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

Climate Change Induced Disaster Management in Africa

Course Syllabus

Course title

Disaster Risk and Climate Change

Course ECTS credits: 10

Course hour distribution by methods of studies

Lectures	Exercises	Self-study	Seminar	Final project	Total
30	40	128	2	50	250

Annotation of the course

The course will introduce students to climate change-induced disaster phenomena and modeling using GIS and RS tools for risk assessment. If focus on floods and droughts, as the main natural events with significant consequences for people and the environment. A particular emphasis on hydrological modeling, especially the modelling of floods using GIS and RS tools, within a risk assessment context, is included in the syllabus.

Aim of the course

The aim of the course is to provide in-depth knowledge and understanding about different disasters that can be expected to occur in a coastal region of southern Africa as a result of more erratic and extreme climate events. It also provides the student with the fundamental concepts used in the risk assessment studies, namely exposure, vulnerability and risk. A particular class of risks, related with hydrological phenomena - floods and droughts, is

addressed in theory and in practice using GIS/RS tools. A synthesizing project related with these topics, enables the students to summarize the knowledge acquired in the course with appropriate GIS/RS tools in a local study area through the risk assessment for an identified hazard or disaster type. On the end of the course, the student will be able to prepare and manipulate spatial data to analyse disaster risks, improving land use planning.

Learning outcomes

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

- Provide a broader perspective on climate changes by understanding causes and effects, recorded and modelled, at a global scale;
- Understand the concepts of susceptibility, vulnerability, resilience and risk that are used in hazardous phenomena assessment and management
- Understand the impacts of climate changes in flooding and drought by analysing patterns (temporally and spatially);
- Get acquainted with recent international and regional directives, protocols and governance documentation concerning climate changes and impacts on society

Skills and abilities

- Be able to incorporate the regional climate change effects that are predicted for southern Africa in GIS-based modelling and analysis;
- Be able to deal with the concepts involved in floods/droughts vulnerability and hazard assessment in practice;
- Be able to identify, compile and harmonize geographical data, in time and space, needed for the risk management analysis;
- Be able to include social and economic parameters in a spatial context, all connected to regional climate change and with its impact on the hydrological processes.

Critical judgement and evaluation

- Critically argue for the choice of parameters in floods/droughts modelling;
- Be able to evaluate constraints in floods/droughts vulnerability and hazard assessment ;
- Evaluate different scenarios of climate changes effects;

- Identify mitigation plans or solutions for climate change-induced effects

Methods of course studies (*Educational approach*)

The methods for learning include:

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

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

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 protection.
Basic skills of Information Technologies.

Tentative Schedule (lectures)

Date	Topic	Objectives
Week 1	Core module, common to all courses: introduction to GIS and RS 1. Basic data structures for both vector and raster (POLIMI) 2. Basic projections and coordinate systems (POLIMI) 3. Attribute handling and spatial operations (SQLs, buffers, spatial searches, overlays) (LU) 4. Basic Cartographic principles (POLIMI) 5. Basic electromagnetic radiation theories (LU) 6. RS resolutions (spatial, temporal, radiometric, spectral) (IST) 7. Different RS Sensors (IST) 8. Passive RS data formats, geo-referencing, metadata and resampling (LU) 9. Introduction to LiDAR and SAR (Active Sensors), plus Thermal RS (KTH) 10. Image pre-processing, enhancement and transformations (KTH) 11. Image classification (KTH)	Provide students with the basic knowledge of tools and data sources used in disaster risk assessment, in a climate change context
Week 2	1. Concepts and examples of exposure, vulnerability, resilience and risk 2. The UN's Sendai framework for disaster risk reduction 3. The UN's Sustainable Development Goals	Introduce the concepts used in risk analysis and assessment, using exposure, vulnerability, and resilience as determinants of risk
Week 3	1. Concepts on climate change (phenomena, effects and impacts, modelling, scenarios, methodology, international reference scenarios, mitigation) 2. UN's Framework Convention for Climate Change (Kyoto Protocol and Paris Agreement) 3. World databases on CC scenarios, impacts Guidelines for CC adaptation (e.g. Climadapt.eu) (UZ)	Introduce the concepts on climate change as a spatiotemporal framework where hazardous events occur
Week 4	1. Hydrological risk analysis - basic concepts (water cycle, hydrological monitoring, watershed and river network, water sources and water use, hydraulic infrastructures, floods and droughts) (IST+LU)	Understand and develop hydrological risk analysis - part I: concepts
Week 5	1. GIS/RS applied to hydrological modelling (e.g. watershed characterization, support data, flood risk analysis, flood peak flow) (IST)	Extend the knowledge on GIS/RS models, tools and resources that are used on hydrological modelling

Week 6	1. Hydrological modelling using GIS for flood analysis (IST) 2. Hydrological and hydraulic models - HEC-HMS and HEC-RAS (IST)	Understand and develop hydrological risk analysis - part II: application in GIS (practical exercises)
Week 7	Project (UZ+ IST)	Develop a project related with the topic of the course; the project should conduct a local area risk assessment for an identified hazard or disaster type, enhancing the reduction of the the impact on local infrastructure and population and also to provide requisite data for improved land use planning and disaster risk reduction

