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

# Climate Change Induced Disaster Management in Africa

# Course Syllabus

**Course title**

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| Disaster Risk and Climate Change |

**Course ECTS credits: 10+5**

**Course hour distribution by methods of studies**

| Lectures | Exercises | Self-study | Seminar | Final project | Total |
|---|---|---|---|---|---|
| 20h+10h | 50h+30h | 120h+75h | 10h+10h | 50h+0h | 250h+125h |

## Annotation of the course

This course will introduce the concepts related to climate change and disaster risk, through documentation that summarizes the corresponding international framework for the management of risk associated with disasters. Practical exercises that use GIS/RS tools and software are used as a way to acquire competencies in modelling and analysis of data for hazardous phenomena such as floods and droughts in Southeastern Africa.

The course is organized into two modules: one of 10 ECTS and one of 5 ECTS. The 5 ECTS module requires that the 10 ECTS one is acquired first. The first module introduces the climate change and risk assessment concepts and the practice of generic GIS/RS tools for mapping spatial phenomena and support for risk management and analysis, the 5 ECTS module presents complementary topics in hydrological models.

## Aim of the course

The aim of the course is to provide in-depth knowledge and understanding of different disasters that can be expected to occur in a coastal region of southern Africa resulting from

more erratic and extreme climate events. It also provides the student with the fundamental concepts used in risk assessment studies, namely exposure, vulnerability and, risk. A particular class of risks, related to hydrological phenomena, is addressed in theory and in practice using GIS/RS tools.

## 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;
- Know and understand the international instruments that regulate the climate change agenda, agreements and protocols;
- Understand the impacts of climate changes in flooding and drought by connecting their effects with local conditions;

***Skills and abilities***

- Be able to model and analyse the regional climate change scenarios that are predicted for southern Africa with GIS/RS tools;
- Be able to discuss the concepts involved in floods/droughts vulnerability and hazard assessment;
- 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 change effects.

## Methods of course studies (*Educational approach*)

Student-based learning and project-based learning are the used approaches, with theory and practice intercalated to provide know-how via applications, examples, and practice.

## Software

In addition to the software for the common week (week 1), the remaining weeks will use:

- QGIS - open-source desktop GIS - we will use QGIS 3.16 Hannover but later versions can be used too
- HEC-HMS - The Hydrologic Modeling System (HEC-HMS) is designed to simulate the complete hydrologic processes of dendritic watershed systems
- HEC-RAS - This software allows the user to perform one-dimensional steady flow, one and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modeling

## Methods for the assessment of student achievements

- Handouts or exercises with software: 60%
- Final project (includes a report and a presentation): 40 %

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

e.g. Basic knowledge of mathematics, geography, physical processing, environmental protection.
Basic skills of Information Technologies.

## Schedule (lectures)

**10 ECTS**

| Date | Topic | Objectives |
|---|---|---|
| Week 1 | Core module, common to all courses:<br>introduction to GIS and RS<br>1.1. Basic data structures for both vector and raster (POLIMI)<br>1.2. Basic projections and coordinate systems (POLIMI)<br>1.3. Attribute handling and spatial operations (SQLs, buffers, spatial searches, overlays) (LU)<br>1.4. Basic Cartographic principles (POLIMI)<br>1.5. Basic electromagnetic radiation theories (LU)<br>1.6. RS resolutions (Spatial, Temporal, Radiometric, Spectral) (IST)<br>1.7. Different RS Sensors (IST)<br>1.8. Passive RS data formats, geo-referencing, metadata and resampling (LU)<br>1.9. Introduction to LiDAR and SAR (Active Sensors), plus Thermal RS (KTH)<br>1.10. Image pre-processing, enhancement and transformations (KTH)<br>1.11. Image classification (KTH) | Provide students with the basic knowledge of tools and data sources used in disaster risk assessment, in a climate change context |

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|---|---|---|
| Week 2 | 2.1. Concepts and examples of exposure, vulnerability, resilience, and risk<br>2.2. The UN's Sendai framework for disaster risk reduction<br>2.3. 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 | 3.1. Concepts on climate change (phenomena, effects and impacts, modelling, scenarios, methodology, international reference scenarios, mitigation)<br>3.2. UN's Framework Convention for Climate Change (Kyoto Protocol and Paris Agreement) | Introduce the concepts on climate change as a spatiotemporal framework where hazardous events occur |
| Week 4 | 4.1. World databases on CC scenarios, impacts Guidelines for CC adaptation (e.g. Climadapt.eu) | Know the resources available for global, regional and local scale modelling of climate variables |
| Week 5 | 5.1. Water and civilization<br>5.2. Water sources and uses<br>5.3. Water cycle basis concepts | Understand the basic concepts of water management and use |
| Week 6 | 6.1. GIS/RS applied to hydrological modelling | |
| Week 7 | | |

