Co-funded by the Erasmus+ Programme of the European Union

Climate Change Induced Disaster Management in Africa

Course Syllabus

Course title

Spatial Modelling for Disaster Analysis

Course ECTS credits: 10+5

Course hour distribution by methods of studies

Lectures	Exercises	Self-study	Seminar	Final project	Total
10	80	100	10	50	250

Annotation of the course

This course is for students of mathematics, geography, environmental studies, engineering, and sustainability at both undergraduate and graduate levels.

Aim of the course

This course aims at providing an in-depth knowledge and skills on the use of Geographic Information System (GIS), Remote Sensing (RS) and Spatial Modelling for effective disaster risk analysis, vulnerability assessment, mitigation, and management. Students will learn geospatial information science and technology related concepts, techniques, algorithms, and tools that can be used for Disaster Risk Management.

Learning outcomes

On completion of the course, the student should be able to:

Knowledge and understanding

- Understand basic GIS and RS concepts
- gain in-depth knowledge and understanding of spatial analysis and spatial modelling
- Understand disaster management issues, especially urban disaster management issue, and how spatial analysis and spatial modelling can be used for disaster analysis and management
- Know what kind of data in general, free and open data in particular and which GIS, RS, and spatial modelling methods and functions are suitable for disaster analysis and management.

Skills and abilities

- be able to collect, analyze, and process geospatial data
- be able to use GIS, RS and spatial modelling tools
- be able to apply GIS, RS and spatial modelling tools for disaster risk analysis, vulnerability assessment, mitigation, and management in Mozambique
- Plan and conduct project-based activities

Critical judgement and evaluation

- Evaluate geospatial data quality and adequacy.
- Evaluate tools' and models' effectiveness
- Assess disasters risks and severity, and apply effective methods and applications towards providing mitigation recommendations
- Validate proposed solutions and understand the uncertainty

Methods of course studies (*Educational approach*)

Integrated approach (theory and practice): theory in parallel with applications and examples
Project-based learning

Methods for the assessment of student achievements (*the formula and the definition of the cumulative score)*

Tests and Exercises: 60%
Final Project (includes a report and a presentation): 40%

Study subject modules to be completed before this Course studies (*Prerequisites*)

Basic knowledge of mathematics, geography, physical processing, environmental studies, other natural sciences, engineering.
Basic skills of Information Technologies.

Tentative Schedule (lectures)

Date	Topic	Objectives
Week 1	Introduction to GIS and Remote Sensing	Introduction to GIS and Remote Sensing
Week 2	Introduction to Spatial Analysis	Define and explain the unique features of spatial phenomena such as spatial autocorrelation, spatial heterogeneity, multiple area unit problem; Explain the importance of spatial modelling; Describe the process of cartographic modelling and multi-criteria evaluation
Week 3	Advanced Spatial Analysis	Spatial statistics: define spatial autocorrelation, describe and apply methods / measures for its detection using Moran's I, Geary's C, its characterization (variogram), spatial interpolation methods such as Inverse Distance Weighting (IDW) and Kriging, spatial regression (Geographically Weighted Regression (GWR))
Week 4	Introduction to Spatial Modelling	Provide an introduction to spatial modelling methods: • Spatial regression models
Week 5	RS for near real-time disaster monitoring and damage assessment	Provide an introduction to remote sensing for disaster management including: • Near real-time disaster monitoring with examples on droughts, flooding and wildfire monitoring • Damage severity assessment with examples on flooding and wildfire damages
Week 6	GIS for disaster risk analysis and vulnerability assessment	Provide an introduction to for disaster risk analysis and vulnerability assessment, including • Apply GIS/remote sensing in hazard, vulnerability, and risk assessment • Visualize hazard and risk information • Utilize risk information in emergency preparedness planning
Week 7	Spatial modelling for disaster risk analysis, e.g., wildFire cLimate impacts and Adaptation Model (FLAM)	Provide an introduction to Spatial modelling for disaster risk analysis, with examples on flooding and wildfires, • WildFire cLimate impacts and Adaptation Model (FLAM) • Flood modelling for urban flood management

+5 ECTS

Week 4	Introduction to Spatial Modelling	Provide an introduction to advanced spatial methods: • Cellular automata • Agent-based modeling

Tentative Schedule (Exercises, Lab work/Self-studies)

