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Research and Teaching for Sustainability in the RUDN University

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Abstract. More than 30 years ago, the participation of RUDN in the Earth Summit in Rio became a milestone in the university history: it was decided to create the first comprehensive ecological faculty in Russia. Now half of the history of RUDN university is also the history of environmental education in Russia. During this time, more than 10,000 ecologists and hundreds of specialists in other sustainability areas have been trained. Almost all programs at the university feature sustainability. Over 15 MOOCs and 10 interdisciplinary courses on relevant aspects have been developed. Annually, over 1,000 specialists improve their skills in various aspects of sustainability. An extensive research program in the areas of environmental safety and sustainability includes only in recent years: a program on environmental safety of transport (a part of the Federal project "Clean Air"); expert work on the implementation of BATs. In 2021, Russia's first Body for the Validation and Verification of Greenhouse Gases was successfully accredited in the university. More than 100 students are annually involved in the campus environmental monitoring program. Since 2022, the university presents a sustainability report. The environmental policy is featured on the university website and has been successfully implemented since 2017. We are confident: the university plays a key role in the formation of personality, the promotion of the sustainability ideas on the example of its home university.

Keyword:
Sustainability, course, project, environment, RUDN University

1. Introduction

Today, higher education programs on various aspects of sustainable development are presented in many Russian universities. However, in 1992 The Peoples' Friendship University became the first university where a comprehensive multidisciplinary faculty of Ecology (currently the Institute of Environmental Engineering) was established to train specialists in a new field – ecology and nature management. This decision was made immediately following the participation of the Russian delegation in the United Nations

Conference on Environment and Development (UNCED or the Earth Summit organized by the United Nations) in Rio de Janeiro. Among different sustainability issues discussed in this conference, environmental education and enlightenment issues were one of the topics. Thus, the history of the RUDN is also the history of Russian environmental education.

The university itself was originally created as an educational institution focused on the ideas of sustainability, although in 1960 there was yet no debate about the goals of sustainable development and the role of universities in achieving them. The ideas of equality of rights and opportunities, cooperation, and peer support have always been at the heart of the university's mission. This article is devoted to the best practices of training specialists and successful research projects in the field of sustainable development, which are being implemented at the Peoples' Friendship University of Russia named after Patrice Lumumba.

2. Education for sustainable development in the RUDN

Education for sustainable development covers a very diverse range of training areas: these are economic specialties, and areas related to social studies as well as environmental ones, including engineering issues. In any case, the 17 Sustainable Development Goals cannot be achieved without the involvement of qualified personnel.

Currently, RUDN University named after Patrice Lumumba is one of the most multidisciplinary universities in Russia and a leader in the field of internationality of education [1]. Our students are representatives of 162 countries from all regions of the world. Issues of sustainable development are presented in almost all higher education programs implemented at the RUDN University. These are separate topics in disciplines, such as environmental protection in civil engineering courses or issues of environmental policy in social studies, as well as whole courses, such as *Environmental Economics* in Faculty of Economics or *Environmental Law* for law students. And surely these are separate special programs on sustainability as in the case of the Institute of Environmental Engineering: specialized bachelor's degrees (in Ecology and Nature Management and in Energy and Resource saving Technologies Chemical Technology, Petrochemistry and Biotechnology), as well as more than 15 master's programs on various issues of environmental economics, natural resources research, climate project management, green economy, industrial and environmental safety (HSE-management).

The higher education programs are developed based on the principles of lifelong learning, active involvement of students in project activities, implementation of best international solutions as well as the use of research advances of our specialists in the educational process and immersion in a professional environment. The latter approach is implemented through virtual educational technologies: virtual simulators, VR-training complexes. Back in 2008, the university developed Russia's first virtual simulator on environmental safety in the oil and gas industry. Scenarios of the “professional environment” included accidental oil spills on the main pipeline with a big set of consequences of different scale which had to be localized and eliminated. This simulation allows the student to immerse oneself in the situation of an emergency oil spill and act as a crisis manager offering optimal solutions to eliminate all the negative consequences of environmental pollution as well as economic damages. The high efficiency of such technologies is due to their basic principle: immediately practical implementation of knowledge obtained in the theoretical classes. According to the «Training pyramid» (National training laboratories, Bethel, Main, USA; Fig. 1) the total efficiency here is much

higher in comparison with traditional lectures, or reading, or audio and video materials. In our case, students who mastered the environmental safety training complex showed high learning results, easily immersing themselves in difficult engineering topics. They are able to see the complexity of a problem of initial mistakes and a variety of adverse consequences because of the destruction of technical system (the min pipeline). The training complex has been awarded two national environmental awards.

