Study course title	Methods of Geospatial Analysis in Environmental Science
Study course code (DUIS)	Ģeog3003
Credits	2
European credit transfer and accumulation system credits	3
Total number of contact hours	32
Number of lecture hours	16
Number of hours for seminars	Click or tap here to enter text.
Number of hours for practical assignments	Click or tap here to enter text.
Number of hours for laboratory assignments	16
Independent study hours	48

Course developer (-s)

Dr. Geol., assoc. prof. Juris Soms; M.Sci.Env., lecturer Dainis Lazdāns

Prerequisite knowledge

basic knowledge of computing and geospatial data editing, visualization and mapping techniques by ESRI ArcGIS software

Study course abstract

The aim of the study course is to develop basic understanding of spatially referenced data (=geospatial data) analysis and to explore the potential of Geographic Information Systems (=GIS) application in environmental studies. The course builds up on the practical skills in geospatial data developing, editing and mapping obtained during the course "Geog2009 Geographic Information Systems", but offers more detailed discussion and wider range of geospatial data visualization methods and introduces analysis of geospatially related features, phenomena and processes. Besides, the course aims at providing both a theoretical understanding and a practical introduction to the use of GIS-based technologies for monitoring and analysis of environmental problems. Students are exposed to the basic techniques and practical skills of extracting relevant information from results of geospatial analysis.

Course plan

Educational Approach: The course consists of computer class-based teacher presentations, supervised in-class exercises, individual consultations and fulfillment of homework tasks and assignments. The course is based on 'learning-by-doing' approach, i.e. in order to acquire and master practical skills in geospatial analysis, principles presented by teacher during laboratory-based classes will be accompanied by students' extensive individual work

Learning outcomes

Theory of geospatial data and its analysis

Awareness of GIS methods and its potential benefits in analysis of geographic patterns and relationships

Practical skills in using ArcGIS extensions and tools for processing environmental data and extracting new information

Practical skills in retrieving and manipulating spatially referenced vector, raster and TIN data

Ability to carry out independent GIS-based research.

Requirements for awarding credits

Grading policy: 20% in-class exercises and 80% homeworks; practical examination at the end of the course

Course content

1. Introduction. Geospatial data and geospatial analysis. Vector (point/line/polygon based) data, raster (regular grid based) and TIN (triangular irregular network based) data: the different ways of

displaying and mapping geographically or geospatially referenced features, phenomena and processes. Application of geospatial techniques for monitoring and analysis of environmental data.
2. Basic geospatial analysis method – creating classes. Grouping of features with similar values by standard classification schemes. Natural breaks (Jenk's), Quantile, Equal Interval, Standard Deviation, Equal Interval, Defined Interval. Comparing classification schemes - what each scheme is good for? Choosing classification scheme, number of classes. Exclusion of outlier values. Principles of visualization. Geospatial analysis and creating of maps using graduated symbols & proportional symbols, different charts and quantities by category.
3. Identification of spatial relationships and patterns as geospatial analysis method. Mapping and visualization of point features density per uniform areal unit. Mapping and visualization of line features density per uniform areal unit. Calculating a density for defined areas.
4. Analyzing and identification of geographic clusters. Random, dispersed and clustered patterns of geospatial data. Identification of "hot spots" and "cold spots" of point data. Spatial statistics tools. Clustering by location and clustering by attribute value. Identification of clusters of polygon data.
5. Interpolation and extrapolation – how to obtain continuous data from discrete data? Representing of geospatially referenced data by surfaces. Deterministic and geostatistical interpolation techniques. Interpolation methods: inverse distance weighting, natural neighbor, spline. Interpolating surfaces by Spatial Analyst tools. Interpolation for defined areas. Application of contour lines for representation of continuous geospatial data. Mapping and visualization of continuous geospatial data obtained in the course of interpolation.
6. Interpolation of Earth's topographic surface – digital elevation modelling. Obtaining the elevation data by remote sensing techniques. Using of LiDAR data for developing digital surface models and digital elevation models. Extraction of information from DEM – slope, aspect, flow accumulation, watershed etc. Conversion of 2D elevation raster data models into 3D TIN models. Mapping and visualization of DEMs. Combining DEM's with remotely sensed digital images.
7. Suitability /sensitivity analysis and modelling by Spatial Analyst tools to find suitable locations. Clip, union, proximity and other tools for geoprocessing of vector data and obtaining thematic layers for subsequent suitability analysis. Limitations of use of vector data in multi-criterion analysis. Conversion of vector data into raster data layers. Raster calculations. Overlaying and processing raster data layers. Mapping and visualization of raster calculations. Application of raster calculations in modelling of environmental processes.
8. Temporal dimension of geospatial data. Nature of temporal data. The purpose of mapping temporal data in the context of geospatial analysis. Methods to map and visualize temporal data. Static displays: superimposed features, isochron maps, small multiples, complementary graphics, change maps, space-time cubes. Dynamic displays..

