# SYLLABUS FOR EARTH 270 - DISASTERS AND NATURAL HAZARDS

## WINTER TERM 2018

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Room 303, Earth Science and Chemistry Building

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1. **General**: the course examines the physical causes and effects of disasters that result from natural hazards including earthquakes, tsunamis, volcanic activity, landslides, glacier–related processes, hurricanes, tornadoes, extreme weather, river and coastal flooding, wildfire, surface subsidence, asteroid impacts, and space weather. Illustrated by case histories, the course will analyse the factors that lead to disasters. The effect of climate change, human activity, and population growth on the magnitude and frequency of disasters will be explored. The course will introduce the basic principles of GeoRisk management and its applications in natural hazards engineering, emergency management, in the development of mitigation strategies and in the finance/re-insurance industries. For each natural hazard examined, methods and strategies of mitigation will be explored. The course is global in scope.
2. **Text book**: in 2018 the course is broadly structured around the text book ***Natural Disasters*** by P.L. Abbott, 10th Edition published in 2016 [ISBN 978-0078022982]
3. **Marking scheme**: marks for the course will be awarded as follows; **FINAL EXAM** (50%), **MID-TERM EXAM** (25%), **DISASTER REPORT** (25%), **ATTENDANCE BONUS** – MAXIMUM 2.5%. Mid-Term and Final examinations do not involve multiple choice questions. Copies of previous examinations are posted on the UWLearn website during the course. The Disaster Report is an individual project involving the preparation of a written report that presents a summary and analysis of an assigned historical/recent disaster event. Note, the submittal of a Disaster Report is a requirement for completion of Earth 270 for credit. The requirements for the Disaster Report are summarised on the course website. The Attendance Bonus is based on the taking of attendance at five randomly selected lectures during the course; each recorded attendance is worth an additional 0.5% to the student's total mark for a maximum of 2.5%.
4. **2018 Timetable**: there are 12 150 minute lectures in the course with the last lecture held on Thursday, March 29. The Mid-Term exam will be held in the first lecture period on Thursday, February 15 [1830-1920h). Students will hand in the Disaster Report at the beginning of last class on Thursday, March 29.
5. **Energy in Natural Hazard Systems and Disasters**: the unifying theme of the course is energy in natural hazard systems. Natural hazards involve a rapid release of energy that involves the movement of water, air, and/or earth materials (or a combination of the three) between locations on the Earth's surface. When this movement intersects people, communities, or infrastructure damage and losses occur. If these losses exceed a defined threshold then a disaster is said to have occurred. The definition of disaster thresholds will be discussed in the course.

6. **Global review:** the course begins with an overview of natural hazard processes and the characteristics of recent disasters with special reference to major events in 2010-2017 (e.g., 2010 Haiti Earthquake, 2011 Japan Tsunami, 2012 Superstorm Sandy, 2013 Calgary Flood, 2013 Typhoon Haiyan (Philippines), 2015 Nepal Earthquake, 2016 Hurricane Matthew, and 2017 Hurricanes Harvey, Irma, and Maria). The major natural hazards are then examined in turn.
7. **Earthquakes**: earthquake processes are examined in a plate tectonic framework with reference to important case histories worldwide. Methods of seismic hazard assessment are discussed particularly with respect to the use of historical records, the use of geological evidence to obtain pre-historic seismic data, and magnitude and frequency of seismic events. Elementary seismology is discussed with reference to seismic waves, magnitude scales, and intensity mapping. Secondary hazards (Landslides, tsunamis, and liquefaction) are outlined.
8. **Tsunamis**: the characteristics of tsunamis are examined and their causal mechanisms are outlined. With reference to important case histories worldwide, the essential features of tsunami disasters are explored. Mitigation strategies and methodologies are discussed with a focus on the DART buoy system. Geological methods of obtaining pre-historic tsunami data from coastline sites are examined with respect to earthquake-generated tsunamis and those tsunamis resulting from massive submarine landslides. Tsunamis resulting from sub-aerial landslides are also discussed.
9. **Volcanic Hazards** : using a global database of case histories, the spectrum of volcanic hazards will be examined including volcanic eruptions, flank collapse, pyroclastic flows and lahars (volcanic debris flows). Volcanic landforms and eruptive style will be explored in a plate tectonic context including a discussion of magma characteristics. The stability of oceanic volcanoes (and the occurrence of related secondary hazards) will be outlined and the hazards associated with flood basalts will be described. Using recent examples volcanic ash hazard to aviation will be examined in some detail.
10. **Landslides**: with reference to case histories from around the world, the range of destructive landslide types and processes are explored. The occurrence and hazard characteristics of catastrophic landslides are outlined with specific reference to rock avalanches, debris avalanches, rockfall, and flowslides in a variety of materials. The formation and behaviour of landslide dams and landslide-dammed lakes are discussed as are engineering methods of mitigation. Landslide-generated tsunamis are also discussed.
11. **Hurricanes (Typhoons, Tropical Cyclones):** the examination of climate-related hazards begins with a detailed treatment of hurricanes, including their global occurrence, formation, evolution, and behaviour. The nature of hurricane-generated storm surges is examined and recent mega-disasters caused by this process in Bangladesh, USA, and Myanmar (Burma) are outlined. The basis for the Saffir-Simpson Scale is examined and elements of hurricane warning and storm surge mitigation are outlined.
12. **Tornadoes:** tornadoes present the most significant hazard to southwestern Ontario as exemplified by the 2011 Goderich tornado. The global occurrence, formation and behaviour of tornadoes are examined with respect to recent tornado disasters from Canada and USA. The basis of the Fujita Scale (and Enhanced Fujita Scale) is outlined.

