COURSE DESCRIPTION

GIS analysis for environmental studies

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University of Cluj-Napoca
1.2. Faculty	Faculty of Environmental Science and Engineering
1.3. Department	Department of Environmental Analysis and Engineering
1.4. Field	Environmental Engineering
1.5. Level of study	Master's Degree
1.6. Degree programme / Qualification	Sustainable Development and Environmental Management
1.7. Form of education	Full-time education

2. Course-related data

2.1. Course title	**GIS analysis for environmental studies**			Course code	**NME4211**
2.2. Course coordinator	Lecturer PhD. Cristian V. Maloș				
2.3. Seminar coordinator	Lecturer PhD. Cristian V. Maloș				
2.4. Year of study	I	2.5. Semester	I	2.6. Type of assessment	Exam
2.7. Course status	Compulsory			2.8. Course type	Specialisation subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**4**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**2**
3.4. Total of hours in the curriculum	56	of which: 3.5. course	28	3.6. seminar/ laboratory	**28**
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					20
Additional research in the library, on subject-specific electronic platforms, and on-site					20
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					18
Tutoring (professional guidance)					2
Examinations					2
Other activities field work					7
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**69**	
3.8. Total hours per semester				**125**	
3.9. Number of credits				**5**	

4. Prerequisites (where applicable)

4.1. curriculum-related	
4.2 skills-related	

5. Specific conditions (where applicable)

5.1. course-related	Classroom equipped with projector	
5.2. seminar/laboratory-related	Classroom with computers, projector, and whiteboard	

6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]

[1] The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes.

Professional competencies	
Competency code	**Competency**
PC4	Investigate pollution: Identify the cause of pollution incidents, as well as its nature and the extent of the risks, by performing tests on the site of pollution as well as in a laboratory and performing research.
PC7	Conduct environmental site assessments: Manage and oversee environmental site prospection and assessments for mining or industrial sites. Designate and demarcate areas for geochemical analysis and scientific research.
PC12	Perform scientific research: Gain, correct or improve knowledge about phenomena by using scientific methods and techniques, based on empirical or measurable observations.
Transversal competencies	
Competency code	**Competency**
TC1	Think analytically: Produce thoughts using logic and reasoning in order to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
TC2	Work in teams: Work confidently within a group with each doing their part in the service of the whole.
TC3	Report on environmental issues: Compile environmental reports and communicate on issues. Inform the public or any interested parties in a given context on relevant recent developments in the environment, forecasts on the future of the environment, and any problems and possible solutions.

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)[2]

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
PC4	1. The student/graduate identifies and describes advanced analytical techniques for the detection and quantification of chemical pollutants, as well as methods for sampling, preparation and analysis of environmental samples.	1. The student/graduate applies advanced analytical techniques for measuring pollutant concentrations in environmental samples. The student/graduate selects appropriate sampling and analysis methods depending on the type of sample and contaminant. The student/graduate interprets analytical results in the context of environmental quality assessment.
PC7	2. The student/graduate identifies and describes the principles of geographic information systems (GIS), remote sensing and computer-aided design applied to environmental studies.	2. The student/graduate identifies and describes the principles of geographic information systems (GIS), remote sensing and computer-aided design applied to environmental studies.
PC12	3. The student/graduate uses GIS and remote sensing tools for the analysis and visualisation of spatial environmental data. The student/graduate creates technical projects using computer-aided design software.	3. The student/graduate actively participates in research and professional practice processes, documenting activities and results. The student/graduate applies integrated theoretical and practical knowledge in solving complex environmental problems. The student/graduate formulates research questions, applies appropriate methodologies and draws well-founded conclusions.

