RUDN Journal of Ecology and Life Safety
Вестник РУДН. Серия: Экология и безопасность жизнедеятельности
ISSN 2313-2310 (Print); ISSN 2408-8919 (Online)
2021 Vol. 29 No. 3 282–288
http://journals.rudn.ru/ecology

ЭКОЛОГИЧЕСКИЙ МОНИТОРИНГ
ENVIRONMENTAL MONITORING

DOI 10.22363/2313-2310-2021-29-3-282-288
UDC 504.064

Scientific report / Научное сообщение

Development of the environmental monitoring system of the RUDN University

Aleksandr P. Khaustov ✉, Margarita M. Redina, Polina Yu. Silaeva, Zhandos D. Kenzhin

Peoples' Friendship University of Russia (RUDN University), Moscow, Russia
✉ khaustov-ap@rudn.ru

Abstract. The brief results of the functioning of the environmental monitoring system of the RUDN University campus are summarized. The monitoring system created in 2017 is aimed at obtaining data on the state of the environment of the campus and the adjacent territory of the Southwestern Forest Park, which is considered as conditionally background. The territory is surrounded by a network of highways with heavy traffic, bordered by residential buildings and an administrative zone. The technogenic load is mainly represented by transport emissions, as most part of Moscow territory. From this point of view, the area is considered as a representative object for study, where it is planned to continue work on environmental monitoring and modeling of pollutant flows, as well as greenhouse gas flows. Since the beginning of observations, more than 4000 records have been received on acoustic and electromagnetic pollution, as well as on pollution of atmospheric air, soil, vegetation, snow cover, which allows to confidently identify areas of influence of traffic flows to the territory and simulate the migration of pollutants, as well as to develop a basis for assessing ecosystem services of the territory. In particular, these are assessments of greenhouse gas emissions and uptake by the soil – plant complex.

Keywords: environmental monitoring, RUDN University, transport pressure, pollutant flows, ecosystem services

Article history: received 18.01.2021; revised 30.01.2021.

For citation: Khaustov AP, Redina MM, Silaeva PYu, Kenzhin ZhD. Development of the environmental monitoring system of the RUDN University. *RUDN Journal of Ecology and Life Safety.* 2021;29(3):282–288. http://dx.doi.org/10.22363/2313-2310-2021-29-3-282-288

Развитие системы экологического мониторинга кампуса РУДН

А.П. Хаустов ✉, М.М. Редина, П.Ю. Силаева, Ж.Д. Кенжин

Российский университет дружбы народов, Москва, Россия
✉ khaustov-ap@rudn.ru

Аннотация. Подводятся краткие итоги функционирования системы экологического мониторинга кампуса РУДН, созданной в 2017 г. Цель системы – получение данных о состоянии окружающей среды кампуса и прилегающей территории Юго-Западного лесопарка, которая рассматривается как условно фоновая. Территория окружена сетью автодорог с интенсивным движением автотранспорта, граничит с жилой застройкой и административной зоной. Техногенная нагрузка представлена в основном выбросами транспорта, как и на большей части Москвы. С этой точки зрения территория представляет собой репрезентативный объект для изучения, на котором запланировано продолжение работ по экологическому мониторингу и моделированию потоков загрязнителей, а также потоков парниковых газов. С начала наблюдений получено более 4000 записей об акустических и электромагнитных загрязнениях, а также о загрязненности атмосферного воздуха, почв, растительности, снегового покрова, что позволяет с уверенностью выделять зоны влияния транспортных потоков на территорию, моделировать миграцию загрязняющих веществ и разработать основы оценки экосистемных услуг территории. В частности, оценки эмиссий и поглощения парниковых газов почвенно-растительным комплексом.

Ключевые слова: мониторинг окружающей среды, РУДН, транспортное давление, потоки загрязняющих веществ, экосистемные услуги

История статьи: поступила в редакцию 18.01.2021; принята к публикации 30.01.2021.

