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

Agrarian-Technological Institute

Approved by ISSU

PROGRAM

Discipline title Advanced statistics

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 - To gain theoretical and practical skills in processing and interpreting experimental data in the field of environmental analysis of urban green infrastructure.

Tasks:

- to master the basic terms, concepts and theoretical approaches to data analysis;
- to learn how to apply methods of descriptive statistics and graphical analysis of data and interpret its results;
- to learn approaches to analyzing data from one, two, and multiple samples;
- to learn how to formulate and test statistical hypotheses;
- to develop skills in applying data analysis methods to solve practical problems in the field of earth sciences, ecology and sustainable development

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

The discipline Advanced Statistics belongs to the basic 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

Предшествующие и последующие дисциплины, направленные на формирование компетенций

№	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-3 readiness to participate in the work of Russian and international research teams to solve scientific and scientific-educational problems; UC-4 readiness to use modern methods and technologies of scientific communication in national and foreign languages; including readiness to	Research planning	Modeling urban ecosystems

	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; UC -5 ability to plan and solve problems of own professional and personal 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		GIS and dynamic modeling in urban environment
Professional competencies			
3	PC-1 master the modern scientific subject field of knowledge in the program area and be able to use it in scientific, practical and pedagogical purposes PC-3 have the skills to conduct surveys, studies and tests in relation to the objects of urban planning		Modeling urban ecosystems

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-3 readiness to participate in the work of Russian and international research teams to solve scientific and scientific-educational problems;

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;

UC -5 ability to plan and solve problems of own professional and personal development;

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

PC-1 master the modern scientific subject field of knowledge in the program area and be able to use it in scientific, practical and pedagogical purposes;

PC-3 have the skills to conduct surveys, studies and tests in relation to the objects of urban planning.

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

Know:
- methods of data collection and analysis, interpretation and presentation of research results;
- methods of descriptive statistics;
- principles of correlation, regression and analysis of variance ;
- basics of geostatistics;

Be able to:
- formulate a scientific problem and correctly select adequate methods of statistical analysis to solve it;
- apply methods of statistical data analysis and interpret the results;

Master*:*
- the theory of statistical methods of analysis ;
- practical skills of statistical and geostatistical data analysis in R Studio;

4. The volume of discipline and types of educational work

The discipline covers 2 ECTS.

Type of study		Total hours	Semesters			
						4
Classroom activities (total)		18				18
Including:		-		-	-	-
Lectures		8				8
Practical Activities (PP)		10				10
Seminars (S)						
Labs (L)						
Individual work (total)		50				50
Control		4				4
Total labor time hour	hours	72				72
	ECTS	2				2

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.	Reviewing descriptive statistics	Principles to organize scientific research. Object and subject of scientific research. Measuring scales: ordinal, integral and ratio scales. Ordinal, quantitative and qualitative features. Continuous and discrete magnitudes. Variables. Discrete objects and specifics of observations.

		Statistical totality. Average of distribution. Features of average. Sample and Population. Representativeness of sample. Statistical hypothesis. Basic statistics in MS Excel. Introduction to R.
2.	Data analysis, modeling and projection	Confident interval. P-level. T-test. Usage of t-test for comparison of averages of two independent samples, for comparison of averages of two related samples, for comparison of average pairs, for testing regression coefficients. T- test structure, null and alternative hypothesis, step-by-step solutions. Estimation of confident interval. Critical values for t-distribution. Correlation. Pearson's (parametric) and Spearman's (nonparametric) correlation coefficients. Linear regression. Simple (one-factor) linear regression. . Fitting regression model and testing its significance. multiple and logistic regression models. Fitting models and testing significance of regression coefficients and model relevance.
3.	Introduction to geostatistical analysis	Variance. Spatial variance. Semivariance. Semivariogram. Nugget. Sill. Range. Experimental variogram. Geostatistical interpolation. Kriging. Ordinary Kriging. Cross-validation. Stratified kriging. Regression kriging. Indicator kriging.

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	Reviewing descriptive statistics	2	2		2	12	2	18
2	Data analysis, modeling and projection	4	4		2	19	1	28
3	Introduction to geostatistical analysis	2	4		2	19	1	26

6. Lab practical

Not included.

7. Practical classes (seminars)

No	Discipline section number	Subjects of practical training (seminars)	Labor capacity (hour.)

1.	1	Introduction to R. Data input and organization. Basic commands. Descriptive statistics and graphics in R.	2
2.	2	Normality. Comparison of means for two samples (t-test) . Relationship between two variables (correlation).	2
3.	2	Comparison of means for multiple samples (ANOVA). Linear regression.	2
4.	3	Modeling and fitting variograms. Spatial analysis and modeling	2
5.	3	Interpolation: inverse distance weighting, ordinary kriging, autokriging.	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 "Advanced Statistics".
- open source software R.

