

GP9573/HRR9573**Natural Catastrophes – Modelling, Assessing, and Mitigating the
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- Course Outline -****1. Course Information****Course Information**

Natural hazards and disaster risk reduction are an important and fast-evolving area of research and practice in Canada and globally. It is an interdisciplinary field that cuts across natural sciences (e.g., geophysics, geology, hydrology, and meteorology), applied sciences (e.g., structural and infrastructure engineering), data sciences (e.g., statistics and GIS spatial data analysis), and risk financing/management (e.g., insurance). This course introduces natural catastrophe modelling as a core technique. The course covers: (i) hazard identification and characterization, (ii) exposure modelling, (iii) vulnerability assessment, and (iv) financial risk quantification and management. The four key elements of natural hazard risks are integrated to quantify the risks of natural disasters to urban environments. The course content is suitable for graduate students who are enrolled in the collaborative graduate specialization in Hazards, Risks, and Resilience (https://uwo.ca/multihazard_risk_resilience/index.html) and for other graduate students who are in Earth Science, Statistical & Actuarial Sciences, Civil & Environmental Engineering, and Geography programs. This course involves computer programming with MATLAB. Hands-on start-up instruction for the use of MATLAB will be given.

List of Prerequisites

N/A

2. Instructor Information

Instructor	E-mail	Office	Phone	Office Hours
Dr. Katsu Goda	kgoda2@uwo.ca	B&GS-1076	Ext. 83189	By appointment

Students must use their Western (@uwo.ca) email addresses when contacting their instructors. There is no set office hours and in-person meetings can be arranged.

3. Course Syllabus, Schedule, Delivery Mode

The course covers: (i) hazard identification and characterization, (ii) exposure modelling, (iii) vulnerability assessment, and (iv) financial risk quantification and management. The four key elements of natural hazard risks are integrated to quantify the risks of natural disasters to urban environments (i.e.,

catastrophe modelling). More specifically, the following ten lectures will be given during the Fall semester.

- Lecture 1 Introduction to catastrophe modelling and its applications for disaster risk management and scientific computing and programming using MATLAB.
- Lecture 2 Data analysis and probabilistic modelling (probability & statistics, probabilistic models, data analysis, and probabilistic modelling of random data and Monte Carlo simulation).
- Lecture 3 Anatomy of catastrophe model, Model input & output, and uncertainty in catastrophe models.
- Lecture 4 Natural hazards, general perspectives of hazard modelling, and overview of seismic hazard & risk.
- Lecture 5 Seismic hazard modelling (probabilistic seismic hazard analysis, earthquake occurrence in time and space, ground motions and seismic intensity measures, ground motion models, uncertainty modelling in PSHA, and Monte Carlo simulation for PSHA).
- Lecture 6 Exposure modelling and basics of spatial data analysis.
- Lecture 7 General perspectives of vulnerability modelling, empirical vulnerability functions, analytical vulnerability functions).
- Lecture 8 General perspectives of financial modelling, financial seismic risk modelling, and extension of seismic hazard and risk analysis to other perils
- Lecture 9 Risk transfer and reinsurance/insurance industry, insurance, and reinsurance, underwriting and pricing, capital modelling and catastrophe modelling, government schemes and insurance, insurance linked securities.
- Lecture 10 Multi-hazard risk assessment and disaster risk reduction & resilience

Note: the extensive knowledge on earthquake hazard and risk assessment is not a requirement (e.g., Lectures 4 and 5). A suitable introduction to these topics will be given as part of the lectures.

Lecture and lab schedules

The course consists of 3-hour lectures/computer labs per week (0.5 course).

Contingency plan

Although the intent is for this course to be delivered in person, should any university-declared emergency require some or all of the course to be delivered online, either synchronously or asynchronously, the course will adapt accordingly. The grading scheme will **not** change. Any assessments affected will be conducted online as determined by the course instructor.

4. Course Materials

Three textbooks will be used in the course:

- *Natural Catastrophe Risk Management and Modelling* – K. Mitchell-Wallace, M. Jones, J. Hillier, and Matthew Foote, Wiley, 2017. (Main textbook)
- *MATLAB Recipes for Earth Sciences* – M. Trauth, Springer, 2015. Available for download through Springer when connected to Western internet: 4th Edition
- *Reliability of Structures* – A. S. Nowak and K. R. Collins, CRC Press, 2012.

