir monitoring were placed at some schools.

RESULTS AND DISCUSSION

Table 1 demonstrates the biotic indices of water quality in some water reservoirs of the Ryazan Region determined within the period from 2005 to 2007. One can see that for the majority of the rivers under investigation they exhibit low and medium values (4–6).

TABLE 1

Biotic indices for water quality in some water reservoirs of the Ryazan Region (2005–2007)

Reservoir (the nearest settlement)	Coordinates	Width of the river, m	Date acquisition date
Priokskiy boat-yard	54°22'N; 40°20' E	200	14.05.07
Priokskiy boat-yard	54°22'N; 40°22' E	200	17.05.07
Priokskiy boat-yard	54°22'N; 40°24' E	200	18.05.07
Priokskiy boat-yard	54°23'N; 40°24' E	200	29.05.07
The Pronya River (The Perkino)	54°15 N; 40°21' E	200	11.10.05
The Pronya River (The Kiritsy)	54°15' N; 40°20' E	10	15.05.07
The Pronya River (The Kiritsy)	54°15' N; 40°19' E	15	15.05.07
The Oka River tributary(the Mosolovo)	54°15' N; 40°31' E	20	26.10.06
The Yaroslavka River (the Zadubrovye)	54°16' N; 40°39' E	10	25.09.06
The Yaroslavka River (the Zadubrovye)	54°16' N; 40°41' E	10	11.05.04
The Yaroslavka River (the Zadubrovye)	54°16' N; 40°41' E	10	25.09.06
The Pra River (the Zheludyevo)	54°15' N; 40°55' E	40	14.10.05
The Pra River (the Zheludyevo)	54°15' N; 40°55' E	40	22.09.06
The Ibred" River	54°15' N; 40°51' E	0	07.05.07
The Ibred" River	54°16' N; 40°51' E	15	07.05.07
The Pra River	54°17' N; 40°57' E	70	09.05.07
The Oka River (the Shilovo)	54°18' N; 40°52' E	250	09.05.04
The Oka River (the Shilovo)	54°18'N; 40°52'B	250	03.05.07
The Oka River (the Shilovo)	54°18'N; 40°52' E	250	15.10.05
The Oka River (the Shilovo)	54°18'N; 40°52' E	250	24.10.06
The Oka River (the Pribrezhnyi)	54°20' N; 40°53' E	250	12.05.04
The Oka River (the Pribrezhnyi)	54°20' N; 40°53' E	250	18.09.06
The Milchus River (the Inyakino)	54°25' N; 41°06' E	20	17.05.04
The Milchus River (the Inyakino)	54°25' N; 41°06' E	20	13.10.05
The Lakashka River (The Lakash)	54°38' N; 40°54' E	5	10.10.05
The Oka River (The Tyrnovo)	54°27' N; 41°00' E	200	27.09.06
The Oka River (The Tyrnovo)	54° 27' N;41° 00' E	200	10.05.07
The Oka River tributary (The Tyrnovo)	54° 27' N;41° 00' E	4	10.05.07
The Myshtsa River (the Svinchus)	54° 32' N;41 04' E	10	12.10.05
The Oka River (the Svinchus)	54° 33' N;41° 04 E	250	20.09.06
The Oka River tributary (the Pochinki)	54° 41' N; 41° 24' E	10	14.05.06
The Oka River tributary (the Pochinki)	54° 41' N; 41° 24' E	10	21.09.06
The Oka River tributary (the Pochinki)	54° 41' N; 41° 24' E	10	21.09.06
The Opra River	54°42' N; 40°50'E	150	13.05.07
The Oka River (The Narmushad)	54° 40' N; 41° 03' E	250	19.09.06
The Oka River tributary (The Kasimov)	54° 56' N; 41° 17' E	10	07.10.05
The Oka River (The Kasimov)	54° 53' N; 41° 22' E	300	12.10.06
The Babenka River (The Kasimov)	54° 55' N; 41° 22' E	20	11.10.06
The Babenka River (The Kasimov)	54° 55' N; 41° 22' E	20	11.10.06
The Oka River (The Elatma)	54° 57' N; 41° 44' E	300	06.10.06
The Oka River (The Elatma)	54° 57' N; 41° 44' E	300	26.04.07