Compulsory reading list

de Smith M.J., Goodchild M.F., Longley P.A., 2007. Geospatial Analysis. A Comprehensive Guide to Principles, Techniques and Software Tools. 2nd edit. Winchelsea Press, London, 491 pp.
free Geospatial Analysis book online (best viewed on a desktop, laptop or tablet screen): https://www.spatialanalysisonline.com/HTML/index.html
Mitchell A., 1999. The ESRI Guide to GIS Analysis. Vol. 1: Geographic Patterns and Relationships. Environmental Systems Research Institute, ESRI Press, Redlands, CA, USA, 186 pp.
Mitchell A., 1999. The ESRI Guide to GIS Analysis. Vol. 2: Spatial Measurements and Statistics. Environmental Systems Research Institute, ESRI Press, Redlands, CA, USA, 238 pp.
Online GIS Dictionary (Look up terms related to GIS operations, cartography, and ESRI technology): https://support.esri.com/en/other-resources/gis-dictionary/search/.

Further reading list

Advanced spatial analysis. The CASA book of GIS, 2003. Longley P.A., Batty M. (eds.), Environmental Systems Research Institute, ESRI Press, Redlands, CA, USA, 463 pp.
Air Pollution Modelling and Simulation, 2002. Sportisse B. (ed.), Springer-Verlag, Berlin, 592 pp.

Brewer, C. A., 2005. Designing Better Maps. A Guide for GIS Users. Environmental Systems Research Institute, ESRI Press, Redlands, CA, USA, 203 pp.
Brimicombe A., 2003. GIS, Environmental modelling and engineering. Taylor &Francis Group, London, 312 pp.
Environmental Modelling. Finding Simplicity in Complexity, 2004. Wainwright J., Mulligan M (eds.), John Wiley & Sons, Chichester, UK, 408 pp.
Hierarchical Modelling for the Environmental Sciences. Statistical Methods and Applications, 2006. Clark J.S., Gelfand A.E. (eds.), Oxford University Press, Oxford, 205 pp.
Jensen J.R., 2007. Remote Sensing of the Environment. An Earth resource perspective. Prentice Hall, New Jersey, 592 pp.
Jones C., 1997. Geographical information systems and computer cartography. Prentice Hall, Harlow, 319 pp.
Knight D.W., Shamseldin A.Y., 2006. River Basin Modelling for Flood Risk Mitigation. Taylor &Francis Group, Leiden, 607 pp.
Kovarik K., 2000. Numerical Models in Groundwater Pollution. Springer, Berlin, 221 pp.
Kraak M.J., Ormeling F., 2003. Cartography – Visualisation of Geospatial Data. Prentice Hall, Harlow, 205 pp.
Li Z., Zhu Q., Gold C., 2005. Digital terrain modelling. Principles and methodology. CRC PRESS, Washington, D.C, 323 pp.
Lillesand T., 1999. Remote Sensing and Image Interpretation. 4th edit. John Wiley & Sons, Chichester, 736 pp.
Long Term Hillslope and Fluvial System Modelling. Concepts and Case Studies from the Rhine River Catchment, 2003. Lang A., Hennrich K., Dikau R. (eds.), Springer-Verlag, Berlin, 248 pp.
Odum T. H., Odum C. E., 2000. Modelling for all scales. An introduction to System Simulation. Academic Press, London, 458 pp.
Scally R., 2006. GIS for Environmental Management. Environmental Systems Research Institute, ESRI Press, Redlands, CA, USA, 187 pp.

Periodicals and other sources

1. Journal of Geovisualization and Spatial Analysis (Springer Link: https://link.springer.com/journal/41651)
2. Geoinformatics & Geostatistics: An Overview (https://www.scitechnol.com/geoinformatics-geostatistics-an-overview.php)
3. Journal of Remote Sensing & GIS (https://www.omicsonline.org/geophysics-remote-sensing.php)
4. Vector1 Media (http://www.vector1media.com)

Notes

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