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

Course of video lectures "Data analysis and statistics in landscape studies" (available on the PFUR portal). Includes 18 sessions

10. Methodological support:

a) main sources:

1. D. M. Diez, C.D. Barr, M. Cetinkaya-Rundel . OpenIntro Statistics. 2014. openintro.org
2. J. Leek. The elements of data analytic style. http://leanpub.com/datastyle
3. R. Lyman Ott & Michael Longnecker. An introduction to statistical methods and data analysis. 6th edition
4. Hans-Peter Pifo. Statistics for bachelors in Agriculture and Renewable Energy sources. Hochenheim. 288 P.
5. Kabacoff R.I. R In Action. Data analysis and graphics with R. Second edition. 2015. 608 p.
6. Logan M. Biostatistical design and analysis using R. A practical guide. 2010. 546 p.

7. Mastitsky S.E., Shitikov V.K. Statistical analysis and visualization of data with R. 2014. E-book, access address: http://r-analytics.blogspot.com (in Russian)
8. Quick J.M., Statistical Analysis in R: Beginners Guide. 2010. 300 p.

б) supplementary sources:

1. Borovkov A.A. Mathematical Statistics. Parameter estimation. Hypothesis Check. Textbook. - Moscow: Nauka, 1984 - 472 p.
2. Dmitriev E.A. Mathematical Statistics in Soil Science. Textbook. - Moscow: Publishing House of Moscow State University, 1995 - 320 p.
3. Kozlov M.V., Prokhorov A. B. Introduction to Mathematical Statistics - Moscow: Moscow State University Press, 1987. -264.Bailey, T. C., and A. C. Gatrell. 1995. Interactive spatial data analysis. Harlow, UK: Longman.
4. Batty, M. J., and P. A. Longley. 1994. Fractal cities: A geometry of form anfunction. San Diego, Calif.: Academic Press.
5. Benenson, I. 2004. Agent-based modeling: From individual residential to urban residential dynamics. In Spatially integrated social science, ed. M. Goodchild and D. J. Janelle, 67–94. New York: Oxford University Press.
6. Berger T. Agent-based spatial models applied to agriculture: a simulation tool for technology diffusion, resource use changes and policy analysis. 2001. Agricultural Economics. # 25. P. 245–260.
7. Dmitriev E.A. Mathematical statistics in soil science. MSU edition. 1995.
8. Fotheringham, A. S., and M. E. O'Kelly. 1989. Spatial interaction models: Formulations and applications. Boston: Kluwer.
9. Goodchild M.F. GIS and modeling overview. In: GIS, Spatial Analysis and Modeling. Maguire D.J. , Batty M., Goodchild M.F. (Eds). ESRI Press, Redlands. P. 2-17.
10. Haining, R. P. 2003. Spatial data analysis: Theory and practice. New York: Cambridge University Press.
11. O'Sullivan, D., and D. J. Unwin. 2003. Geographic information analysis. New York: John Wiley and Sons.
12. Peuquet, D. 2002. Representations of space and time. New York: Guilford.
13. Tomlin, C. D. 1990. Geographic information systems and cartographic modeling. Englewood Cliffs, N.J.: Prentice Hall.

11 Methodological Guidelines for Students in the Discipline (Module)

The final grade for the Advanced Statistics course is based on the final grade obtained during the semester. The course includes thematic lectures with control of mastering of the material by means of express tests and practical works with the use of open source software R and R Studio. The practical work welcomes the use of own research results as databases for analysis and processing. Postgraduate students are required to attend classes, fulfil the assignments of the teacher of the discipline, get acquainted with the recommended literature and software, including during independent training. During the attestation of the student is assessed 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. All practical classes are focused on gradual development of data processing and analysis skills using R package. The acquired skills will have to be demonstrated by the postgraduate student while preparing an independent project based on the analysis of the postgraduate student's own research data.
Seminars and lectures in classrooms provide an overview of relevant topics using multimedia equipment (computer, projector). Independent work during extracurricular hours can also take place

in the classrooms of the department and in the computer lab, where students can study the material using presentations prepared by the teachers of the department.
Electronic tutorials on a number of topics can be found on the Department and its staff pages on the PFUR educational portal, as well as on the local resources of the PFUR electronic library system.
Extracurricular independent work includes:
study of the materials recommended by the teacher for use, preparation for assignments at the seminars, in particular, work with methodological literature and performing exercises (tutorials) to consolidate the skills of working with the software.
Postgraduate student's knowledge control is carried out by the teacher, who leads the discipline "Advances statistics". Current knowledge control is carried out during lectures and seminars (practical) classes. In the course of the seminar (practical exercises) the postgraduate student must present the work performed during the seminar (practical exercises), describe the algorithm of his/her actions, be able to answer the questions of the teacher. 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 "Statistics" (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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