Biotic index value	Comments
5	Beyond the Spassk
4.8	Near the Spassk
4.2	Near to the place of flowing into the Oka River, nearby to the city and industrial objects
3.9	Near to the place of flowing into the Oka River
4.9	In the river bottomland, near to several industrial objects
2.25	Water discharge from a polluted lake dug out for the second time
4.5	300 m downstream with respect to the previous place
4.2	Downstream with respect to the factory
4.6	Upstream with respect to the village, the point of sewage and garbage discharge
0	The river is completely contaminated with industrial wastes
4.6	For today the work of the factory is stopped. The river is restoring
4.7	The settlement of rural type nearby to industrial objects
4.7	The settlement of rural type nearby to industrial objects
5	1 km upstream with respect to the point of industrial wastes discharge
1.5	In the immediate proximity to the point of industrial wastes discharge
5.2	Omitting the place where the Ibred River flows into the Pru River, 2 km from the point of industrial wastes discharge
4.9	Near to a large urban-type settlement, as well as to the points of industrial wastes and wastewater discharge
4.9	The same
4.25	The same
5	The same
4.8	Downstream with respect to a large urban-type settlement, as well as the points of industrial wastes and wastewater discharge
4.6	The same
4.4	Rural-type settlement, nearby to a pig farm located upstream
5.2	Rural-type settlement, a large pig farm has been closed down in 2004
3.9	Nearby to the point of wastewater discharge (a settlement and a farm)
6	Large river, at a significant distance from the Shilovo
5.3	Large river flowing through meadows and large forests
5	Small fleeting tributary of the Oka River
4.6	Countryside, nearby to a beaver dam and farms
5.1	Large river; there are no known industrial objects, but there are farmers' grounds
5.5	Countryside
4.9	Downstream with respect to a large-scale farm
4.4	Small tributary flowing across a village
5	A peat river flowing through a reserve
4.6	Wide river within a cultivated bottomland
5.5	Forest river
4.9	Large river flowing across the city
2.7	1 km away from the point of wastewater discharge from the city sewage disposal plant
3.5	200 m downstream with respect to the previous site nearby to the Oka River
5	Very wide river flowing across the Elatma
6	The same

At the same time water in some rivers is characterized by much lower values of biotic indices, which could be connected with man-caused impact. So, the value of biotic index we have determined for the Lakashka River flowing near the Lakash settlement amounted to 3.9, which is caused by the fact that there is a point of wastewater discharge from the settlement and an agricultural farm near to the place of the monitoring carried out.

The biotic indices of the Babenka River flowing nearby to the Kasimov city vary within the range of 2.7–3.5. The minimal value (2.7) has been determined at a distance of 1 km from the Kasimov. Downstream the Babenka River several times curves, which results in a more active movement of water as well as in the saturation of the river waters with oxygen. At that some improvement of water quality is observed. At a long distance from the Kasimov, near to the place where the Babenka River flows into the Oka River, the value of biotic index increases up to 3.5.

Water quality of in the region of the Priokskiy boat-yard is reduced from 5 to 3.9 after the river flowing through the Spassk becomes considerably polluted.

Water in the Ibred River is heavily polluted with industrial wastes of a starch factory, whose percentage in the volumes the Russian production of starch and treacle amounts 20 %. At the place of waste products discharge the biotic index amounted to 1.5; one can notice the contamination of water with waste fungi such as *Tubifex* spp. and *Chironomid* spp., water being black in colour. The negative influence of the activities of the starch factory upon the quality of water is also indicated by the fact that the biotic index of water reached the value equal to 5 already 1 km away from the discharge point of the factory waste products, upstream the Ibred River.

Water in the Yaroslavka River in the region of the Zadubrovye settlement was also catastrophically polluted with the waste products discharged by a local starch factory. The biotic index we determined in 2004 was equal to zero. Two years after the activity of the factory had stopped, water quality improved, the biotic index grew up to 4.6 (see Table 1).

The schoolchildren taking part in the practical work who revealed a high contamination level in flowing water reservoirs located near starch factories could potentially face with the problem of a confrontation of residential population having the work at factory as the only source of income.

The monitoring of water in the Pronya River has revealed a poor quality of water (2.25) in area of the Kiritsy village owing to waters from a polluted lake. However, already 300 m downstream the biotic index of water of the same river amounted to 4.5 due to the processes of self-purification.

Water quality in the Oka River in the region of the Shilovo has almost not changed for the period since May 2004 to May, 2007. The biotic index of water in the Milchus River near the Inyakino has exhibited an increase from 4.4 in 2004 to 5.2 in 2005 due to closing down a pig farm discharged the wastewater to the river, as well as due to an annual rotation of water reservoir inhabitants.

The maximal biotic index value (6) for water of the Oka River has been registered at the places where the river flows through countryside far from industrial objects and the points of wastewater discharge. It has been established that the quality of water in the Oka River has almost not changed for the period of time from 2004 to 2007.

Nymphs of the caddis fly have been found out in the Myshtsa River and in a small tributary the Oka River nearby the Pochinki village, which indicates a potentially high content of oxygen in water. At the same time it should be noted that *Nemouridae* spp. exhibit an increased tolerance with respect to polluted environment.

In the course of practical work with the pupils of the Perkin secondary school at the Pronya River in October, 2005 they have found out mussels (bivalves), molluscan shellfish and snails identified as *Unio pictorum,* the fresh-water pearl-oyster *(Margaritifera margaritifera),* the mussel *(Dreissen polymorpha), Acroloxus fluviatilis* and the eelpout *(Viviparus* spp.). Besides they first have revealed the swan mussel *(Anodonta anotina)* in the waters of this river.