7. Subject-specific learning outcomes

If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

[2] The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

Knowledge and comprehension
1. The student knows: The foundations of GIS analysis applied to environmental impact assessment and management
2. Types of geospatial data and their processing and visualization methods in environmental studies Key functionalities of GIS software relevant for environmental auditing and compliance
3. Key functionalities of GIS software relevant for environmental auditing and compliance
4. Environmental legislation and how spatial data support compliance
5. The stages of conducting a GIS-based environmental study
Specific academic skills
1. Use GIS applications to analyse environmental data
2. Develop and apply spatial analysis methodologies to support environmental audits and studies
3. Create thematic maps and cartographic outputs for pollution prevention consulting
4. Apply spatial analysis techniques in real-world contexts (including fieldwork), using data from multiple sources
5. Communicate results effectively through reports, maps, and integrated interpretations

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks[3]**
Introduction to GIS Analysis in Environmental Studies	Lecture, heuristic conversation	Conceptual framework and examples
Types of Geospatial Data and Their Sources in Environmental Studies	Lecture, brainstorming	Vector, raster, field data
Structure and Organization of Spatial Databases	Lecture, demonstration	Integration in GIS projects
Coordinate Systems and Map Projections	Lecture, applied discussion	Importance in accurate analysis
Basic Functionalities in GIS Software (QGIS, GRASS, etc.)	Lecture, demonstration	Introduction to tools
Spatial Analysis in the Context of Environmental Impact Assessment	Lecture, case studies	Connection to EIA
Environmental Audit Supported by GIS	Lecture, case study	Practical applicability
Modelling Ecological Risks Using Geospatial Data	Lecture, brainstorming	Examples: floods, pollution
Thematic Maps and Visualization of Results in Environmental Studies	Lecture, applied debate	Digital cartography
Working with Geospatial Data from Official and Open Sources	Lecture, resource exploration	ANPM, Copernicus, INSPIRE
Advanced Analysis Techniques: Interpolation, Reclassification, Raster Calculator	Lecture, demonstration	Applications for soil, air, water
Integration of Field Data in GIS Projects	Lecture, case study	GPS, direct observations
Presentation and Interpretation of Results for Decision-Makers	Lecture, practical simulation	Visual and decision-making language
Perspectives on Using GIS for Sustainability and Environmental Policies	Lecture, open discussion	Professional development

[3] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

Bibliography
Longley, P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. Geographic Information Systems and Science. Wiley, 2005.

Heywood, I., Cornelius, S., Carver, S. An Introduction to Geographical Information Systems. Pearson Prentice Hall, 2006.

Burrough, P. A., McDonnell, R. A. Principles of Geographical Information Systems. Oxford University Press, 1998.

Bolstad, P. GIS Fundamentals: A First Text on Geographic Information Systems. Eider Press, 2016.

Tomlinson, R. Thinking about GIS: Geographic Information System Planning for Managers. ESRI Press, 2011.

Goodchild, M. F., Longley, P. A., Maguire, D. J., Rhind, D. W. Geographic Information Science and Systems. Wiley, 2015.

Cloetingh, S., Negendank, J. (eds.) The Earth and its Sciences: GIS Applications in Geosciences. Springer, 2006.

Kresse, W., Danko, D. Springer Handbook of Geographic Information. Springer, 2012.