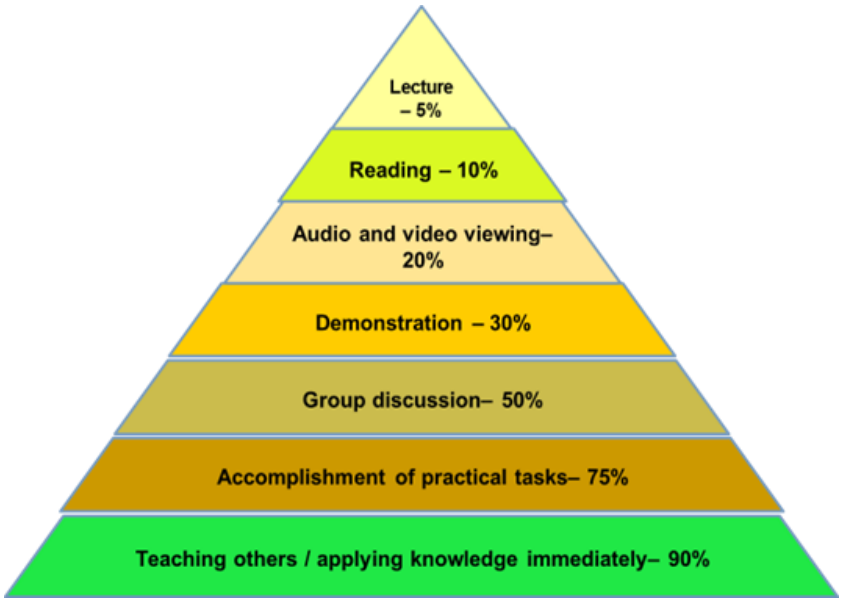

Figure 1. «Training pyramid» – efficiency of various forms of training

The traditional problem for many educational programs is their inconsistency with the demands of the labor market. Our university makes significant efforts to ensure that the programs are in demand not only by applicants (they do not always realize where they will be able to work after 5-6 years), but also by employers. To tackle this issue, leading practitioners are involved in the implementation of bachelor's and master's degree programs, as well as in the organization of special workshops and seminars on the profiled topics. In the recent year, more than 15 meetings of students with professionals whose activities are related to sustainable development, environmental safety, environmental policy, and climate neutrality were organized. These are Russian and foreign experts, representatives of business, academic organizations, and industry.

Another very efficient solution is an organization of “basic departments” of leading industry organizations. Thus, the Institute of Environmental Engineering of the RUDN University currently includes the basic departments of the National Institute of Accreditation, the All-Russian Scientific Research Institute of Plant Quarantine, and the Institute of Oil and Gas Problems. This also makes it plausible to significantly expand the possibilities of practical training of future specialists: they will have an opportunity to study modern approaches to research work in real labs, on real objects, involved in real project teams.

Another area of focus is the participation of our specialists in the development of professional standards – a set of requirements for specialists employed in certain positions. So, for a long time in Russia, the only standard of the ecological line of studies implemented was the "Specialist in the field of environmental safety". However, the needs of the labor

market are much broader. In order to coordinate training programs and qualification requirements for graduates, a whole series of new professional standards have now been proposed. Currently, a set of new professional standards has been developed, including the standards for the professional fields of green economy, waste management, environmental issues in biotechnologies, engineering and environmental surveys for urban planning activities etc.

