Federal state autonomous educational institution higher education
"PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA" (RUDN University)

Agrarian-Technological Institute

Approved by ISSU

PROGRAM

Discipline title Modeling urban ecosystems

Recommended for the educational direction

05.06.01 «Earth Sciences»

Program curriculum (direction)
« Green Infrastructure and Sustainable Development»

1. Aims and tasks of the discipline:

Aim - Developing an environmental outlook and understanding of one's professional work from the perspective of sustainable urban development

Tasks:

-to understand the role of the main components of urban ecosystems: flora and fauna, soils, surface and groundwater, tropospheric air masses,
-to form the principles of sustainability of urban ecosystem components to the impact of urban environment factors.
-to master modern methods for assessing the components of the urban ecosystem

2. Place of discipline in the structure of the Educational program plan:

The discipline Modeling Urban Ecosystems belongs to the variative part of Block 1 “Disciplines (modules)”. Table No. 1 shows the previous and subsequent disciplines aimed at the formation of the competencies of the discipline in accordance with the competency matrix of CH EP

Table 1

Previous and subsequent disciplines aimed at the formation of competencies

№	Code and name of competency	Previous disciplines	Subsequent disciplines (groups of disciplines)
Universal competencies			
1	UC-1 ability to critically analyze and evaluate modern scientific achievements, generate new ideas when solving research and practical problems, including interdisciplinary areas UC-2 ability to design and carry out complex research, including interdisciplinary, based on a holistic systematic scientific worldview using knowledge in the history and philosophy of science; UC-4 readiness to use modern methods and technologies of scientific communication in national and foreign languages; including readiness to communicate in oral and written forms in Russian and foreign languages to solve professional problems, proficiency in foreign language communication competence in official-business, educational-professional, scientific, socio-cultural, everyday life spheres of foreign-language communication;	Research planning	Sustainable Urban Development
General professional competencies			

2	GPC-1 ability to independently carry out research activities in the relevant professional area using modern research methods and information and communication technologies	Research planning	Sustainable Urban Development
Professional competencies			
3	PC-2 to be able to regulate, plan and organize quality assessment and expertise activities in urban planning PC-3 be able to analyze and assess the impact of the environment on human health and livelihoods	Research planning	Sustainable Urban Development

3. Requirements for the results of mastering the discipline:

The process of studying the discipline is aimed at the formation of the following competencies:

UC-1 ability to critically analyze and evaluate modern scientific achievements, generate new ideas when solving research and practical problems, including interdisciplinary areas

UC-2 ability to design and carry out complex research, including interdisciplinary, based on a holistic systematic scientific worldview using knowledge in the history and philosophy of science;

UC-4 readiness to use modern methods and technologies of scientific communication in national and foreign languages; including readiness to communicate in oral and written forms in Russian and foreign languages to solve professional problems, proficiency in foreign language communication competence in official-business, educational-professional, scientific, socio-cultural, everyday life spheres of foreign-language communication

GPC-1 ability to independently carry out research activities in the relevant professional area using modern research methods and information and communication technologies

PC-2 to be able to regulate, plan and organize quality assessment and expertise activities in urban planning

PC-3 be able to analyze and assess the impact of the environment on human health and livelihoods

As a result of studying the discipline the graduate student must:

Know:

- the environmental problems of cities and their relation to the over-concentration in relatively small areas of population, transport and industrial plants;

- the essence of the urbanization process and the environmental problems associated with it;

- sanitary and hygiene aspects of the urban environment;

- the essence of an integrated analysis of the natural environment;

- research methodology of the urbanized landscape;

- knowledge of the regularities of the dynamics of urban ecosystems in different climatic and geographical conditions with different intensity of anthropogenic load;

- basics of ecological regulation of urban environment quality;

- modern directions of the reduction of environmental pollution of urban ecosystems;

Be able to:

- work with reference literature, use UN demographic compendia to analyze problematic situations of modern urbanization;

- collect, process, analyze and systematize scientific and technical information on the environmental problems of the urban environment

- justify ways to improve the sustainability of urbanized landscapes;

- assess the quality of urban soils;

- organize and conduct environmental monitoring;

- apply monitoring methods for observation, estimation and prognosis of urban environment condition in order to take operative decisions on its quality improvement.

have a theoretical knowledge of the main issues of urban landscapes:

- theoretical knowledge of the main issues of urban ecology;

- Modern methods of research and possibilities of their practical use, as well as advanced methods of organizing research;

- ability to use theoretical knowledge to analyze processes in urbanized environment;

- ability to evaluate modern methods of quantitative information processing;

- the methodology of urban environment monitoring

4. The volume of discipline and types of educational work

The discipline covers 5 ECTS.

