COURSE SYLLABUS

SPATIAL DATA ANALYSIS IN R

1. Data about the program

1.1 Higher education institution	Babeș-Bolyai University
1.2 Faculty	Faculty of Biology and Geology
1.3 Doctoral school	Integrative Biology
1.4 Field of study	BIOLOGY
1.5 Study cycle	Doctorate
1.6 Study program / Qualification	Doctoral training / PhD in Biology

2. Course data

2.1 Name of discipline	**Spatial data analysis in R**						
2.2 Teacher responsible for lectures	C.S. II Dr. Turtureanu Pavel Dan / Conf. Dr. László Zoltán						
2.3 Teacher responsible for seminars	C.S. II Dr. Turtureanu Pavel Dan / Conf. Dr. László Zoltán						
2.4 Year of study	1	2.5 Semester	2	2.6. Type of evaluation	C	2.7 Course framework	O

C – colloquium; O – optional

3. Estimated total time of teaching activities(hours persemester)

3.1 Hours per week	4	Out of which: 3.2 Lectures	2	3.3 Seminars / Laboratory classes	2
3.4 Total hours in the curriculum	48	Out of which: 3.5 Lectures	24	3.6 Seminars / Laboratory classes	24
Allocation of study time:					hrs
Study supported by textbooks, other course materials, recommended bibliography and personal student notes					64
Additional learning activities in the library, on specialized online platforms and in the field					64
Preparation of seminars / laboratory classes, topics, papers, portfolios and essays					38
Tutoring					34
Examinations					4
Other activities: -					-
3.7 Individual study (total hours)	204				
3.8 Total hours per semester	252				
3.9 Number of credits	10				

4. Preconditions (where applicable)

4.1 Curriculum	• Not applicable
4.2 Competences	• Basic knowledge of geography and ecology • User-level computing skills • Speaking and writing skills in English

5. Conditions (where applicable)

5.1 Conducting lectures	• Audio-video logistics, whiteboard, access to WiFi internet
5.2 Conducting seminars/laboratory classes	• Audio-video logistics, whiteboard, access to WiFi internet

6. Specific competences acquired

Professional competences	• Integrating georeferenced ecological information into accessible, digital systems. • Manipulating georeferenced ecological information. • Mapping and performing of exploratory/statistical analyses on information derived from georeferenced data.
Transversal competenc	• Competences in the analysis of spatial data, a requisite of scientific research in any field of biogeography and ecology, which involves a quantitative approach.

7. Course objectives (based on the acquired competencies grid)

7.1 The general objective of the course	• To learn concepts and specific techniques to create, manipulate, map and perform analyses on spatial data.
7.2 Specific objectives	• To learn various techniques to integrate, structure, store and analyse spatial data for further analyses, as implemented in the R statistical environment.

8. Content

8.1 Lectures	Teaching methods	Comments
1. Introduction to R - Basic commands - Functions - Importing and exporting data - Plotting	Presentation, discussion, case studies	2 hours
2. Types of spatial objects - Points - Polygons - Rasters - GPS in the field		2 hours
3. Loading and interrogating spatial data - Importing spatial objects - Transforming spatial objects - Filtering - Extracting values from spatial objects		2 hours
4. Visualize spatial data: - Cropping rasters - Plotting rasters, polygons, points - Digital Elevation Model (DEM)		2 hours
5. Multiple spatial data manipulation: - Manipulating multiple spatial objects		2 hours
6. Spatial data analysis I: patterns - Percentage of area covered by various land cover types - Spatial processes underlying the distribution of phenomena - The species-area relationship		2 hours
7. Spatial data analysis II: statistics - Spatial distances - Spatial autocorrelation		2 hours

- Distance decay in biogeography - Clustering of spatial data		
8. Introduction to remote sensing - Satellite missions and products - Spatial and temporal resolutions of remote sensing products		2 hours
9. Remote sensing data processing - Manipulating remote sensing imagery - Transformation and correction		2 hours
10. Remote sensing image classification - Categorizing pixels in satellite data - K-nearest neighbors algorithm		2 hours
11. The Normalized Difference Vegetation Index - Calculation and ecological meaning of NDVI - Spatial variability of NDVI - Modeling NDVI		2 hours
12. Greening trends - Temporal variability of NDVI - Greening trends of terrestrial ecosystems		2 hours
		Total: 24 hours