Since 2018, the university has been actively developing massive open online courses (MOOCs), most of which are dedicated to sustainability issues. This is a very interesting format of work for us: students at other universities, including a large foreign audience, have the opportunity to get acquainted with the RUDN and, possibly, choose our university to continue their education. The list of MOOCS includes now courses in English, Spain, Russian presented on international and Russian national platforms (Open Learning; Iversity; Stepik and others):

- Drinking Water: quality and treatment systems;
- Environmental Standards and Norms for the Sustainability;
- Monitoreo y evaluación de la calidad ambiental;
- Surface Water Quality: Management and Modeling Technologies of Water Treatment;
- Climate Change and its Consequences (in Russian);
- Global and Regional Climate Change: Strategies of Adaptation and Mitigation;
- Practical Tools of Solid Waste Management & Environmental Damage Reducing;
- HSE-management and Audit;
- Management of Energy Resources.

The audience of each of the listed courses is now several hundred people. Massive open online courses are effective learning tools due to a convenient format: the student works in a flexible safe-paced schedule. Each course contains a theoretical component (interactive text with necessary illustrations), videos (mini lectures presented by the instructors) and a set of tasks and tests. To complete the tasks, the student has to demonstrate a certain creative approach: it is necessary to select material on any topic, to give comments on the questions asked. Despite the high degree of learner autonomy, the student always has the opportunity to get advice by writing to the instructor.

The system of interdisciplinary courses has become a new word for the university: students of "non-core" specialties have the opportunity to study in a special course of a different line of studies. Thus, more than 150 engineering, economics, and philology students have attended seven interdisciplinary environmental courses in the past year alone:

- Biodiversity;
- Dangerous Natural Geoecological Processes in the City;
- Evaluating Natural Resources;
- Transport and the Environment;
- Carbon Footprint: Counting, Reducing, Preventing (in English);
- Environmental Safety in the Oil and Gas Complex;
- Environmental Standards and Regulations.

This rather new tool of raising public awareness about sustainable development demonstrates real effectiveness. It allows us to involve students in exploring sustainable development issues and activities, deepen understanding of environmental issues and spread the culture of sustainability in the university.

RUDN assigns an important role in education for sustainable development to the system of additional professional education. Today, our university offers a variety of additional education programs – from short courses (training) to large-scale retraining programs, graduates of which receive a second diploma with additional qualification. The programs are organized jointly with prominent Russian research organizations, government agencies, and leading companies. So, in the pandemic 2020 alone, which was very challenging in terms of economics, more than 800 specialists received qualification in the field of environmental safety management: "Ensuring environmental safety by managers and specialists of general economic systems" and "Elimination of accumulated environmental damage". In total, more than a thousand students annually improve their skills in various aspects of environmental regulation, occupational safety, and greenhouse gas emissions management. These are both Russian specialists and foreign students. In particular, in recent years, summer schools and long-term internship programs have been organized for students from Pakistan, China, Indonesia, and Ghana. The main topics of these programs were:

- Environmental safety in oil and gas complex;
- Environmental sustainability;
- Russian studies;
- Waste management and green economy;
- Environmental issues of the underground hydrosphere protection;
- Microplastics in the environmental media;
- Sustainable urban development.

Such additional educational programs are becoming increasingly popular among our Russian and foreign partners. Probably, the main reason here is the flexibility of such programs: it is possible to organize a short-term course on a relevant and modern topic taking into account the initial level of students, their professional and scientific interests and needs, as well as the preferred form of education (distance, full-time, mixed). At the same time, the quality of training is quite high: the most popular programs undergo examination by leading specialists in the field. As a leader in the environmental direction at the University of Shanghai Cooperation Organization and the BRICS University, we pay considerable attention to the creation of joint educational programs with universities from partner countries. So, in November 2023, summer schools were held within the framework of these network universities, and students from Brazil, Kazakhstan, and South Africa became the students of our RUDN University for a short term.

But short-term courses and trainings for students are not the only direction in the system of additional education in the field of sustainable development. Now the university has developed a significant number of programs for professionals. Some of them are mandatory in accordance with the current country legislation (such as programs in the field of environmental safety and programs on waste management). The relevance of other programs is due to general trends in education and economic development. First, these are programs in the field of ecology and programs in the field of greenhouse gas management. The direction of greenhouse gas management is relatively new for us, but we consider it one of the leading ones. In developing programs, we are actively supported by foreign partners from universities and research organizations in Italy, Indonesia, Sri Lanka, China. Among them are developers of national and international standards, experts from accreditation bodies, validation and verification bodies for greenhouse gases. As a result, the programs are in great demand among specialists: studying for several modules, one can

practically get a new qualification, and not just expand your horizons on topical issues.