Для цитирования: *Автор.* Development of the environmental monitoring system of the RUDN University // Вестник Российского университета дружбы народов. Серия: Экология и безопасность жизнедеятельности. 2021. Т. 29. № 3. С. 282–288. http://dx.doi.org/10.22363/2313-2310-2021-29-3-282-288

Introduction

Since creation in 2017 the environmental monitoring system in the main campus of the RUDN University, a team of specialists controls a set of characteristics of this area in connection with a main source of the pollution – transport flows surrounding and crossing the campus. Currently, there are over 4 thousand results of measurements are collected. This is an information on atmospheric pollution (main pollutants, including carbon oxide, sulfur and nitrogen dioxides, soot, hydrogen sulfide), presence a set of aliphatic hydrocarbons and polycyclic aromatic hydrocarbons in snow, soil, plant organisms; acoustic pressure and radioactivity. According to these data the territory of 144 ha was divided in 3 main zones: transport, social & administrative and “background” – park zone.

The necessity of a monitoring system was justified in comparison of the monitoring data obtained using the Moscow city environmental monitoring system: our first estimations showed, that the complex atmospheric pollution in-

dex based on the data of three nearest monitoring stations vary up to 1.5–2 times. Thus, a detailed impact models must be based on the detailed observations. The system of 33 monitoring points was developed in 2017; it is quasi regular network with a unified measurements complex that guaranties a possibility of comparison of measurements in time. Currently, the main results of the monitoring are presented in over 20 articles in peer-reviewed publications, including [1–12].

In 2019, the project became a central part of the program of First World Tour in Sustainable Campuses organized in the RUDN University after the suggestion of the UI GreenMetric World University Rankings. Representatives of more than 20 universities from different regions of the world got an opportunity to get acquainted with an observation system and data processing models.

Since 2020 the project on environmental monitoring of the university campus became a part of a research project "Development of Methodological, Information-Analytical and IT Support for Monitoring the State of the Environment of Territories and for the Elimination of the Consequences of Emergency Situations" supported by the university. In 2022–2023, the project will develop refined algorithms for assessing the impact of transport loads of various intensities on the state of the urban ecosystem based on data on the distribution of marker substances that are priority for control.

The relevance of the project is due to the need to assess the impact of transport loads on urban ecosystems. Existing models for estimating the impact of emissions on urban ecosystems are limited to aggregated calculations of the potential concentrations of major pollutants at worst meteorological conditions. However, in practice, the consequences of pollution are much more diverse. A distinctive feature of the project is the construction of integrated ("multi-media") models of interaction of ecosystem components, which are becoming increasingly common in foreign and domestic studies.

Currently, the results of the environmental monitoring are presented in the web site of the RUDN University in the "Environmental Policy" page and are updated quarterly.

The accumulated data allowed us to substantiate the possibility of organizing monitoring to determine the temporal and spatial characteristics of pollutant flows through the territory and to assess the level of man-made loads in its various zones. The next step should be to assess the dynamics of ecosystem services produced by soil and plant complexes under conditions of loads of varying intensity. In particular, attempts are being made to develop a system for assessing greenhouse gas flows. After the project of environmental monitoring became a part of a research project "Development of Methodological, Information-Analytical and IT Support for Monitoring the State of the Environment of Territories and for the Elimination of the Consequences of Emergency Situations," this direction got a new impulse for the development: we consider a monitoring project as an opportunity to justify new approaches to the control of environmental state of the urban areas.

A new stage of the project is aimed at solving the problem of choosing optimal models for the formation and manifestation of the mechanisms of stability of urban ecosystems exposed to the flow of pollutants in the urban environment. This is the most urgent problem: the choice of the model determines the subse-

quent quality of the forecast of the state of urban ecosystems and, accordingly, determines the effectiveness of decision-making to optimize environmental loads.

Research objectives of this study include:

– preliminary multicriterial assessments of the state of the model territory;

– substantiation of the choice of the most significant geochemical markers characterizing the impact of man-made pollutant flows on urban ecosystems;

– selection of optimal methods for constructing models of migration and accumulation of pollutants;

– thermodynamic assessments of the processes of migration and accumulation of marker substances;

– development of algorithms for estimation of the impact of technogenic flows of marker compounds on a set of objects representing different subsystems of the urban ecosystem;

– obtaining additional information about the flows of marker compounds and verifying the constructed models;

– development of practical recommendations for modeling the resistance of urban ecosystems to technogenic flows of priority marker compounds.

