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**Federal State Autonomous Educational Institution
of Higher Education "Peoples' Friendship University of Russia"**

Agrarian and Technological Institute

(name of the main educational unit-developer of the EP HE)

PROGRAM OF THE DISCIPLINE

Green infrastructure urban, climate and carbon neutrality

(name of the discipline/module)

Recommended by the ISSN for the direction of training/specialty:

35.04.09 Landscape architecture

Management and design of urban green infrastructure

(code and name of the direction of training/specialty)

The development of the discipline is carried out within the framework of the implementation of the main professional educational program of higher education:

Landscape architecture

(name (profile/specialization) of the EP HE)

1. THE AIM OF MASTERING THE DISCIPLINE

The aim of discipline «Green infrastructure urban, climate and carbon neutrality» is to provide solid fundamental knowledge in the interrelations between urban climate and C balance in urban ecosystems, as well as to master basic skills in monitoring and quantification C stocks and fluxes in urban ecosystems under various climatic conditions.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

The development of the discipline "Green infrastructure urban, climate and carbon neutrality " is aimed at the formation of the following competencies among students:

Table 2.1. List of competencies formed by students during the development of the discipline (results of the development of the discipline)

Code	Competency	Indicators of competence achievement (within the framework of this discipline)
UC-1	Student is able to search, critically analyze problem situations based on a systematic approach, and develop a strategy for action	UC1.1 student is able to apply systematization to solve tasks; UC-1.2 Student is able to search and analyze information;
UC -3	Student is able to organize and manage the work of the team, developing a team strategy to achieve the goal	UC-3.1 Student is able to organize team work on the project; UC-3.2 student is able to interact with the executive authorities to coordinate all stages of design;
UC -4	Student is able to apply modern communication technologies in the state language of the Russian Federation and foreign language(s) for academic and professional interaction	UC4.1 Student is able to prepare all the necessary documentation for the project in Russian and a foreign language; UC-4.2 Student is able to communicate on the project in Russian and a foreign language;
UC-5	Student is able to analyze and take into account the diversity of cultures in the process of intercultural interaction	UC-5.2 Student is able to overcome the cultural barrier, perceiving cross-cultural differences;
UC-6	Student is able to determine and implement the priorities of his own activities and ways to improve it based on self-assessment	UC-6.1 "Student is able to plan his life activities for the period of study in an educational organization"; UC6.2 Student is able to determine the tasks of self-development and professional growth, distribute them for long-medium- and short-term with justification of their relevance and determination of the necessary resources;
GPC-2	Student is able to transfer professional knowledge using modern pedagogical techniques;	GPC-2.1 Student is able to transfer professional knowledge; GPC-2.2 Student is able to transfer professional knowledge using information technology;
PC-10	Readiness to manage the objects of landscape architecture in the field of	PC-10.1 Readiness to manage the objects of landscape architecture in the field of

	their functional use, protection and conservation	their functional use, protection and conservation PC-10.2 Ability to manage objects of landscape architecture
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3. THE PLACE OF DISCIPLINE IN THE STRUCTURE OF THE EP HE

The discipline " **Green infrastructure urban, climate and carbon neutrality** " belongs to the variative part of the block B1 of the EP HE.

Within the framework of the educational program, students also master other disciplines and/or practices that contribute to achieving the planned results of mastering the discipline « **Green infrastructure urban, climate and carbon neutrality** ».

Table 3.1. The list of the components of the educational program that contribute to the achievement of the planned results of the development of the discipline

Code	Competency	Previous disciplines/modules, practices*	Subsequent disciplines/modules, practices*
UC-1	Student is able to search, critically analyze problem situations based on a systematic approach, and develop a strategy for action	<i>Data analysis and statistics, International regulation in city planning and environmental protection, Phytopathology and Plant Protection, Scientific writing skills</i>	<i>Landscape planning and sustainable development, Landscape engineering and nature-based solution, Green infrastructure urban climate and carbon neutrality, Principles of remote sensing and modeling, Advances in environmental monitoring, Research planning</i>
UC -3	Student is able to organize and manage the work of the team, developing a team strategy to achieve the goal	<i>Data analysis and statistics, International regulation in city planning and environmental protection, Phytopathology and Plant Protection, Scientific writing skills, Urban ecology</i>	<i>Landscape planning and sustainable development, Landscape engineering and nature-based solution, Green infrastructure urban climate and carbon neutrality, Principles of remote sensing and modeling, Advances in environmental monitoring, Research planning</i>
UC -4	Student is able to apply modern communication technologies in the state language of the Russian Federation and foreign language(s) for academic and professional interaction	<i>Data analysis and statistics, International regulation in city planning and environmental protection, Phytopathology and Plant Protection, Foreign language (Russian language)</i>	<i>Landscape planning and sustainable development, Green infrastructure urban climate and carbon neutrality, Principles of remote sensing and modeling, Advances in environmental monitoring, Research planning</i>
UC-5	Student is able to analyze and take into account the diversity	<i>Data analysis and statistics, International regulation in city planning and environmental protection,</i>	<i>Landscape planning and sustainable development, Landscape engineering and nature-based solution, Green infrastructure urban climate</i>