Type of study		Total hours	Semesters			
				2		
Classroom activities (total)		80		80		
Including:		-		-	-	-
Lectures		40		40		
Practical Activities (PP)		40		40		
Seminars (S)						
Labs (L)						
Individual work (total)		90		90		
Control		10		10		
Total labor time hour	hours	180		180		
	ECTS	5		5		

5. Discipline content
5.1. Contents of the discipline sections

№ п/п	The name of the discipline section	The content of the section (topic)
1.	Modeling urban ecosystem components	Urbanization as a rapid trend of current land-use change. Urban ecosystem and its components. Urban atmosphere and air quality. Urban climate. Air pollution in cities. Water pollution and water protection in urban environment. Sewage water categories and key pollutants. Water purification techniques. Urban vegetation: properties, function and factors of influence. Urban soils.
2.	Statistical, spatial and process-based modeling	Data analysis in urban environment studies using R program. Statistical analysis and modeling. Comparison of samples. Correlation. Simple linear regression. QGIS: a tool for spatial analysis. The theory of remote sensing. Climate and atmosphere models. Equipment and software for eddy covariance measurements. Green infrastructure and soils' models.

5.2 Sections of disciplines and types of classes

№	The name of the discipline section	Lect	Practicals and labs			IW	C	Total
			P/S	L	Online format			
1	Modeling urban ecosystem components	20	20		5	45	5	90
2	Statistical, spatial and process-based modeling	20	20		5	45	5	90

6. Lab practical

Not included.

7. Practical classes (seminars)

No	Discipline section number	Subjects of practical training (seminars)	Labor capacity (hour.)
1.	1	City structure.	2

2.	1	Sub-categories and over-categories of urban areas.	2
3.	1	Composition and properties of urban atmosphere.	2
4.	1	Urban climate.	2
5.	1	Monitoring of urban air quality.	2
6.	1	Global distribution of water sources.	2
7.	1	Water pollution: sources, thresholds and control.	2
8.	1	Monitoring of urban water quality.	2
9.	1	Establishment and management of urban greenery: from design towards realization.	2
10.	1	Classification and diagnostics of urban soils.	2
11.	2	What is R?	2
12.	2	Getting start work with R.	2
13.	2	Data structure in R.	2
14.	2	Correlation.	2
15.	2	Simple linear regression.	2
16.	2	QGIS: a tool for spatial analysis.	2
17.	2	Remote sensing.	2
18.	2	Climate and atmosphere models.	2
19.	2	Equipment and software for eddy covariance measurements.	2
20.	2	Green infrastructure and soils' models.	2

8. Educational and methodical support of discipline:

1. Classrooms equipped with multimedia projectors.
2. Computer labs of the ATI, PFUR Library Information Center with access to the PFUR electronic library system and the Internet.
3. R software (open source software), MS office (Word, Excel, Power Point)

9. Information support

a) Software

- curriculum for the discipline "Sustainable Urban development".
- open source software R.
- open source software QGIS.

b) Databases, reference and search engines

- RUDN Electronic Library System - RUDN EBS: http://lib.rudn.ru:8080/MegaPro/Web
- University Library Online: http://www.biblioclub.ru
- IQlib: http://www.iqlib.ru
- Science Direct: http://www.sciencedirect.com
- EBSCO: http://search.ebscohost.com
- Springer/Kluwer: http://www.springerlink.com
- Tailor & Francis: http://www.informaworld.com
- RUSSIA University Information System: http://www.cir.ru/index.jsp
- RUDN educational portal: http://web-local.rudn.ru/

- Graduate Student Advisor http://www.studmedlib.ru

10. Methodological support:

a) main sources:

1. Kurbatova A.S., Bashkin V.N., Kasimov N.S. «Ecology of a city». – M.: 2004 – 624 p (in Russian).
2. Denisov V.V.., Kurbatova A.S., Denisova I.A.., Bondarenko V.L., Gracheva V.A., Gutenev V.V., Nagnibeda B.A. «Ecology of a city». M.: Rostov on Don: 2008-832 p.(in Russia).
3. Alberti M. Advances in Urban Ecology: Integrating Humans and Ecological Processes in Urban Ecosystems Springer; 2008 366 p.
4. R.T.T. Forman. Urban Ecology: Science of Cities Cambridge University Press 2014. 474 p.
5. J. Niemela,J. H. Breuste, G.Guntenspergen. Urban Ecology: Patterns, Processes, and Applications. Oxford University Press; Reprint edition. 2012. 392 p.
6. Working with the ARCINFO Open Development Environment.
7. Васенев И. И., Мешалкина Ю.Л., Грачев Д.А. Геоинформационные системы в почвоведении и экологии Интерактивный курс/ Под ред. И.И. Васенева – М.: РГАУ-МСХА, 2010. 212
8. Геоинформатика. Кн. 1; под ред. В.С. Тикунова. – М.: Издательский центр «Академия», 2008. -384 с.
9. Де Мерс М. Географические информационные системы. Основы.: Пер. с англ. - М: Дата+, 1999, 384 с.
10. Журкин И. Г., Шайтура С. В. Геоинформационные системы. - М.: Кудиц-Пресс, 2008. - 272с.

б) supplementary sources:

1. Bandaranayake W., Qian Y. L., Parton W. J., Ojima D. S. and Follett R. F., 2003. Estimation of Soil Organic Carbon Changes in Turfgrass Systems Using the CENTURY Model. Agron. J. 95, 558–563.
2. Dolgikh, A.V., Aleksandrovskii, A.L., 2010. Soils and cultural layers in velikii Novgorod. Eurasian Soil Science, 43, 477–48.
3. Gerasimova, M.I., Stroganova, M.N., Mozharova, N.V., Prokofieva, T.V., 2003. Urban Soils. Oykumena, Smolensk.(in Russian)
4. Golubiewski, N.E., 2006. Urbanization Increases Grassland Carbon Pools: Effects of Landscaping in Colorado's Front Range. Ecological Applications 16, 555-571.
5. Ilina, I.N. (Eds.), 2000. Environmental atlas of the Moscow city. ABF. Moscow (in Russian)
6. Jo, H.K., McPherson E.G., 1995. Carbon Storage and Flux in Urban Residential Greenspace. Journal of Environmental Management 45, 109–133.
7. Kaye, J.P., McCulley, R.L., Burkez, I.C., 2005. Carbon fluxes, nitrogen cycling, and soil microbial communities in adjacent urban, native and agricultural ecosystems. Global Change Biology 11, 575-587.
8. Lorenz, K., Lal, R., 2009. Biogeochemical C and N cycles in urban soils. Environment International 35, 1–8.
9. Pickett, S.T.A., Cadenasso, M.L., Grove, J.M., Boone, C.G., Groffman, P.M., Irwin, E., Kaushal, S.S., Marshall, V., McGrath, B.P., Nilon, C.H., Pouyat, R.V., Szlavecz, K., Troy,