Date	topic	Type*/objective
Week 1	Introduction to GIS and Remote Sensing	Gain basic analytical skills in GIS and Remote Sensing
Week 2	Spatial Analysis I: Map Algebra, MCE	Apply map algebra and MCE in the context of disaster management using QGIS, e.g., find suitable locations for emergency field hospitals.
Week 3	Spatial Analysis II: Spatial Autocorrelation, Interpolation, and regression	Apply interpolation and spatial regression to model the relationship between topography, rainfall, land-use / land-cover and flood damage in QGIS.
Week 5	Remote Sensing for near real-time disaster monitoring and damage assessment	Apply remote sensing for near real-time drought, wildfire or flood monitoring and damage assessment, GEE
Week 6	GIS for disaster risk analysis and vulnerability assessment	Apply GIS for disaster risk analysis and vulnerability assessment in QGIS
Week 7	Project: Disaster Modelling: Wildfire Modelling	Apply wildFire cLimate impacts and Adaptation Model (FLAM) in Mozambique
+5 ECTS		
Week 4	Introduction to Spatial Modelling	Apply cellular automata for urban flooding modelling

* e.g. answering questions, collecting data, performing analysis, writing codes, etc.

Tentative Schedule (Seminar, Project)

Date	topic	Type*/objective
Week 1	Introduction to GIS and Remote Sensing	Introduction to GIS and Remote Sensing
Week 2	Introduction to Spatial Analysis	Understand basic spatial analysis concepts and analytical methods
Week 3	Advanced Spatial Analysis	Understand advanced spatial analysis concepts and analytical methods
Week 4	Introduction to Spatial Modelling	Understand basic concepts of spatial modelling
Week 5	RS for near real-time disaster monitoring and damage assessment	Understand the literature on remote sensing for near real-time disaster monitoring and damage assessment
Week 6	GIS for disaster risk analysis and vulnerability assessment	Understand the literature on GIS for disaster risk analysis and vulnerability assessment
+5 ECTS		
Week 7	Spatial modelling for disaster risk analysis	Understand the literature on spatial modelling for disaster risk analysis

Main bibliography (no more than 3 sources)

No.	Publication authors, year of issue, name, place of issue, publisher, (address of electronic publications and website)
1	Geospatial Analysis - A comprehensive guide
2	Geographic Information Systems (GIS) for Disaster Management
3	Geospatial Techniques in Urban Hazard and Disaster Analysis

Additional bibliography (no more than 10 sources)

No.	Publication authors, name, place of issue, publisher, year of issue (address of electronic publications and website)
1	Weekly reading list, see examples below:
2	Jarkko Kari. Cellular Automata: Tutorial https://grammars.grlmc.com/LATA2008/slides/lata2008_cellular_automata.pdf
3	Teng, J., A.J. Jakeman, J. Vaze, B.F.W. Croke, D. Dutta, S. Kim, 2017. Flood inundation modelling: A review of methods, recent advances and uncertainty analysis. Environmental Modelling & Software, Volume 90, pp. 201-216, https://doi.org/10.1016/j.envsoft.2017.01.006.
4	Hartnett, M and S. Nash, 2017. High-resolution flood modeling of urban areas using MSN_Flood, Water Science and Engineering, Volume 10, Issue 3, pp. 175-183, https://doi.org/10.1016/j.wse.2017.10.003.
5	Oulad Sayad, Y., H. Mousannif, H. Al Moatassime, 2019. Predictive modeling of wildfires: A new dataset and machine learning approach, Fire Safety Journal, Volume 104, pp. 130-146, https://doi.org/10.1016/j.firesaf.2019.01.006.
6	Krasovskii. A., N. Khabarov, J. Pirker, F. Kraxner, P. Yowargana, D. Schepaschenko and M. Obersteiner. 2018. Modeling Burned Areas in Indonesia: The FLAM Approach. Forests 2018, 9, 437; doi:10.3390/f9070437.

Required IT Resources

No.	*Name of the software, manufacturer*	*License type*
1	QGIS	Open access
2	GEE	Open access
3	Cellular Automata	Open access
4	FLAM	TBD

Course completed by

(Signatures)

(Signatures)

Project Coordinator

(Signature)

Confirmation

The module certified by	Faculty of ….., University of ….		
Chairman of the studies committee (full name, signature)		**Date**	