Western Science

Department of Earth Sciences
Department of Statistical & Actuarial Sciences

GP9573/HRR9573
Natural Catastrophes – Modelling, Assessing, and Mitigating the Impact
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 as part of assignments.

List of Prerequisites
N/A

2. Instructor Information

Instructor	E-mail	Office	Office Hours
Dr. Katsu Goda	kgoda2@uwo.ca	B&GS-1076	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 (one lecture may span over a few weeks) 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.
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).

4. Course Materials

Textbook and Other Learning 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.
- *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 Brightspace site (https://westernu.brightspace.com/d2l/login?logout=1) 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 Brightspace: https://westernu.brightspace.com/d2l/login?logout=1.

If students need assistance with the course OWL Brightspace site, they can seek support on the OWL Brightspace 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

Grading Scheme and Assessment Dates
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 topic for the individual project shall be decided based on each student's research interest (i.e., not limited to specific hazards and risks discussed in the lectures). The project can be aligned with the thesis research project.

The overall course grade will be calculated as listed below:

Assignment I:	20%, October 27, 2026 (Subject to change)
Assignment II:	20%, November 24, 2026 (Subject to change)
Knowledge Test:	20%, December 8, 2026 (Subject to change)
Project:	40% (20% presentation and 20% written report, December 15, 2026 (Subject to change)

Regarding two assignments, 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
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 (e.g., 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 (last) lecture hours.

Essential Learning Requirements
Even when Academic Consideration is granted for missed coursework, all assignments, test, and project need to be completed. Extra times will be given by considering individual circumstances. When a student has not demonstrated proficiency in an essential learning requirement listed above, and when the shortfall results from a granted Academic Consideration, they will be withdrawn (WDN) from the course. The student may appeal to the Associate Dean (Academic) for reinstatement with an Incomplete (INC) standing. Where an appeal for INC is granted, their maximum course load may be reduced during the term in which they complete the outstanding course requirements.

Use of Generative AI Tools
The use of AI tools is permitted. However, the students are responsible for the correctness and accuracy of the information that is included in their submissions (e.g., Assignments and course project).

Information about Missed Coursework
Students must familiarize themselves with the *University Policy on Academic Consideration – Undergraduate Students in First Entry Programs,* posted on the Academic Calendar: https://uwo.ca/univsec//pdf/academic_policies/appeals/academic_consideration_Sep24.pdf.

This policy does not apply to requests for Academic Consideration submitted for **attempted or completed work**, whether online or in person. The policy also does not apply to students experiencing longer-term impacts on their academic responsibilities. These students should consult Accessible Education.

For procedures on how to submit Academic Consideration requests, please see the information posted on the Office of the Registrar's webpage: https://registrar.uwo.ca/academics/academic_considerations/. All requests for Academic Consideration must be made within 48 hours after the assessment date or submission deadline.

Deadlines: The 48-Hour No-Late-Penalty Period
All assignments and course project with a stated due date include an automatic 48-hour period after the deadline during which students may still submit without a late penalty. For example, if an assignment is due on November 5, they may submit it until November 7 without penalty. After this 48-hour period, no further submissions will be accepted, and students do not need to request Academic Consideration for a missed deadline; their grade for this component will be calculated as described above.

6. Additional Statements

6.1 Religious Accommodation
When a recognized religious holiday either requires a student to be absent from the University, or requires or prohibits an activity that makes it impossible for them to complete an academic requirement scheduled that day, they are entitled to accommodation. No student will be penalized for an absence for religious reasons, and an alternative means of satisfying the requirement will be arranged. This accommodation is provided in accordance with the University's policy on Accommodation for Religious Holidays:

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

The student should submit their requests through the Student Absence Portal (SAP), identifying the conflict and the specific course component(s) affected (e.g., test, midterm, exam).

> **Midterms and Tests**: If a religious observance conflicts with a midterm test, they must submit their request no later than **one week** before the test. Their instructor will arrange an early sitting of the test. As set out above, no makeup test is offered for any other reason; this early sitting is available specifically for this accommodation.
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> **Final Examinations**: If a religious observance conflicts with the final exam, the student must submit their request no later than **two weeks** before the exam. Their instructor will arrange a Special Examination to take place no later than one month after the end of the examination period.

Students are responsible for finding out what was covered in any class they miss due to a religious observance, and for taking the appropriate steps to keep up with the course.

If a suitable arrangement cannot be reached between a student and their instructor, they should consult the Undergraduate Chair of the department offering the course, and if necessary, the Associate Dean (Academic) of the Faculty of Science.

For a list of recognized religious observances, please visit the calendars posted on the Equity, Diversity & Inclusion website - https://www.edi.uwo.ca (About Us – Resources – Additional Resources – Calendars).

6.2 Academic 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.

6.3 General Academic Policies

The website for Registrar Services is https://www.registrar.uwo.ca/.

Use of @uwo.ca email: 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 email address. It is the responsibility of the account holder to ensure that emails received from the University at their official university address are attended to in a timely manner.

Requests for Relief (formally known as "appeals")

Policy on Request for Relief from Academic Decision:
https://uwo.ca/univsec//pdf/academic_policies/appeals/requests_for_relief_from_academic_decisions.pdf

Procedures on Request for Relief from Academic Decision (Graduate):
https://uwo.ca/univsec//pdf/academic_policies/appeals/graduate_requests_for_relief_procedure.pdf

6.4 Scholastic Offences

Policy on Scholastic Offences:
https://uwo.ca/univsec//pdf/academic_policies/appeals/scholastic_offences.pdf

Procedures on Scholastic Offences (Graduate):
https://uwo.ca/univsec//pdf/academic_policies/appeals/graduate_scholastic_offence_procedure.pdf

Use of Electronic Devices During Assessments

In courses offered by the Faculty of Science, the **possession** of unauthorized electronic devices during any in-person assessment (such as tests, midterms, and final examinations) is strictly prohibited. This includes, but is not limited to: mobile phones, smart watches, smart glasses, hidden cameras and wireless earbuds.

Unless explicitly stated otherwise in advance by the instructor, the presence of any such device at a student's desk, on their person, or within reach during an assessment will be treated as a scholastic offence, **even if the device is not in use**.

Effective September 2026, the typical penalty for this offence is a failing grade in the course AND a 12-month prohibition on retaking the course.

Only devices expressly permitted by the instructor (e.g., non-programmable calculators) may be brought into the assessment room. It is their responsibility to review and comply with these expectations.

6.5 Support Services

Academic Advising. Please visit the Science & Basic Medical Sciences Academic Advising webpage for information on adding/dropping courses, academic considerations for absences, requests for relief, exam conflicts, and many other academic-related matters: https://www.uwo.ca/sci/advising/.

Mental Health Support. 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.

Gender-Based and Sexual Violence. Western is committed to reducing incidents of gender-based and sexual violence (GBSV) and providing compassionate support to anyone who has gone through these traumatic events. If a student has experienced GBSV (either recently or in the past), they can 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.

Accessibility for Coursework. A student may contact the course instructor if they require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to them. If they have any questions regarding accommodations, they may also contact Accessible Education at http://academicsupport.uwo.ca/accessible_education/index.html.

Learning Development and Success. Learning-skills counsellors at Learning Development and Success (https://learning.uwo.ca) are ready to help students improve their learning skills. The facility offers 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.

Student Councils.
Student-run support services are offered by the University Students' Council (https://westernusc.ca) and the Science Students' Council (https://www.westernssc.ca).