Participation in international partnerships on environmental education significantly expands our opportunities to share training experience. So, since 2019, RUDN joined the Alliance of Belt and Road Environmental Deans, organized by Tongji University (China), and already in 2021, a team of RUDN students took second place in the global environmental competition organized by this university. Another very positive experience for us is participation in the Indonesian International Students Mobility Awards (IISMA) project supported by the Indonesian Government: in 2024, 2nd time RUDN will host a group of the international students – winners of the IISMA program.

In general, academic mobility is a very important moment in the organization of the educational process. Both for students and instructors it is very important to get acquainted modern approaches to teaching research activities in the universities of the world. From this point of view, the RUDN University has very good positions. It is one of the most international universities not only in Russia but also in the world. Partner universities from all the continents support various academic mobility programs and academic cooperation projects. That is why every year, independent of the political situation or other issues many joined research events are organized together with our international partners. But not only the universities and research institutions support our international programs. Understanding the importance of multilateral cooperation, the university also participates in different professional associations. Every year we plan and implement research projects, expert works, joint publications, seminars, and workshops together with colleagues from such professional associations. This activity contributes significantly to the development of our research in the most relevant directions of modern science and education. Is example of such professional associations and unions it's possible to remember the International Association of Hydrogeologists, the waste to energy research and technology council, International Association of Hydrological Sciences, Society of Petroleum Engineers, Federation of European Biochemical Societies, Society of Soil Scientists named after V.V. Dokuchaev, International Association of Landscape Ecology, Russian Geographical Society, Russian Ecological Society, Russian Academy of Ecology , and of course the biggest union of green universities in the world UI GreenMetric.

3. RUDN, the Research University

Education for sustainable development would be impossible without a research base. A significant part of the research projects that are being implemented at the university are devoted to sustainable development. These are projects in the fields of social sciences, economics, engineering, natural sciences, as well as numerous interdisciplinary studies. In many projects, sustainability issues are “incorporated” into the main content of the research and are an essential part of the study.

Among the largest projects implemented by the university in recent years are the participation in the Federal Clean Air Project, research in the field of validation and verification of greenhouse gases, the implementation of best available technologies, environmental monitoring of the urban areas, the study of pollution of natural environments and anthropogenic objects with microplastics.

Increased levels of urban air pollution are a problem that exists in many cities around the world. A large-scale project is currently being implemented for Russian cities related to the identification of the main sources of emissions (for example, in Moscow more than 83% of the atmospheric pollution is the share of motor vehicles), the establishing of emission

limits and the distribution of emission quotas among enterprises and organizations [2, 3, 5]. To implement this control system, information about the transport load is required. RUDN organized work on monitoring and evaluating the structure of traffic flows in more than 20 major cities of Russia. The number of observations in each of the controlled cities were impressive: up to 450. Using this information, it is possible to estimate the total emission caused by different vehicles presented on the roads and to understand their contribution to the total amount of the main polluting substances presented in the atmospheric air. The data obtained became the basis for a model for calculating atmospheric pollution due to transport activity and the following distribution of the pollution permits for the industrial enterprises. Almost all faculties and institutes of the RUDN were involved in the project. The work was highly appreciated and is expected now to be continued.

