

# **EOSC 114: The Catastrophic Earth – Natural Disasters**

## **Course-level and Lecture-level Learning Goals**

### **Course-level learning goals**

A. For earthquakes, volcanoes, landslides, storms, waves, and meteor impacts, you will:

1. Learn how they work.
2. Locate the dangerous places where they've often occurred.
3. Learn ways to observe and monitor them.
4. Find out why it's hard to forecast them.
5. Learn what you and your community can do to prepare for them.

B. We will strive to:

1. Empower you to be a survivor.
2. Enable you to approach new challenges insightfully.
3. Sharpen your observations of nature.
4. Stimulate your excitement in our planet.

These course-goals will be modified slightly to mesh with the Faculty of Science Learning Goals, and the EOSC Dept learning goals, after they have been decided.

See also the matrix of course goals with service courses curriculum goals (*Dept-Course-goalsmatrix-114.xlsx*).

### **Module- or lecture-level learning goals**

#### **Module: Fragile System - Part 1**

Day 1

- List the main topic modules we will cover.
- Recognize (most of) the instructors.
- Use the i>Clicker system.
- Access content information from the online course notes and from the textbook.
- Use the course web page to anticipate learning goals, reading assignments, warm-up assessments, exams, and other scheduled events.
- Know where to go for help (web FAQs, Vista Discussion Board, ECAC).
- Actively participate with your classmates to enhance your learning

Day 2

- Explain what density is, & how it relates to stratification.
- Explain why disaster scales are based on the Order-of-Magnitude concept.
- Interpret graphs with logarithmic scales.
- Relate natural-disaster intensity to frequency & return period.
- Describe how concentration or dilution of energy relates to disasters.
- Get the disaster info you need from reliable sources.

#### Day 3

- List the 1st and 2nd most common elements in the earth, ocean, and atmosphere.
- Describe how viscosity and compressibility relate to the phase of matter.
- Be able to diagnose the type of strain by the way a material deforms.
- Explain why gravity is a force.
- List the 5 types of energy, and describe what causes them to vary.

#### Day 4

- Explain (with examples) how energy conservation applies to natural disasters.
- Describe relationships between force, pressure, stress, strain, energy, and power.
- Describe population growth and explain why it is important for natural disasters.
- Explain how Earth's carrying capacity and overpopulation are related to the fate of the human race, and anticipate your role in it.

#### Day 5 - Explore Your Background.

- Know more about aspects of the Carl Wieman Science Education Initiative (CWSEI) and active learning.
- Use feedback about warm-up exercises to focus YOUR learning.
- Re-do the background exercise perfectly.
- Become more interested in current, global natural hazards.

### **Module: Earthquakes**

#### Day 1

- Use concepts of (1) stress causing strain and (2) plastic versus brittle deformation to explain how energy is released causing earthquakes
- Recognize visual evidence of tectonic forces in rocks and landscapes (e.g. fault types)

#### Day 2

- Explain the global distribution of earthquakes (i.e. rare, large and frequent small quakes) in terms of tectonic plate interactions and the forces that drive them
- Describe how the Earth builds, stores, and releases energy in earthquakes
- Describe how an earthquake moves through the Earth

#### Day 3

- Describe how an earthquake is recorded and how to locate the epicentre
- Compare and contrast the meanings and uses of earthquake magnitude and intensity scales
- Given any structure, ground type and earthquake location, predict the types and extent of damage likely to be caused by all four seismic waves

#### Day 4

- Understand that earthquake prediction is difficult and why
- Difference between prediction and forecasting
- Be aware of earthquake hazards and notice how they can be the cause of other natural disasters

#### Day 5

- Be aware of large and local earthquakes (when are we expecting an earthquake in BC?)

- Know what to do in the event of an earthquakes (survival techniques)

## **Module: Volcanoes**

### Day 1

- What is magma?
- Why does magma erupt?
- Why is magma important?
- Why are gases are critical?

### Day 2

- Why do volcanoes occur where they do?
- What are the different types of volcano?
- Why are there different types of volcano?