**+5 ECTS**

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|---|---|---|
| Week 1 | | |
| Week 2 | 1. Modelling of elevation for hydrology applications | Extend the knowledge on GIS/RS theoretic models, tools and resources that are used on hydrological modelling |
| Week 3 | 1. GIS/RS applied to hydrological modelling (e.g. watershed characterization, support data)<br>2. Introduction to concepts related to flood modelling and analysis (flood risk analysis, flood peak flow) | |

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

**10 ECTS**

| Date | topic | Type*/objective |
|---|---|---|
| Week 1 | Exercises and lab work of core week | |

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|---|---|---|
| Week 2 | Exposure, vulnerability, resilience and risk | • Quiz on basic concepts<br>• Identification and analysis (applying the concepts) of major and minor risks on an area known by the student<br>• Review of an article, identifying how the exposure, vulnerability, resilience and risk were considered by the authors |
| Week 3 | 1. Concepts on climate change (phenomena, effects and impacts, modelling, scenarios, methodology, international reference scenarios, mitigation)<br>2. UN's Framework Convention for Climate Change (Kyoto Protocol and Paris Agreement) | • Quiz on basic concepts<br>• Identification of major and minor risks on an area known by the student<br>• Exercise that includes identification of reference scenarios for an area known by the student |
| Week 4 | 1. World databases on CC scenarios, impacts Guidelines for CC adaptation (e.g. Climadapt.eu) | • Exercise with information retrieval from Climadapt or other world databases |
| Week 5 | 1. Water and civilization<br>2. Water sources and uses<br>3. Water cycle basis concepts | • Quiz on basic concepts<br>• Identification and analysis of water use in an watershed known by the student |
| Week 6 | GIS exercises using QGIS | • Interpolation of meteorological variables (precipitation, temperature, evapotranspiration)<br>• Watershed delimitation (QGIS)<br>• Watershed characterization |
| Week 7 | Project | see below |

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

**+ 5 ECTS**

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|---|---|---|
| Week 1 | | Essay on climate change adaptive strategies |
| Week 2 | Hydrological modelling using GIS for flood analysis | GIS exercises (stream delineation / drought severity analysis) |
| Week 3 | Hydrological and hydraulic models - HEC-HMS and HEC-RAS | Computation of flood hydrographs<br>Calculation of hydrologic parameters (time of concentration, flow path) |

## Schedule (Seminar, Project)

### 10 ECTS

| Date | topic | Type*/objective |
|---|---|---|
| Week 1 | | |
| Week 2 | | |
| Week 3 | | |
| Week 4 | Seminar | Interview with Mozambican expert on management of disaster events (water resources institutions, such as Direcção-Nacional de Águas, watershed commissions in MZ) - short video(s) |
| Week 5 | | |
| Week 6 | | |
| 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 |

### + 5 ECTS

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|---|---|---|
| Week 1 | Seminar | Several seminars with topics developed in the first part of the course:<br>• Resilience and global adaptation<br>• Ecosystem restoration<br>• Climate-resilient infrastructure<br>• Water supplies and security<br>• Long-term planning |
| Week 2 | | |
| Week 3 | | |

## 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 |

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| | 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 - https://locatepress.com/book/hyd2 |
| **3** | Sendai framework for disaster risk reduction |

## 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** | Pravat Kumar Shit, Hamid Reza Pourghasemi, Gouri Sankar Bhunia, Pulakesh Das, Adimalla Narsimha. Geospatial Technology for Environmental Hazards: Modeling and Management in Asian Countries. Springer International Publishing, ISBN: 9783030751968 - https://www.springerprofessional.de/en/geospatial-technology-for-environmental-hazards/19924822 |

## Required IT Resources

| No. | *Name of the software, manufacturer* | *License type* |
|---|---|---|
| **1** | Internet browser (Firefox/Chrome) | - |
| **2** | QGIS desktop GIS | Open Source |
| **3** | SNAP (ESA) | Freeware |
| **4** | Google Earth Engine (Google) | Freeware |
| **5** | HEC-RAS | Free use |
| **6** | HEC-HMS | Free use |

**Course completed by**

(Signatures)

(Signatures)

**Project Coordinator**

(Signature)

## Confirmation

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