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

Date	topic	Type*/objective
Week 1		
Week 2	Exposure, vulnerability, resilience and risk	• Quiz on basic concepts • Identification and analysis (applying the concepts) of major and minor risks on an area known by the student • Review of an article, identifying how the exposure, vulnerability, resilience and risk were considered by the authors
Week 3	Concepts on climate change, international framework and world reference databases	• Quiz on basic concepts • Identification of major and minor risks on an area known by the student • Exercise that includes identification of reference scenarios for an area known by the student • Exercise with information retrieval from Climadapt or other world databases
Week 4	Hydrological risk analysis	• Quiz on basic concepts - floods • Quiz on basic concepts - droughts
Week 5	GIS exercises using QGIS Watershed delimitation	• Watershed delimitation • Watershed characterization • Interpolation of meteorological variables (precipitation, temperature, evapotranspiration)
Week 6	GIS exercises using QGIS	• Calculation of hydrologic parameters (time of concentration, flow path) • Computation of flood hydrographs • Computation of flood areas

		• Flood models (HEC-HMS, HEC-RAS, etc.)
Week 7	Project	Develop a project related with the topic of the course; the project should conduct a local area risk assessment for an identified hazard or disaster type, enhancing the reduction of the the impact on local infrastructure and population and also to provide requisite data for improved land use planning and disaster risk reduction

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

Tentative Schedule (Seminar, Project)

Date	topic	Type*/objective
Week 1		
Week 2	Exposure, vulnerability, resilience and risk (UZ)	Interview with Mozambican experts (e.g. civil defense) - short video(s)
Week 3	Concepts on climate change, international framework and world reference databases (UZ)	Interview with Mozambican experts (e.g. civil defense institution:, Instituto Nacional de Gestão de Calamidades) - short video(s)
Week 4	Hydrological risk analysis (UZ)	Interview with Mozambican experts (e.g. water resources institutions, such as Direcção-Nacional de Águas, watershed commissions in MZ) - short video(s)
Week 5		
Week 6		
Week 7	Project (UZ+IST)	Develop a project related with the topic of the course; the project should conduct a local area risk assessment for an identified hazard or disaster type, enhancing the reduction of the the impact on local infrastructure and population and also to provide requisite data for improved land use planning and disaster risk reduction

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	Cardona, O.D., M.K. van Aalst, J. Birkmann, M. Fordham, G. McGregor, R. Perez, R.S. Pulwarty, E.L.F. Schipper, and B.T. Sinh, 2012: Determinants of risk: exposure and vulnerability. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 65-108. Available in IPCC website, https://www.ipcc.ch/site/assets/uploads/2018/03/SREX-Chap2_FINAL-1.pdf
2	Hans van der Kwast, Kurt Menke. *QGIS for Hydrological Applications: Recipes for Catchment Hydrology and Water Management*, Locate Press, ISBN: 978-0998547787
3	Sendai framework for disaster risk reduction, available in English in https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

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	Richard Beilfuss, "Risco Hidrológico e grandes hidroélectricas na África Austral" (Hydrological risk and large hydroelectric plants in Southern Africa) - available in Portuguese at https://www.internationalrivers.org/sites/default/files/attached-files/portuguese_execsum.pdf
2	Review of **GIS** applications in **hydrologic** modeling available at https://apps.dtic.mil/dtic/tr/fulltext/u2/a279076.pdf)
3	World Bank, Estratégia Nacional de Assistência para Recursos Hídricos em Moçambique (National Strategy of Assistance for Water Resources in Mozambique, in Portuguese available at https://energypedia.info/images/e/e6/PT_Estrategia_Nacional_de_Assistencia_para_Recursos_Hidricos_em_Mo%C3%A7ambique_Banco_Mundial.pdf
4	Mapeamento de áreas favoráveis aos reassentamentos da população vítima de **cheias** ao sul da bacia do Limpopo-**Moçambique**. available at: (https://www.alice.cnptia.embrapa.br/bitstream/doc/1112613/1/PLMapeamentoareasSBSR2019Bolfe.pdf)
5	SARDC, Division of Early Warning and Assessment (DEWA), United Nations Environment Program (UNEP), Droughts and Floods in Southern Africa: Environmental Change and Human Vulnerability, 2009. Available in English at **https://www.sardc.net/en/books/droughts-and-floods-in-southern-africa-environmental-change-and-human-vulnerability/**

Required IT Resources

No.	*Name of the software, manufacturer*	*License*
1	QGIS (QGIS consortium)	Open Source
2	HEC-RAS (Hydrologic Engineering Center's River Analysis System)	
3	SNAP (ESA)	
4		

Course completed by

(Signatures)

(Signatures)

Project Coordinator

(Signature)

Confirmation

The module certified by	Faculty of Environmental Engineering and Natural Resources, Zambeze University		
Chairman of the studies committee (Pedro Fernando Chimela Chume)		**Date**	