The urgency of climate change problems and the need to regulate greenhouse gas emissions have led to the development of a new direction of state regulation in Russia, as well as the creation of a network of greenhouse gases' validation and verification bodies. The RUDN Greenhouse Gas Validation and Verification Body was the first in the country to be successfully accredited. Now it is accredited for work in the largest in the country number of areas of economic activity. Our experts successfully cooperate with enterprises of mechanical engineering, energy, oil and gas sector, etc. Among the most interesting regions for the validation and verification activities there is Sakhalin Region – one of the most eastern regions in Russia. This is the first region where a special program on climate neutrality has been developed - *The Program for Conducting an Experiment to Limit Greenhouse Gas Emissions in the Sakhalin Region*. It was a great honor for our university to take part in the first works on the verification of greenhouse gas emissions reporting by enterprises operating in the Sakhalin Region. Also, an international cooperation in this area is developing intensively: only over the past year, RUDN academics have organized trainings and joint seminars for Russian specialists on the basis of leading greenhouse gas management organizations in Indonesia, Sri Lanka, and China devoted to the reporting on greenhouse gases, accreditation of greenhouse gases validation and verification bodies, greenhouse gases projects. Among the research topics of our specialists, there are issues of changes of ecosystem services because of climate change, evaluations of greenhouse gases balance etc.

A significant part of the research topics in the university is devoted to the problems of water resources quality, their study and conservation. This research area is being developed in cooperation with leading national and international partners, in particular the International Association of Hydrogeologists. More than 300 specialists and young scientists from Russia, Kazakhstan, Belarus, and Poland take part in joint IAH–RUDN academic seminars every year. Among the topics discussed in such meetings are groundwater pollution, protection of the underground hydrosphere, priority pollutants and marker compounds, GIS and remote sensing for hydrogeological studies.

Another actively developing area is environmental monitoring of the urban environment. The university campus has become a kind of test zone, a green lab where the processes of interaction of urban ecosystems with anthropogenic objects (primarily transport) are studied [2, 4, 5]. Nowadays, the observation network of the university consists of 33 monitoring points. For each of them there is a data set formed including the information about the atmospheric pollution, state of the vegetation, soil, snow cover (every winter). The total amount of data includes over 4,000 records. The results of such observations are presented in the web page of the university in the *Environmental policy*

section. There maps of environmental monitoring results presented there since 2017 (for example, the map presented in the Fig.2). Quite a regular and detailed system of observation points allows us to conduct various assessments of the state of our campus and to consider it as an impact monitoring area. Despite a comfortable and green (environmentally wholesome) location of the RUDN University campus in the South-West of Moscow the territory faces a visible technogenic pressure: it is surrounded and crossed by four roads, two of which are characterized by quite a high intensity of transport activity. Thus, several studies were organized and successful conducted here:

– assessment of snow cover pollution,
– assessment of the intensity of geochemical exchange processes,
– evaluation of the accumulation of priority pollutants caused by the transport activity: particulate matter $PM_{2.5}$, PM_{10}; polycyclic aromatic hydrocarbons;
– environmental zoning of the territory (justification of the borders of zones with different level of traffic load: background, social and administrative, traffic zones);
– evaluations of the change in ecosystem services caused by the traffic load;
– assessment of the vehicles caused acoustic load in the functional zones of the territory;
– estimation of the greenhouse gases fluxes in the polluted and “background” zones.