13. **Climate and natural hazards**: other climate-related natural hazards are examined, i.e., heavy rains, extreme heat (heat waves), and wildfire. Discussion will also be directed towards whether drought and famine should be considered as a natural hazard rather than the result of the persistence of chronic conditions.
14. **Climate Change and natural hazards**: evidence for post-Little Ice Age (i.e., ca. 1900 to the present) climate change will be critically examined by reviewing recent IPCC documents. In addition, evidence for the climate-change related increase in the frequency, magnitude, and intensity of climate-related natural hazards will be critically examined. Glacial hazards resulting from very rapid climate-change-related glacier ice loss in the mountain areas of the world will be outlined in detail with a focus on the Canadian Cordillera, the Russian Caucasus, and the Peruvian Andes. These hazards include the formation and failure of glacial lakes, glacial debris flows, and glacier-related rockslides and rock avalanches.
15. **River and Coastal Floods**: globally, river floods are probably the universal hazard. The mechanisms and behaviour of river flooding are examined with respect to recent events from Canada, USA, Europe, Pakistan and Australia. Mechanisms include heavy rains, rapid snowmelt, rain-on-snow events, flash floods due to localised heavy rainfall or dam breaks, and ice jams. Methods and strategies of river flood mitigation are examined with respect to the Red River (Manitoba) and Fraser River (British Columbia) in Canada, the Mississippi and Missouri Rivers in USA, and the Indus River in Pakistan. Coastal flooding along sea and lake coasts primarily due to strong winds is also examined with particular reference to the North Sea surge of 1953 and the lake shore flooding in Manitoba in 2011.
16. **Space Weather**: a brief treatment of hazards associated with space weather will be presented. Space weather results from episodic increases in solar activity and the associated bursts of electromagnetic energy may impact on the integrity of electricity transmission, the working of computers and the operation of smart phone devices.
17. **Asteroids and the Impact Hazard on Earth**: the nature of extra-terrestrial hazards to Earth are examined with detailed reference to asteroids. The impact record of the world is examined and the 1908 Tunguska event is described in detail. The magnitude-frequency of Earth impacts is described and its significance and implications for risk to life on Earth is discussed. Mitigation techniques for Earth impact are described.
18. **Black Swan**: the concept of a Black Swan and engineering risk is introduced with reference to the siting and performance of major engineering facilities and infrastructure (e.g., coastal dykes of Holland and the Fukushima nuclear plant, Japan).
19. **Current events**: course structure may be modified at any time to discuss and examine current natural hazard occurrences and/or to discuss and analyse the occurrence of major natural disasters that occur during the running of the course (e.g., 2010 Haiti Earthquake, 2011 Japan Tsunami).
20. **Hazards in SW Ontario**: as time allows, aspects of hazards in SW Ontario will be examined with particular reference to heavy rains, urban flooding, ice storms, heavy winds, and tornadoes.