8.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
Navigation in the QGIS Interface, Adding Raster and Vector Layers, Metadata Exploration	Demonstration, guided exercise	Familiarization with the software interface and data structure – 2 hours
Downloading and Integrating Open Data (Copernicus, OSM, Natural Earth)	Individual work, practical assistance	Understanding differences between vector/raster and official data sources – 2 hours
Creating a Vector Database (GeoPackage); Attribute Management	Guided practical exercise	Foundation of structured GIS projects – 2 hours
Data Reprojection and Coordinate System Conversion	Practical application, comparison	Impact of projections on spatial measurements – 2 hours
Basic QGIS Functionalities: Measurements, Selections, Styling	Demonstration, interactive exercise	Practicing basic functions for new users – 2 hours
Buffer Analysis for Environmental Impact Assessment	Case study, applied analysis	Direct link to protected areas assessment – 2 hours
Environmental Audit Simulation: Industrial and Residential Areas	Applied exercise, debate	Introduction to GIS-assisted audits – 2 hours
Ecological Risk Modelling: Floods, Pollution	Guided exercise, discussion	Integration of DEM data and raster analysis – 2 hours
Creating Thematic Maps and Final Layout	Demonstration and practical application	Effective and professional visual communication – 2 hours
Importing and Geoprocessing Data from ANPM and INSPIRE	Exploration, individual exercise	Relevance and limitations of official sources – 2 hours
Raster Reclassification, IDW Interpolation	Guided exercise, case study	Applications in environmental quality: soil, air – 2 hours
Integration of GPS Coordinates and Field Observations in QGIS	Demonstration, practical application	Link between GIS and fieldwork – 2 hours
Creating a Dashboard or Multi-Layer Layout	Individual exercise with feedback	Visual presentation for decision-makers – 2 hours
Scenario Planning with Advanced Functions (MCA, Time Manager)	Case study, applied debate	Exploring the role of GIS in planning and policy – 2 hours

Bibliography
QGIS User Guide (available online at https://docs.qgis.org)

GRASS GIS Documentation (https://grass.osgeo.org/documentation/)

Chang, K. Introduction to Geographic Information Systems. McGraw-Hill Education, 2019.

Corbin, T. Learning ArcGIS Pro 2. Packt Publishing, 2020.

Korte, G. B. The GIS Book. OnWord Press, 2001.

Course notes and working documents

R documentation and geospatial packages (e.g., sf, terra, tmap, leaflet, ggplot2)

9. Evaluation

Type of activity	9.1 Evaluation criteria[4]	9.2 Evaluation methods[5]	9.3 Percentage in the final grade
9.4. Course	Understanding of theoretical concepts, ability to argue and apply them in real-life contexts	Oral exam for theoretical knowledge	40%
9.5. Seminar/ laboratory	Accuracy, efficiency, and relevance of a spatial analysis applied in environmental contexts	Final individual computer-based exercise (GIS project)	60%
9.6 Minimum standard for passing			
• Correct execution of a basic GIS analysis (e.g., thematic map using vector and raster data); • Brief explanation of the main GIS functionalities used in environmental studies.			

10. SDG labels (Sustainable Development Goals)[6]

	○	Sustainable Development Generic Label						
1 FĂRĂ SĂRĂCIE	2 FOAMETE „ZERO"	3 SĂNĂTATE ȘI BUNĂSTARE	4 EDUCAȚIE DE CALITATE	5 EGALITATE DE GEN	6 APĂ CURATĂ ȘI SANITAȚIE	7 ENERGIE CURATĂ ȘI LA PREȚURI ACCESIBILE	8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ	9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ
○	○	x	○	○	○	○	x	○
10 INEGALITĂȚI REDUSE	11 ORAȘE ȘI COMUNITĂȚI DURABILE	12 CONSUM ȘI PRODUCȚIE RESPONSABILE	13 ACȚIUNE CLIMATICĂ	14 VIAȚA ACVATICĂ	15 VIAȚA TERESTRĂ	16 PACE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE	17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR	No label applies
○	○	○	x	x	x	○	○	○

[4] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[5] Both final evaluation methods and ongoing evaluation strategies should be established.

[6] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *"No label applies."*

Date of entry:
26.01.2026

Signature of course coordinator

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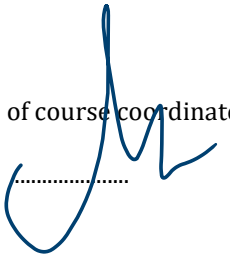

Signature of seminar coordinator

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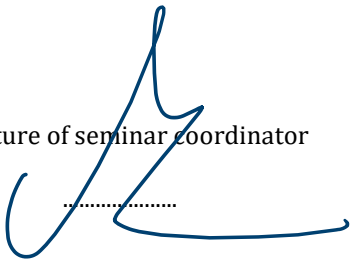

Date of approval in the department:
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Signature of the head of department

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