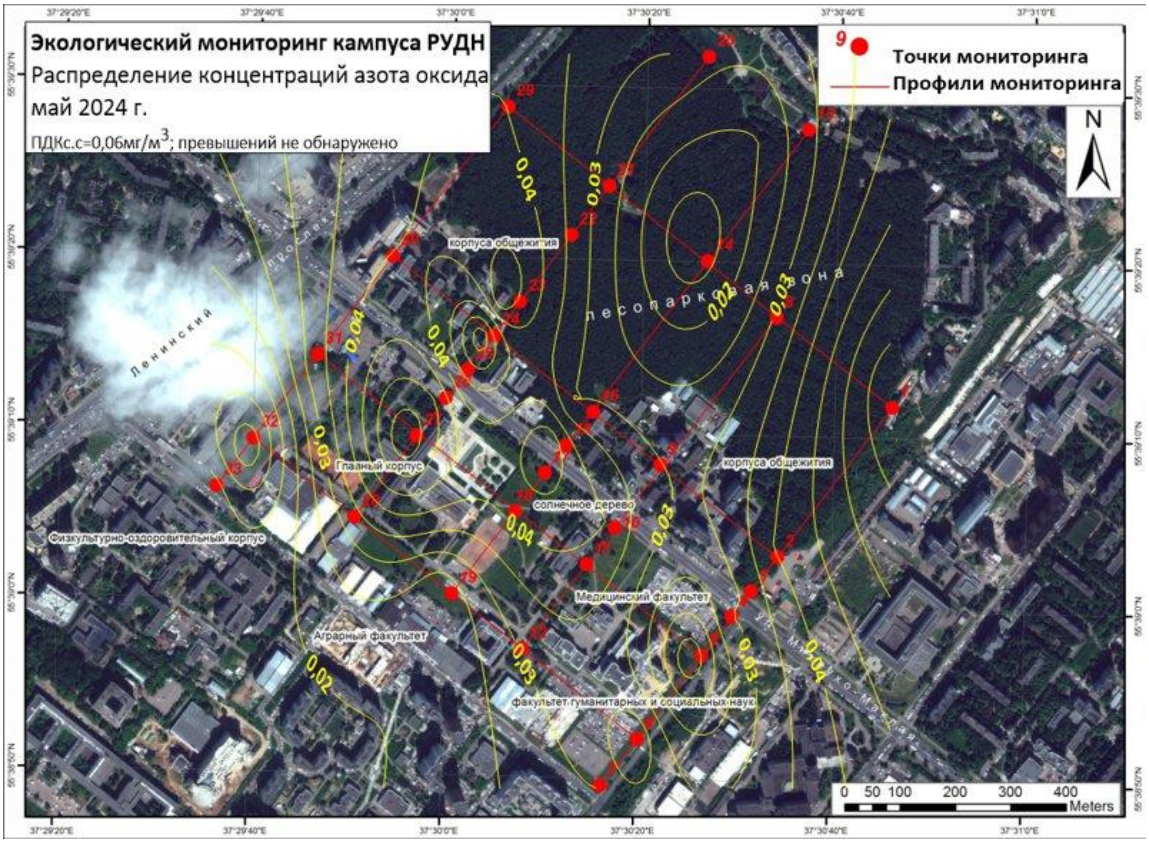

Figure 2. Results of the environmental monitoring of the RUDN University campus: a distribution of the NO2 concentrations over the territory in May 2024 (there is also marked an MPC level; all the concentrations measured are lower)

These results allow to create methodologies for the assessment of the urban territories from the point of view of traffic load and environmental health as well as to justify the use of innovative materials for the construction of road cover. It is very important for us that such relevant research involves students of the university and serves as a base for their further professional development in geochemistry, urban sustainability, environmental monitoring etc. The environmental monitoring project has been implemented since 2017, and in 2019 it was demonstrated as part of the First World Tour of Sustainable Campuses, which was organized by RUDN on the initiative and with the support of UI GreenMetric team.

This project was presented in different research events and platforms. As we see, the experience of environmental monitoring of university campuses could be interesting for many universities not only in Russia but also in other countries. That is why currently we are working on the preparation of recommendations on environmental monitoring for the universities. Such an observation system can be a good contribution to the understanding of environmental issues by the students and the development of environmental culture and culture of sustainability. An example of home university is always closer to the student; it helps to adopt the best approaches to resource saving, environmental protection in everyday life, and to the distribution of environmental knowledge outside the university.

Implementation of best practices is now one of the most relevant and required topics in environmental regulation. The system of environmental standards (norms of maximum permissible concentrations, limits of environmental impacts, environmental requirements to the industrial processes and product quality as well as organizational standards) was developed in Russia a while ago. So, the first norms of maximum permissible concentrations were established in the USSR in 1940s. But in the past decade the implementation of technical norms and differentiation of polluting objects in different categories according to their activity of the environmental impacts have been introduced. This work needs expert support: it is necessary to justify that some technology suggested by a company can be accepted as the best available technology according to the actual criteria. Our experts work on such evaluations and in general on the development of the system of environmental norms and regulations. There are special corporate environmental regulations for companies and for the federal level developed. For example, the first regulation (corporate standard) on environmental management system for the Gazprom company was prepared with a participation of our specialists as well as a set of some other documents on environmental management regulation.