	of cultures in the process of intercultural interaction	<i>Phytopathology and Plant Protection, Scientific writing skills</i>	<i>and carbon neutrality, Principles of remote sensing and modeling, Advances in environmental monitoring, Research planning</i>
UC-6	Student is able to determine and implement the priorities of his own activities and ways to improve it based on self-assessment	<i>Data analysis and statistics, International regulation in city planning and environmental protection, Phytopathology and Plant Protection, Scientific writing skills, Urban ecology</i>	<i>Landscape planning and sustainable development, Landscape engineering and nature-based solution, Green infrastructure urban climate and carbon neutrality, Principles of remote sensing and modeling, Advances in environmental monitoring, Research planning</i>
GPC-2	Student is able to transfer professional knowledge using modern pedagogical techniques;	<i>Data analysis and statistics, International regulation in city planning and environmental protection, Phytopathology and Plant Protection, Scientific writing skills</i>	<i>Landscape planning and sustainable development, Green infrastructure urban climate and carbon neutrality, Principles of remote sensing and modeling, Advances in environmental monitoring, Research planning</i>
PC-10	Readiness to manage the objects of landscape architecture in the field of their functional use, protection and conservation	<i>Phytopathology and Plant Protection</i>	<i>Landscape planning and sustainable development, Landscape engineering and nature-based solution, Green infrastructure urban climate and carbon neutrality</i>

* - filled in in accordance with the matrix of competencies and SC EP HE

4. SCOPE OF DISCIPLINE AND TYPES OF ACADEMIC WORK

The total labor intensity of the discipline " **Green infrastructure urban, climate and carbon neutrality** " is 6 credits.

Table 4.1. Types of educational work by periods of mastering the OP in for **FULL-time** education

Type of educational work		TOTAL, ac.h	Semesters			
			1			
<i>Contact work, ac.h</i>		34	34			
Including:						
Lectures (LC)		17	17			
Laboratory works (LW)		17	17			
Practical/seminar classes (SC)						
<i>Independent work of students, ac.h</i>		158	158			
<i>Control (exam/test with assessment), ac.h</i>		24	24			
Total labor intensity of the discipline		216	216			
	credits	6				

5. CONTENT OF THE DISCIPLINE

Table 5.1. The content of the discipline (module) by type of academic work

Name of the discipline section	Content of the section (topics)	Type of educational work*
1. Global climate change and carbon neutrality	1.1 Global climate change and carbon neutrality	LC
1. Global climate change and carbon neutrality	1.2 Reviewing IPCC reports	LW
2. Urban climate	2.1 Introduction to urban meteorology	LC
2. Urban climate	2.2 Monitoring urban climate	LW
2. Urban climate	2.3 Climate comfort in cities	LC
2. Urban climate	2.4 Assessing heat stresses in Russian cities	LW
2. Urban climate	2.5 Interim assignment on urban climate	LW
3. Carbon balance in urban ecosystems	3.1 C stocks in urban soils and biomass	LC
3. Carbon balance in urban ecosystems	3.2 Measuring and mapping C stocks in urban soils	LW
3. Carbon balance in urban ecosystems	3.3 Greenhouse gases emissions	LC
3. Carbon balance in urban ecosystems	3.4 Measuring and assessment of GHG emissions	LW
3. Carbon balance in urban ecosystems	3.5 Modeling and quantification of C balance	LC
3. Carbon balance in urban ecosystems	3.6 Accounting C balance in an urban lawn ecosystem	LW
3. Carbon balance in urban ecosystems	3.7 Interim assignment on urban carbon balance	LW
4. UGI in climate mitigation and adaptation	4.1 Cooling effect of UGI	LC
4. UGI in climate mitigation and adaptation	4.2 Real-time monitoring of UGI cooling effect	LW
4. UGI in climate mitigation and adaptation	4.3 Final assignment (project)	LW

* - it is filled in only by **FULL-time** education: LC – lectures; LW – laboratory work; SC - seminars.