A specific task that will be solved within the framework of the project is the analysis of the relationship between the type and intensity of anthropogenic impacts (flows of marker compounds) and the response of the polluted system. The project focuses on local models. Unlike common regional and global assessments, it is at the local level that detailed, concretized assessments of the contributions of individual pollutants to a particular effect manifested in the ecosystem become possible. The obtained individual estimates of the accumulation and migration of PAHs are the basis for subsequent algorithms and methodological approaches to forecasting the state of local ecosystems of the city. Thus, the problem has a complex character (forecasts of the state of soil and plant systems under conditions of transport loads), but its solution is based on obtaining detailed estimates of pollution of local areas of urban territory.

Results

The main expected results of the future stages of the projects include:

– detailed models of accumulation and migration of individual PAH compounds in the soil – plant system at different levels of anthropogenic load;

– algorithms for assessing the zones of influence of motor transport on soil and plant systems;

– methods of environmental monitoring for local territories under conditions of transport load;

– recommendations for reducing the impact of man-made pollution flows caused by transport activity.

Conclusion

During the realization time of the project the efficiency of these works was demonstrated: innovative research results, educational efficiency (campus as an open laboratory), as well as informational ad image. In particular, the scientific novelty of the project consists in the following provisions:

1) fundamentally new models are being developed based on the thermodynamic characteristics of the interaction of several components of the urban ecosystem ("multi-media" models);

2) estimates of the leading factors of accumulation and migration of flows of priority pollutants (PAHs as geochemical indicators) are given;

3) estimates of the impact of technogenic pollutant flows on urban ecosystems and recommendations for regulating the activity of sources of exposure are proposed.

Thus, the project involves the development of new methods for studying the dynamics of the state of urban ecosystems affected by man-made sources of pollution.

Список литературы

[1] *Боева Д.В., Хаустов А.П.* Оценка влияния автотранспорта на территорию кампуса Российского университета дружбы народов // Вестник Российского университета дружбы народов. Серия: Экология и безопасность жизнедеятельности. 2018. Т. 26. №4. С. 419–430. http://dx.doi.org/10.22363/2313-2310-2018-26-4-419-430

[2] *Редина М.М., Хаустов А.П., Ли С., Кенжин Ж.Д., Силаева П.Ю.* Показатели опасности загрязнения городских почв полициклическими углеводородами на примере результатов мониторинга кампуса РУДН // Вестник Российского университета дружбы народов. Серия: Экология и безопасность жизнедеятельности. 2020. Т. 28. № 2. С. 112–130. http://dx.doi.org/10.22363/2313-2310-2020-28-2-112-130

[3] *Силаева П.Ю., Хаустов А.П.* Транспортная нагрузка на кампус РУДН // Потаповские чтения – 2019: сборник материалов ежегодной Всероссийской научно-практической конференции, посвященной памяти доктора технических наук, профессора Александра Дмитриевича Потапова. М.: Изд-во МИСИ – МГСУ, 2019. С. 142–147. URL: http://mgsu.ru/resources/izdatelskaya-deyatelnost/izdaniya/izdaniya-otkr-dostupa/ (дата обращения: 10.01.2021).

[4] *Хаустов А.П., Редина М.М*. Фракционирование полициклических ароматических углеводородов на геохимических барьерах // Вестник Санкт-Петербургского университета. Науки о Земле. 2021. Т. 66. № 1. С. 123–143.

[5] *Хаустов А.П., Редина М.М*. Оценка пирогенного загрязнения почвенно-растительной системы на основе геохимических маркеров для локальной модели транспортной нагрузки // Антропогенная трансформация природной среды. 2021. Т. 7. № 1. С. 65–86. http://doi.org/10.17072/2410–8553-2021-1-65-86

[6] *Хаустов А.П., Редина М.М., Алейникова А.М., Мамаджанов Р.Х., Силаева П.Ю.* Проект экологического мониторинга кампуса Российского университета дружбы народов // Вестник Российского университета дружбы народов. Серия: Экология и безопасность жизнедеятельности. 2017. Т. 25. № 4. С. 562–584. http://dx.doi.org/10.22363/2313–2310-2017-25-4-562-584.