A., Warren, P., 2011. Urban ecological systems: scientific foundations and a decade of progress. Journal of Environmental Management 92, 331–362
10. Prokofieva, T.V., Stroganova, M.N., 2004. Soils of Moscow city (soils in urban environment, their specifics and environmental significance). Moscow Biological. GEOS, Moscow.
11. Scalenghe, R., Marsan, F.A. The anthropogenic sealing of soil in urban areas, 2009. Landscape and urban planning 90, 1-10. .
12. Vasenev, V.I., Ananyeva, N.D., Makarov, O.A., 2012. Specific features of the ecological functioning of urban soils in Moscow and Moscow oblast. Eurasian Soil Science 45, 194-205.
13. Vrscaj, B., Poggio, L., Marsan, F., 2008. A method for soil environmental quality evaluation for management and planning in urban areas. Landscape and Urban Planning 88, 81-94.
14. V.I. Vasenev, J.J. Stoorvogel, R. Leemans, R. Valentini, R.A. Hajiaghayeva. 2018. Projection of urban expansion and related changes in soil carbon stocks in the Moscow Region. Journal of Cleaner Production 170, 902-914.
15. Romzaykina, O.N., Vasenev, V.I., Khakimova, R.R., Hajiaghayeva, R., Stoorvogel, J.J., Dovletyarova, E.A. 2017. Spatial variability of soil properties in the urban park before and after reconstruction. Soil and Environment, 36 (2), pp. 155-165.
16. V.I. Vasenev, A.V. Smagin, N.D. Ananyeva, K.V. Ivashchenko, E.G. Gavrilenko, T.V. Prokofeva, A. Patlseva, J.J. Stoorvogel, D.D. Gosse and R. Valentini.2017. Urban Soil's Functions: Monitoring Assessment and Management. Pages 359-409 in A. Rakshit et al. (eds.), Adaptive Soil Management: From Theory to Practices, Springer Nature Singapore
17. Koldoba A.V., Poveshchenko Y.A., Samarskaya E.A., Tishkin V.F. Methods of mathematical modelling of environment.-Moscow: Nauka, 2000.
18. Lurie I. Geoinformation mapping: methods of geoinformatics and digital processing of satellite images. - MOSCOW: KDU, 2008. - 423 c.
19. Lychak A.I., Bobra T.V. New computer technologies in ecology. - Textbook - Simferopol: Tavria-Plus, 2004. - 156 c.
20. Trifonova T.A., Mischenko N.V., Krasnoschekov A.N. Geo-information systems and remote sensing in ecological research - Moscow: Academic Project, 2005. - 352 c
21. ActiveX Controls and Automation Servers for Windows NT Developers
22. ARCINFO Data Management. Concepts, data models, database design, and storage.
23. http://landscape.edu.ru
24. http://www.dataplus.ru

11 Methodological Guidelines for Students in the Discipline (Module)

The final grade for the Modeling urban ecosystems course is based on the final grade obtained during the semester. Graduate students are required to attend classes, complete the assignments of the teacher of the discipline, read the recommended literature, etc. During the attestation of the student the quality of work in the classes, the level of preparation for independent activity in the chosen field, the quality of performance of the tasks of the teacher of the discipline, the ability to independently study the training material is assessed.

At seminars and lectures in classrooms, the relevant topics are discussed using multimedia equipment (computer, projector). Independent work during extracurricular hours can also take place in the classrooms of the department and the computer lab, where students can study the material by presentations prepared by the teachers of the department. Presentations on the topics of classes can be recorded on a CD or a flash card for independent work of postgraduate students on a home computer.

Electronic tutorials on a number of studied topics are available on the department and department staff pages on the PFUR educational portal, as well as on local resources of the PFUR electronic library system. One of the forms of independent work is individual assignments in Quantum GIS, which has been mastered during the course.
Extracurricular independent work includes:
study of the materials recommended by the teacher for use, preparation for assignments at the seminars using PCs and QGIS software; preparation for tests on each of the specified sections of the discipline. Postgraduate student's knowledge control is carried out by the teacher who leads the discipline "Modeling urban ecosystems ". Current knowledge control is carried out in the course of lectures and seminars (practical) classes. During the seminar (practical class) the postgraduate student should present the work done during the seminar (practical class), describe the algorithm of his/her actions, be able to answer the teacher's questions. This type of work is aimed at solving the following pedagogical tasks: 1) stimulating independent work of postgraduate students; 2) monitoring the degree of mastering of the training material by postgraduates; 3) identifying problematic aspects and topics that require special attention and concentration. The follow-up control is carried out in the form of a midterm and ongoing assessment in the form of a test.

12. Assessment tools for interim certification of students in the discipline (module)

Materials for assessing the level of mastering of the study material of the discipline "Modeling urban ecosystems" (assessment materials), including a list of competencies with an indication of the stages of their formation, a description of indicators and assessment criteria for competencies at various stages of their formation, a description of assessment scales, standard control tasks or other materials necessary to assess knowledge, abilities, skills and (or) activity experience that characterize the stages of competence formation in the development of the educational programme, methodological materials that determine the assessment procedures for knowledge, skills and (or) activity experience, characterizing the stages of competence formation, are developed in full and are available for students on the discipline's TUIS PFUR website.

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