6. MATERIAL AND TECHNICAL SUPPORT OF THE DISCIPLINE

Table 6.1. Material and technical support of the discipline

Audience type	Equipping the audience	Specialized educational/laboratory equipment, software and materials for the development of the discipline (if necessary)
Specialized audience	An auditorium for laboratory work, individual consultations, a routine monitoring and interim	Draper Diplomat 213x213 83” tripod screen, a workstation based on a complete system unit and a monitor for

Audience type	Equipping the audience	Specialized educational/laboratory equipment, software and materials for the development of the discipline (if necessary)
	certification, equipped with a set of specialized furniture and equipment. (audiences 203, 418)	working with graphical applications. Model AG_PC Axiom Group/Intel Core I3 Processor 8 Cooperative memory Crucial by Micron DDR4 8SV*2;Motherboard PRIME B360-PLUS;MoHHTop Samsung 23.5, Software ArchiCAD 15, AutoCAD12, SketchUp, QGIS 2.10 (Quantum GIS), Certified soil-ecological lab
For independent work of students	An auditorium for laboratory work, individual consultations, routine monitoring and interim certification, equipped with a set of specialized furniture and equipment. (audiences 203, 418)	Draper Diplomat 213x213 83” tripod screen, a workstation based on a complete system unit and a monitor for working with graphical applications. Model AG_PC Axiom Group/Intel Core I3 Processor 8 Cooperative memory Crucial by Micron DDR4 8SV*2;Motherboard PRIME B360-PLUS;MoHHTop Samsung 23.5, Software ArchiCAD 15, AutoCAD12, SketchUp, QGIS 2.10 (Quantum GIS)

* - the audience for independent work of students is called **MANDATORY!**

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Basic literature:

Printed publications:

1. S. Curwell, M. Deakin, M. Symes (Eds). 2005. Sustainable Urban Development. V.1. The Framework and protocols for Environmental Assessment. Taylor & Francis Group. London.
2. M. Deakin, P. Nijkamp, G. Mitchell, R. Vreeker (Eds) 2006. Sustainable Urban Development. V.2. The Environmental Assessment Methods. Taylor & Francis Group. London.
3. S. Curwell, M. Deakin, P. Lombardi, G. Mitchell, R. Vreeker (Eds) 2006. Sustainable Urban Development. V.3 A toolkit for assessment. Taylor & Francis Group. London.
4. R. Valentini, J. Sievenpiper, M. Antonelli, K. Dembska. 2019. Achieving the Sustainable Development Goals Through 7 Sustainable Food Systems. Springer Nature Switzerland...

Electronic and printed full-text materials:

1. Farina A, James P, Bobryk C, Pieretti N, Lattanzi E, McWilliam J (2014) Low cost (audio) recording (LCR) for advancing soundscape ecology towards the conservation of sonic complexity and biodiversity in natural and urban landscapes. Urban Ecosyst 17:923–944 . doi: 10.1007/s11252-014-0365-0

2. Frolova M (2019) From the Russian/Soviet landscape concept to the geosystem approach to integrative environmental studies in an international context. *Landsc Ecol* 34:1485–1502 . doi: 10.1007/s10980-018-0751-8
3. Haase D, Larondelle N, Andersson E, Artmann M, Borgström S, Breuste J, Gomez-Baggethun E, Gren Å, Hamstead Z, Hansen R, Kabisch N, Kremer P, Langemeyer J, Rall EL, McPhearson T, Pauleit S, Qureshi S, Schwarz N, Voigt A, Wurster D, Elmqvist T (2014) A Quantitative Review of Urban Ecosystem Service Assessments: Concepts, Models, and Implementation. *AMBIO* 43:413–433 . doi: 10.1007/s13280-014-0504-0
4. Herrero-Jáuregui C, Arnaiz-Schmitz C, Herrera L, Smart SM, Montes C, Pineda FD, Schmitz MF (2019) Aligning landscape structure with ecosystem services along an urban–rural gradient. Trade-offs and transitions towards cultural services. *Landsc Ecol* 34:1525–1545 . doi: 10.1007/s10980-018-0756-3
5. Krause BL (1993) The niche hypothesis: a virtual symphony of animal sounds, the origins of musical expression and the health of habitats. *Soundscape Newsl* 6:6–10
6. Meyfroidt P, Roy Chowdhury R, de Bremond A, Ellis EC, Erb K-H, Filatova T, Garrett RD, Grove JM, Heinimann A, Kuemmerle T, Kull CA, Lambin EF, Landon Y, le Polain de Waroux Y, Messerli P, Müller D, Nielsen JØ, Peterson GD, Rodriguez García V, Schlüter M, Turner BL, Verburg PH (2018) Middle-range theories of land system change. *Glob Environ Change* 53:52–67 . doi: 10.1016/j.gloenvcha.2018.08.006
7. Pijanowski BC, Farina A, Gage SH, Dumyahn SL, Krause BL (2011) What is soundscape ecology? An introduction and overview of an emerging new science. *Landsc Ecol* 26:1213–1232 . doi: 10.1007/s10980-011-9600-8
8. Tello E, Gal?n E, Sacrist?n V, Cunfer G, Guzm?n GI, Gonz?lez de Molina M, Krausmann F, Gingrich S, Padr? R, Marco I, Moreno-Delgado D (2016) Opening the black box of energy throughputs in farm systems: A decomposition analysis between the energy returns to external inputs, internal biomass reuses and total inputs consumed (the Vall?s County, Catalonia, c.1860 and 1999). *Ecol Econ* 121:160–174 . doi: 10.1016/j.ecolecon.2015.11.012