Bibliography:

(1) Bivand, R., Pebesma, E., Gómez-Rubio, V. (2013) Applied Spatial Data Analysis with R. Springer New York, NY.
(2) Pettorelli, N. (2019) Satellite remote sensing and the management of natural resources. Oxford University Press, UK.
(3) Spector, P. (2008) Data manipulation with R. Springer, Printforce, Netherlands.
(4) Wegmann, M., Schwalb-Willmann, J., & Dech, S. (2020) An Introduction to Spatial Data Analysis: Remote Sensing and GIS with Open Source Software. Pelagic Publishing Ltd.

8.2 Seminars / laboratory classes	Teaching methods	Comments
1. First steps in R - Applying and checking results for basic maths - Introducing basic functions and help - Importing and exporting data from Excel - Plotting in R graphics interface using 'base' package	Practical work. Problem-solving and discussion.	2 hour
2. Manipulating spatial objects - Check local available file formats - Joining coordinates and measurement sheets - Importing shapefiles and rasters - Checking of and re-projecting in different coordinate reference systems (CRS)		2 hours
3. Interrogating spatial objects - Filtering of spatial objects: points and rasters - Extracting values from rasters - Analyses on Digital Elevation Models (DEM)		2 hours
4. Visualizing spatial data: - Plotting raw spatial objects - Cropping spatial objects - Plotting the resulted spatial objects - Producing maps with statistical information for publication		2 hours

5. Multiple spatial data manipulation: - Listing available spatial objects - Looping through spatial objects - Transforming and interrogating multiple spatial objects		2 hours
6. Spatial data analysis I: patterns - Mapping objects to identify spatial patterns - Calculating spatial distances - Calculating topographic indices - Modeling species-area relationships		2 hours
7. Spatial data analysis II: statistics - Testing spatial autocorrelation in example data - Modeling distance decay in example data - Clustering of spatial data in example data		2 hours
8. Introducing remote sensing products - Downloading and handling different satellite missions spatial products - Checking spatial resolution - Inspecting available temporal resolutions		2 hours
9. Remote sensing data processing - Manipulating collections of remote sensing imagery - Pre-processing “level 0” remote sensing raw imagery		2 hours
10. Remote sensing image classification - Raw categorization of pixels in satellite data - Applying the k-nearest neighbors algorithm		2 hours
11. Using the Normalized Difference Vegetation Index - Calculating of NDVI using band values and rasters - Checking spatial variability of NDVI in example data - Modeling NDVI in example data		2 hours
12. Assessing greening trends - Extracting multi-year NDVImax values - Estimating greening trends		2 hours
		Total: 24 hours
Bibliography:		
(1) Crawley, M.J. (2013) The R Book, 2nd edition. John Wiley, UK. (2) Chang, W. (2013) R Graphics Cookbook. O’Reilly Media, CA. (3) Kamusoko, C. (2019) Remote Sensing Image Classification in R. Springer Geography, Singapore. (4) Spector, P. (2008) Data manipulation with R. Springer, Printforce, Netherlands.		

9. Aligning the contents of the discipline with the expectations of the epistemic community representatives, professional associations and standard employers operating in the program field

- The course has a similar content to courses from other European universities, and considers the level of training and abilities of doctoral students.
- The content of the course is regularly updated and incorporates the most novel approaches from the field of ecology, nature conservation, biogeography.
- The course is fundamental for doctoral students in the field of ecology, as quantitative skills are essential for scientific research activities.

10. Examination

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final grade
10.4 Lectures	Assessment of knowledge	Colloquium (written)	50%
10.5 Seminars/laboratory classes	Skills in understanding and reviewing the latest scientific information	Colloquium (written)	50%
10.6 Minimum performance standard			
• Knowledge of 50% of the information content of the course • Knowledge of 50% of the information content of the laboratory work.			

Date of issue

19.09.2022

Signature of the teacher responsible for lectures

C.S. II Dr. Turtureanu Pavel Dan /

Conf. Dr. László Zoltán

Signature of the teacher responsible for seminars

C.S. II Dr. Turtureanu Pavel Dan /

Conf. Dr. László Zoltán

Date of approval by the doctoral school council

20.09.2022

Signature of the doctoral school director

Prof. Pap Péter László