The research findings and project work are the property of not only the executing team and the customer side. The results obtained are being implemented in the educational process for the training of Russian and foreign specialists. Thus, cooperation with enterprises of the oil and gas complex made it possible to open the first HSE management master's program in Russia (it unifies the issues of occupational safety, industrial and environmental safety management), which was awarded several national environmental awards. And since 2024, two new master's degree programs based on research experience in the field of climate conservation and green economy have been offered at the university – *Climate Project Management* and *Integrated Solid Waste Management*. 30 Ghanaian representatives will become RUDN students. Another application of research results is the development of textbooks for universities. Our professors have created textbooks and teaching aids, which are used by universities all over the country, where ecologists are trained. These are textbooks on environmental rationing, environmental monitoring, waste

management, and environmental management.

Achieving the SDGs involves active cooperation and joint solution of problems in the field of environmental safety, economics, and social aspects. However, this is impossible without uniform rules and standards for all areas. Therefore, RUDN has taken the initiative to prepare a standard based on which the success of the university in achieving SDGs can be assessed. We consider university not only as a place where students can gain theoretical knowledge and practical professional skills. The University should become a model for future development. That is why such attention is paid to the issues of the actual sustainability of the university. We plan to distribute this standard among Russian universities to support their efforts in greening and improving sustainability culture.

Our experience shows that the university can contribute (and should contribute) to the achievement of all 17 sustainable development goals. Transparency in the achievement of sustainability is one of the most important conditions for the distribution of sustainability culture. In the case of the People's friendship university of Russia named after Patrice Lumumba we're always open: all our activities in sustainability are easy to find on the web site of the university. There is information on best practices in environmental education, research projects, student initiatives, most interesting and popular social events and research workshops and seminars devoted to the issues of sustainability, environmental protection, international cooperation on all these topics.

Another way for disseminating of our experience, and at the same time, an opportunity to our network of partner organizations interested in sustainability issues are different academic events such as seminars, conferences, symposia. Annually the university organizes more than 70 events of different levels where the issues of sustainability are presented as the core topic or as one of the directions. As an example, it's possible to list the topics of research seminars organized by the Institute of Environmental Engineering during 2023-2024 academic year. These are more than 10 seminars on the various aspects of the environmental protection, biodiversity conservation, environmental monitoring, human ecology and geoecology:

– GIS and remote sensing in hydrogeology and geoecology;
– Underground hydrosphere and technogenesis;
– Modern methods of research of plant resources;
– Bioelementology as an integrative field of life science;
– Natural exposure of the population;
– Remote sensing in environmental monitoring: innovative tools and approaches;
– Environmental Protection in Agriculture:
– Nuclear methods of environmental research;
– Ecobiotechnologies for waste disposal and elimination of objects of accumulated environmental damage;
– Transport and environmental pollution;
– Microplastics in the underground hydrosphere and neighboring environmental media;
– Ozone as a priority atmospheric pollutant.

The university experts demonstrate their achievements and best practices in implementing sustainability ideas at annual scientific events. Thus, the annual International Scientific Conference “For the Sustainable Development of Civilization: Cooperation Science, Education, Technology” is becoming increasingly popular, where leading domestic and foreign experts present the current state of research in all areas of sustainability to young scientists and students. In addition, at least 70 different academic and technical

events dedicated to this topic are organized annually at the university. We consider these activities a good way for the distribution of our experience and for exchange of ideas among specialists in the field of sustainability and environmental protection. In our opinion, it will contribute to the cooperation in the field of sustainable development, organization of joint research and educational programs for students and specialists.

4. Future Perspectives

The development of the university involves the implementation of a sustainability strategy that combines global and national SDGs. This work includes the implementation of a whole range of educational programs and research projects, as well as the involvement of the entire academic team and the student community followed by the dissemination of achievements.

The SDGs are global, so RUDN is always open for cooperation in research and educational projects. We highly appreciate the opportunity to share knowledge and experience, ideas and suggestions on the GreenMetric UI platform. Having come quite a long way over the years of participation in the ranking from positions 300+ to 26th place in 2022 and 2023 (as well as recognition as the most active national coordinator in 2021), we understand how important it is to move together towards achieving sustainability goals, together with responsible and sustainable universities around the world.

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