### Day 3

- Estimate the SIZE of eruptions.
- Compare different types of eruption:
  - LAVAS
  - PYROCLASTIC FALL
  - PYROCLASTIC FLOWS
  - LAHARS (next class)
- Use them to rank the danger of probable hazards.

### Day 4

- have examined the major volcanic hazards:
  - LAVAS (Wednesday)
  - PYROCLASTIC FALL (Wednesday)
  - PYROCLASTIC FLOWS
  - LAHARS
  - SECTOR COLLAPSE
  - POISONOUS GASES
- and used this knowledge to MAP major hazards around different volcanoes.

### Day 5

- describe and assess different volcano monitoring techniques
- discuss the way BC's volcanoes are monitored
- evaluate hazards and risks associated with an eruption from Mount Baker

## **Module: Landslides**

### Day 1

- Explain how the socio-economic impact of landslides depends on the type and characteristics of the landslide hazard.
- Define the chief components of landslide risk.
- Distinguish the different modes of failure (falls, flows, slides, topples, and spreads) and how they are influenced by geology.
- Compare and contrast landslide causes and how they differ from landslide triggers.

## Day 2

- Compare and contrast the role of causes and triggers in the occurrence of landslides.
- Assess the balance between the strength of the slope and the destabilizing forces acting on it (Factor of Safety)
- List and describe how groundwater affects shear stress and shear strength, and how it contributes towards the increased likelihood of a landslide.
- Outline the different factors, both natural and human, that contributed to the Vaiont landslide disaster.

## Day 3

- Compare and contrast several of the key triggers of landslides and how they affect the force balance equation (i.e. Factor of Safety)
- Differentiate the mechanism by which liquefaction landslides develop in loose sands and sensitive clays.
- Explain why British Columbia has the highest frequency of landslides in Canada and what the future holds as the population expands into mountainous regions.
- List the different human activities that contribute to increased landslide hazards.

## Day 4

- Relate the type of landslide damage expected as a function of its velocity.
- Identify tell-tale signs of an unstable slope.
- Compare and contrast avoidance, prevention, and protection strategies for dealing with landslide hazards.
- List the mitigation techniques commonly used for avoidance, prevention and protection strategies.

## **Module: Storms**

### Day 1

- Be wary of the main storm hazards.
- Describe the different types of lightning, how they form, and what happens when they strike something.
- Recognize thunderstorms, be able to identify Tstorm components, and explain how they evolve.
- Explain how storms get their energy from the sun.

### Day 2

- Explain the main characteristics that make a supercell so much nastier than a normal Tstorm.
- Be able to recognize thunderstorms in radar and satellite images.
- Explain the behavior of downbursts and gust fronts, and identify their associated cloud & dust features.
- Describe why the fact that cold air holds less water vapour is critical in explaining how Tstorms can extract energy from humid air.

### Day 3

- Be able to recognize tornadoes and wall clouds.
- Explain why supercell thunderstorms spawn the most dangerous tornadoes.
- Relate the Enhanced Fujita scale to different amounts of damage.

- Describe safety procedures near tornadoes.
- Identify the times and places for high tornado risk.

#### Day 4

- Recognize mammatus clouds and the flanking line, and describe their relationship to Tstorms.
- Explain how vertical and horizontal winds are created by heat released in storms.
- Explain what the continuity effect is, and how it ties vertical and horizontal motions into circulations.
- Describe rain and hail hazards of Tstorms, and state actions you can take to be safe near Tstorms.

#### Day 5

- Identify the components of a hurricane.
- Explain how hurricanes get and utilize heat energy, and why hurricanes can exist for weeks.
- List the requirements for hurricane existence, describe how hurricanes evolve, and what causes them to die.
- Describe the risks associated with hurricanes, and appropriate safety procedures.