Electronic copies of these textbooks (e.g., PDF) are available from Western Libraries.

Students are responsible for checking the course OWL site (<http://owl.uwo.ca>) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class.

All course material will be posted to OWL: <http://owl.uwo.ca>.

If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

Technical requirements

To complete Assignments I and II, intermediate level of computer programming using MATLAB, R, or Python will be necessary. Acquiring such computational skills is one of the learning outcomes of this course. Western students have access to these software packages from Western Technology Services (MATLAB) or with free of charge (R and Python).

5. Methods of Evaluation

There will be two assignments, and an individual project (oral presentation and written report). The ability to express ideas in a coherent and logical manner is an important factor in evaluation of assignments and tests.

The overall course grade will be calculated as listed below:

Assignment I:	20%, October 20, 2024 (Subject to change)
Assignment II:	20%, November 17, 2024 (Subject to change)
Knowledge Test:	20%, November 21, 2024 (Subject to change)
Project:	40% (10% presentation and 30% written report, December 15, 2024 (Subject to change))

Given that students' interests are widespread, students can choose problem sets: (i) geophysical hazards and risks and (ii) non-geophysical hazards and risks (e.g., tornados and hails, subject to change). The non-geophysical hazard and risk option is available to non-Earth Science students.

For the geophysical hazards and risks:

Assignment I consists of solving three problems (Problems 1 to 3):

- Problem 1: Data analysis using a real earthquake catalog and generation of a stochastic event set from a simple seismic source model
- Problem 2: Ground motion regression analysis and generation of scenario shake maps
- Problem 3: Simulation-based probabilistic seismic hazard analysis

Assignment II consists of solving three problems (Problems 4 to 6):

- Problem 4: Seismic exposure analysis using WorldPop/NRCAN data
- Problem 5: Empirical tsunami fragility analysis using the MLIT database and analytical seismic fragility modelling
- Problem 6: Seismic risk assessment and financial calculations

For the non-geophysical hazards and risks (at the moment, tornados and hails):

Assignment I consists of solving three problems (Problems 1 to 3):

- Problem 1: Data analysis of hail events using the CoCoRaHS database.
Problem 2: Hail hazard modeling using the CoCoRaHS database.
Problem 3: Simulation-based hail hazard analysis

Assignment II consists of solving five problems (Problems 4 to 6):

- Problem 4: Wind/hail exposure analysis using CatIQ data
Problem 5: Empirical wind/hail fragility analysis using the CatIQ Loss Event database
Problem 6: Hail risk assessment and financial calculations

The knowledge test covers the entire teaching materials of the course (i.e., topics covered in Lectures 1 to 10). The test occurs during the regular lecture hours.

6. Student Absences

For work totalling 10% or more of the final course grade, you must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible. For further information, please consult the University's medical illness policy at

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf.

The Student Medical Certificate is available at

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.

Regarding this course, if students miss the knowledge test (20%), this weight is transferred to the individual project (i.e., its weight will be changed from 40% to 60%).

Depending on the circumstances, extensions may be given for the submission of assignments I and II as well as the final project report.

7. Accommodation and Accessibility

Religious Accommodation

When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at

<https://multiculturalcalendar.com/ecal/index.php?s=c-univwo>.

Accommodation Policies

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf.

8. Academic Policies

The website for Registrarial Services is <http://www.registrar.uwo.ca>.

In accordance with policy,

https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf,

the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

No electronic device is permitted during the knowledge test. It is a closed book test.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

9. Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: <https://www.uwo.ca/sci/counselling/>.

Students who are in emotional/mental distress should refer to Mental Health@Western (<https://uwo.ca/health/>) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at

http://academicsupport.uwo.ca/accessible_education/index.html

if you have any questions regarding accommodations.

Learning-skills counsellors at the Student Development Centre (<https://learning.uwo.ca>) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: <https://www.uwo.ca/se/digital/>.

Additional student-run support services are offered by the USC, <https://westernusc.ca/services/>.