[7] *Хаустов А.П., Кенжин Ж.Д., Редина М.М., Алейникова А.М.* Распределение полициклических ароматических углеводородов в системе почва – растение под влиянием автотранспортных нагрузок городской среды // Почвоведение. 2021. № 7. С. 871–883. http://doi.org/10.31857/S0032180X21070066

[8] *Khaustov A., Redina M.* Justification of geochemical markers of the soil – plant system state for a local model of traffic pressure // Arabian Journal of Geosciences. 2021. Vol. 14. Article number 2845. https://doi.org/10.1007/s12517-021-08868-5

[9] *Khaustov A., Redina M.* Polycyclic aromatic hydrocarbons in the snow cover of Moscow (case study of the RUDN University campus) // Polycyclic Aromatic Compounds. 2021. Vol. 41. No 5. Pp. 1030–1041.

[10] *Khaustov A., Redina M.* Specificity of accumulation of hydrocarbons in various components of geosystems // E3S Web Conf. 2020. Vol. 169. Article number 01013. https://doi.org/10.1051/e3sconf/202016901013

[11] *Khaustov A.P., Kenzhin Zh.D., Redina M.M., Aleinikova A.M.* Distribution of polycyclic aromatic hydrocarbons in the soil – plant system as affected by motor vehicles in urban environment // Eurasian Soil Science. 2021. Vol. 54. No. 7. Pp. 1107–1118. http://doi.org/10.1134/S1064229321070061

[12] *Khaustov A., Redina M., Kenzhin Zh., Gabov D., Yakovleva E.* Identification of the state of the soil – plant systems on the RUDN University campus (based on PAH concentrations) // E3S Web Conf. 2020. Vol. 169. Article number 01015. https://doi.org/10.1051/e3sconf/202016901015

References

[1] Boeva DV, Khaustov AP. Assessment of the vehicles impact on the RUDN University campus. *RUDN Journal of Ecology and Life Safety*. 2018;26(4):419–430. (In Russ.) http://dx.doi.org/10.22363/2313-2310-2018-26-4-419-430

[2] Redina MM, Khaustov AP, Li X, Kenzhin ZhD, Silaeva PYu. Hazard indicators of urban soil contamination with polycyclic hydrocarbons on the example of monitoring results of the RUDN campus. *RUDN Journal of Ecology and Life Safety.* 2020; 28(2):112–130. (In Russ.) http://dx.doi.org/10.22363/2313-2310-2020-28-2-112-130

[3] Silaeva PY, Khaustov AP. Transport load on PFUR campus. *Potapov Readings – 2019: Collection of Materials of the Annual All-Russian Scientific Conference Dedicated to the Memory of Doctor of Technical Sciences, Professor Alexander Dmitrievich Potapov.* Moscow: Moscow State University of Civil Engineering Publ.; 2019. p. 142–147. (In Russ.) Available from: http://mgsu.ru/resources/izdatelskaya-deyatelnost/izdaniya/izdaniya-otkr-dostupa/ (accessed: 10.01.2021).

[4] Haustov AP, Redina MM. Fractionation of polycyclic aromatic hydrocarbons on geochemical barriers. *Bulletin of St. Petersburg University. Earth Sciences.* 2021;66(1):123–143. (In Russ.)

[5] Khaustov AP, Redina MM. Evaluation of pyrogenic pollution of soil and vegetation system based on geochemical markers for local model of transport load. *Anthropogenic Transformation of the Natural Environment.* 2021;7(1):65–86. (In Russ.) http://doi.org/10.17072/2410-8553-2021-1-65-86

[6] Haustov AP, Redina MM, Aleinikova AM, Mamadjanov RH, Silaeva PYu. Project of environmental monitoring of the Campus of People friendship University of Russia. *RUDN Journal of Ecology and Life Safety.* 2017;25(4):562–584. (In Russ.) http://dx.doi.org/10.22363/2313-2310-2017-25-4-562-584

[7] Khaustov AP, Kenzhin JD, Redina MM, Aleinikova AM. Distribution of polycyclic aromatic hydrocarbons in the soil – plant system under the influence of vehicular loads of urban environment. *Soil Science.* 2021;(7):871–883. (In Russ.) http://dx.doi.org/10.31857/S0032180X21070066

[8] Khaustov A, Redina M. Justification of geochemical markers of the soil – plant system state for a local model of traffic pressure. *Arabian Journal of Geosciences*. 2021;14:2845. https://doi.org/10.1007/s12517-021-08868-5

[9] Khaustov A, Redina M. Polycyclic aromatic hydrocarbons in the snow cover of Moscow (case study of the RUDN University campus). *Polycyclic Aromatic Compounds.* 2021;41(5):1030–1041.