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Additional literature:

Electronic and printed full-text materials:

1. Aspinall R, Staiano M (2017) A Conceptual Model for Land System Dynamics as a Coupled Human–Environment System. *Land* 6:81 . doi: 10.3390/land6040081
2. Cortinovis C, Geneletti D (2018a) Ecosystem services in urban plans: What is there, and what is still needed for better decisions. *Land Use Policy* 70:298–312 . doi: 10.1016/j.landusepol.2017.10.017
3. Cortinovis C, Geneletti D (2018b) Mapping and assessing ecosystem services to support urban planning: A case study on brownfield regeneration in Trento, Italy. *One Ecosyst* 3:e25477 . doi: 10.3897/oneeco.3.e25477
4. Costanza R, de Groot R, Braat L, Kubiszewski I, Fioramonti L, Sutton P, Farber S, Grasso M (2017) Twenty years of ecosystem services: How far have we come and how far do we still need to go? *Ecosyst Serv* 28:1–16 . doi: 10.1016/j.ecoser.2017.09.008
5. Ellis EC, Klein Goldewijk K, Siebert S, Lightman D, Ramankutty N (2010) Anthropogenic transformation of the biomes, 1700 to 2000: Anthropogenic transformation of the biomes. *Glob Ecol Biogeogr* no-no . doi: 10.1111/j.1466-8238.2010.00540.x

6. Elmqvist T, Fragkias M, Goodness J, Güneralp B, Marcotullio PJ, McDonald RI, Parnell S, Schewenius M, Sendstad M, Seto KC, Wilkinson C (eds) (2013) *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*. Springer Netherlands, Dordrecht
7. Farina A (2014) *Soundscape Ecology*. Springer Netherlands, Dordrecht

Resources of the Internet information and telecommunication network:

RUDN library system: <http://lib.rudn.ru:8080/MegaPro/Web>

University online library: <http://www.biblioclub.ru>

Ecosystem Services Partnership <https://www.es-partnership.org/>

Millennium Ecosystem Assessment <https://www.millenniumassessment.org/en/index.html>

IQlib: <http://www.iqlib.ru>

Science Direct: <http://www.sciencedirect.com>

EBSCO: <http://search.ebscohost.com>

Springer/Kluwer: <http://www.springerlink.com>

Taylor & Francis: <http://www.informaworld.com>

RUDN web-portal

Data bases and survey systems

GISLAB: <http://www.gis-lab.info>

Google Earth Engine <https://explorer.earthengine.google.com/#workspace>

USGS Earth Explorer <https://earthexplorer.usgs.gov/>

Copernicus Global Land Service <https://land.copernicus.eu/global/products/lc>

Global Soil Map and Database <https://soilgrids.org/>

Educational and methodological materials for independent work of students during the development of the discipline/ module:*

1. Workbook on the discipline « **Green infrastructure urban, climate and carbon neutrality** ».

2. Methodological guidelines for students on the development of the discipline « **Green infrastructure urban, climate and carbon neutrality** »

* - all teaching materials for independent work of students are placed in accordance with the current procedure on the discipline page in the **TUIS!**

8. EVALUATION MATERIALS AND A POINT-RATING SYSTEM FOR ASSESSING THE LEVEL OF COMPETENCE FORMATION IN THE DISCIPLINE

Evaluation materials and a point-rating system* for assessing the level of competence formation (part of competencies) based on the results of mastering the discipline "**International regulation in city planning and environmental protection**" are presented in the Appendix to this Work Program of the discipline.

* - EM and PRS are formed on the basis of the requirements of the relevant local regulatory act of the RUDN.

DEVELOPERS:

Associate Professor of the
Department of Landscape Design
and Sustainable Ecosystems

Position, BTU



Signature

V.I. Vasenev

Name

HEAD OF THE BTU

Director of the Department of
Landscape Design and Sustainable
Ecosystems

Position, BTU



Signature

E.A. Dovletyarova

Name

РУКОВОДИТЕЛЬ ОП ВО:

Director of the Department of
Landscape Design and Sustainable
Ecosystems

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Signature

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Name