Figure 1 demonstrates the map of the Ryazan Region with pointing out the data concerning biotic indices of investigated water reservoirs. The use of biotic indices has allowed us

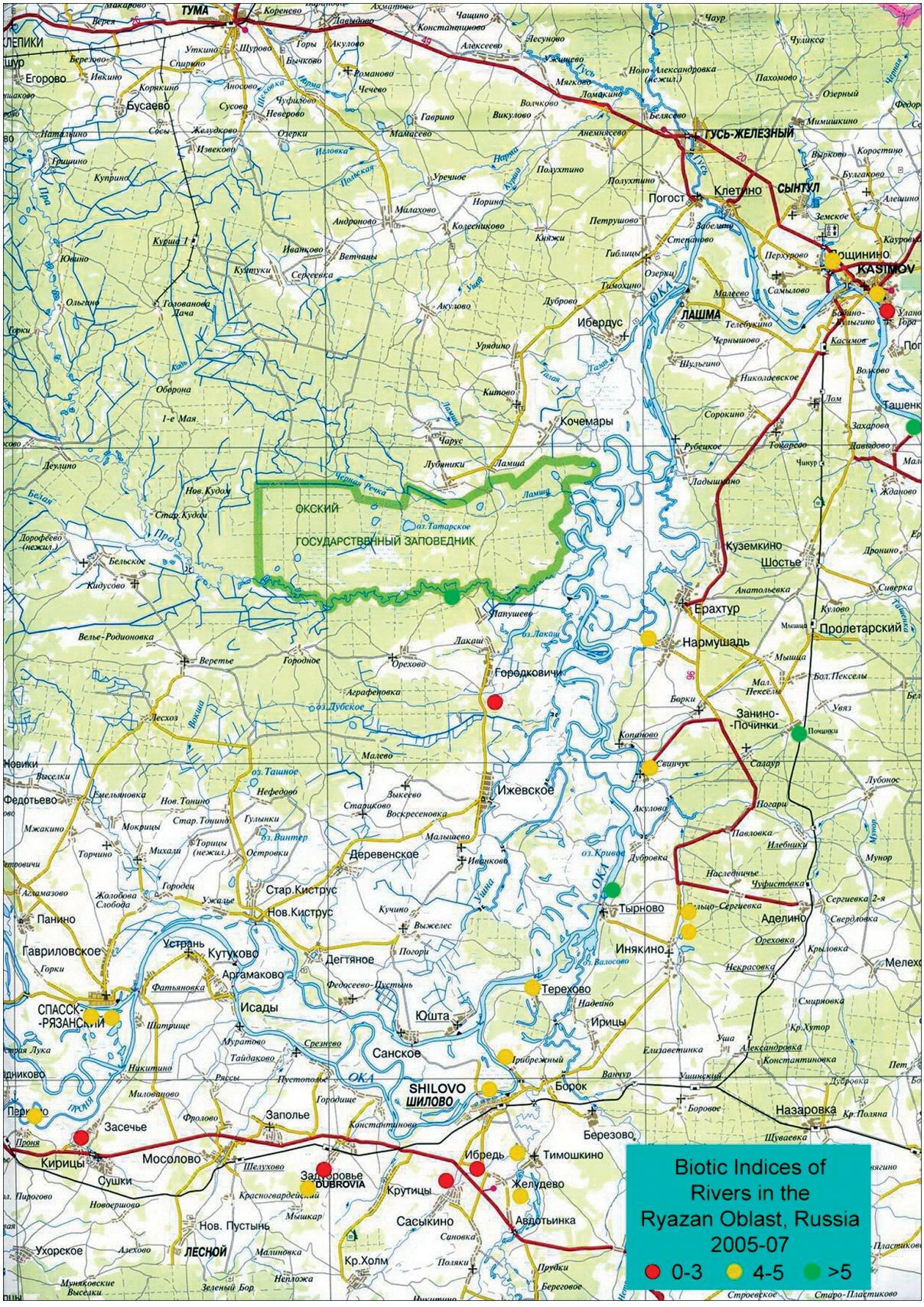

Fig. 1. Data concerning the biotic indices of water reservoirs investigated in the Ryazan Region (2005–2007).

to divide all the area under investigation into the zones of bad, medium and good ecological quality. The highest water quality has been registered in the area of the Prioksky Terraced State Wildlife Biosphere Reserve, whereas the lowest quality was observed in the area of industrial enterprises, agricultural objects and settlements.

Many schoolchildren, who participated in the monitoring, have shown a special interest to similar research work. Some of them have won various awards for the studies devoted to the problems of sustainable development. There is a schoolgirl Julia Sharova among them, the pupil of the Mosolovo school (the Shilovo District of the Ryazan Region) who used our system of monitoring. She has become a winner of the 2nd Ryazan Regional competition of schoolchildren in ecology of 2007, and then she has been rewarded with a Diploma of the winner of the 22nd Russian Open competition of scientific, research and creative works "National property of Russia" as well as a gold medal of "National system of science, creativity and innovation development among the youth of Russia"

CONCLUSION

The project had tremendously succeeded among the schoolchildren and teachers of the Ryazan Region. The positive experience of the lessons for studying the problems of sustainable development, as well as carrying out ecological monitoring of the wild nature with schoolchildren allows us to recommend these courses as a compulsory regional component of the school education process.

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