[10] Khaustov A, Redina M. Specificity of accumulation of hydrocarbons in various components of geosystems. *E3S Web Conf.* 2020;169:01013. https://doi.org/10.1051/e3sconf/202016901013

[11] Khaustov AP, Kenzhin ZhD, Redina MM, Aleinikova AM. Distribution of polycyclic aromatic hydrocarbons in the soil – plant system as affected by motor vehicles in urban environment. *Eurasian Soil Science.* 2021;54(7):1107–1118. http://doi.org/10.1134/S1064229321070061

[12] Khaustov A, Redina M, Kenzhin Zh, Gabov D, Yakovleva E. Identification of the state of the soil – plant systems on the RUDN University campus (based on PAH concentrations). *E3S Web Conf.* 2020;169:01015. https://doi.org/10.1051/e3sconf/202016901015

Сведения об авторах:
Хаустов Александр Петрович, доктор геолого-минералогических наук, профессор, ведущий специалист Института экологии, Российский университет дружбы народов, Россия, 117198, Москва, ул. Миклухо-Маклая, д. 6. ORCID: 0000-0002-5338-3960, eLIBRARY SPIN-код: 7358-5798. E-mail: khaustov-ap@rudn.ru

Редина Маргарита Михайловна, доктор экономических наук, доцент, профессор департамента экологической безопасности и менеджмента качества продукции, Институт экологии, Российский университет дружбы народов, Россия, 117198, Москва, ул. Миклухо-Маклая, д. 6. ORCID: 0000-0002-3169-0142, eLIBRARY SPIN-код: 2496-8157. E-mail: khaustov-ap@rudn.ru

Силаева Полина Юрьевна, магистр экологии, Институт экологии, Российский университет дружбы народов, Россия, 117198, Москва, ул. Миклухо-Маклая, д. 6. ORCID: 0000-0002-7090-481X, eLIBRARY SPIN-код: 6986-0890. E-mail: silaeva-pyu@rudn.ru

Кенжин Жандос Даудович, магистр экологии, ассистент департамента экологической безопасности и менеджмента качества продукции, Институт экологии, Российский университет дружбы народов, Россия, 117198, Москва, ул. Миклухо-Маклая, д. 6. ORCID: 0000-0001-9655-8049. E-mail: kenzhin-zh@rudn.ru

Bio notes:
Aleksandr P. Khaustov, Dr.Sc. (Geol.)., Professor, chief specialist, Institute of Environmental Engineering, Peoples' Friendship University of Russia (RUDN University), 6 Miklukho-Maklaya St, Moscow, 117198, Russia. ORCID: 0000-0002-5338-3960, eLIBRARY SPIN-code: 7358-5798. E-mail: khaustov-ap@rudn.ru

Margarita M. Redina, Dr.Sc. (Econ.). Associate Professor, Professor of the Department of Environmental Security and Product Quality Management, Institute of Environmental Engineering, Peoples' Friendship University of Russia (RUDN University), 6 Miklukho-Maklaya St, Moscow, 117198, Russia. ORCID: 0000-0002-3169-0142, eLIBRARY SPIN-code: 2496-8157. E-mail: redina-mm@rudn.ru

Polina Yu. Silaeva, M.Sc. (Ecology and Nature Management), Institute of Environmental Engineering, Peoples' Friendship University of Russia (RUDN University), 6 Miklukho-Maklaya St, Moscow, 117198, Russia. ORCID: 0000-0002-7090-481X, eLIBRARY SPIN-code: 6986-0890. E-mail: silaeva-pyu@rudn.ru

Zhandos D. Kenzhin, M.Sc. (Ecology), assistant, Department of Environmental Security and Product Quality Management, Institute of Environmental Engineering, Peoples' Friendship University of Russia (RUDN University), 6 Miklukho-Maklaya St, Moscow, 117198, Russia. ORCID: 0000-0001-9655-8049. E-mail: kenzhin-zh@rudn.ru