### **Module: Waves**

#### Day 1

- Identify key properties of waves
- Use these properties to determine wave speed and behavior in either shallow or deep water
- Explain how waves move matter and energy
- Describe the forces that generate waves, eliminate waves, and return the ocean to a flat surface.
- Explain the factors that determine the roughness of the sea

#### Day 2

- Define wave breaking, and determine when a wave will break.
- Explain differences between plunging and spilling breakers.
- Predict the type of breaker that will be found on a given beach.
- Describe how coastlines affect waves, and how waves affect coastlines.
- Compare the effects of breakers, groins, seawalls, and other structures on coastal erosion.

#### Day 3

- Determine how two waves will interact, and explain constructive and destructive interference.
- Discuss wave reflections, standing waves, and resonance.
- Relate wave interference and resonance to marine hazards.
- Explain how a tsunami differs from more common ocean waves.

#### Day 4

- Discuss why tsunami come ashore so violently.
- Describe how tsunami form.
- Identify tsunami warning signs, and know how to respond.
- Describe the processes responsible for a storm surge, and identify where in a hurricane the maximum surge will occur.

## Day 5

- List 2 causes of eustatic changes in sea level.
- List 2 causes of regional changes in sea level.
- Relate these changes to risks for coastal communities.
- Describe the impact of sea ice and permafrost melt on erosion in the Arctic.
- Describe the impact of Mississippi erosion efforts on New Orleans.

## Module: Impacts

### TOPIC 1: Extinctions

1. Concept of a biosphere`
  - a. Understand the concept of a biosphere and Earth System Science and that the biosphere has evolved over time
2. Principles of Stratigraphy
  - a. Distinguish between the oldest and youngest portion of a geological section using principles of superposition, original horizontality and cross cutting relationships
3. Biostratigraphy
  - a. Describe the concept of faunal succession and the use of fossils in correlation and in the subdivision of Earth history
  - b. Recognize the qualities that make fossils useful in biostratigraphy
4. Historical Figures
  - a. Identify important historical figures in the development of stratigraphy and biostratigraphy
5. The concept of deep time
  - a. Appreciate the scale of changes that can occur over geological time scales
  - b. List some of the major subdivisions /ages of the geological time scale and appreciate the relative scale between the Phanerozoic and the Precambrian
  - c. Understand how extinction events are linked to the structure of the geological time scale
6. Mass extinction events
  - a. Define the characteristics of a mass extinction
  - b. List the 'big 5' mass extinction events and their order through time
  - c. Distinguish between broad extinction producing phenomena.
  - d. Describe the late Ordovician and Permo-Triassic extinction

### TOPIC 2: Case study, the K/T extinction

1. K/T Extinction
  - a. Describe the character of extinctions at the K/T boundary
  - b. Discuss the evidence used to support the K/T impact
  - c. Describe the location and probable nature of the K/T impactor
  - d. Describe the initial and long-term effects of the impact and their environmental consequences
  - e. Consider other potential causes of the K/T environmental collapse

### TOPIC 3: Impacts

1. Our place in the solar system / galaxy
  - a. Describe the type and location of potential impactors and rate of meteoroid influx
2. History of impacts
  - a. List some of the major impact features preserved on the Earth's surface and explain why impact craters appear to be rare on Earth
3. Periodicity of mass extinctions and possible ET driving mechanisms
  - a. Describe the hypothesis proposed by Raup and Sepkoski
4. Recent history of impacts and risk assessment
  - a. List and describe some recent impacts and "near misses"
5. Impact risk and mitigation
  - a. Understand the risk associated with an impact hazard
  - b. List possible mitigation strategies and appraise their relative effectiveness

From the textbook Readings:

- a. List some of the major developments in the history of life on Earth
- b. Describe some of the features and processes of crater formation
- c. Provide examples of Canadian Impact Craters

### **Module: Fragile System — Part 2**

- Synthesize your knowledge of individual disasters into a coherent understanding.
- Analyze your neighborhood's risk to various natural hazards, and recommend activities to mitigate some of the future risk.
- Critique your own and your family's preparedness. Design plans to be better prepared, and implement them.
- Evaluate the actual situation when faced with a natural disaster, make decisions based on available (often incomplete) info, and take well-reasoned action to enhance your survival.
- Make well-informed life decisions, such as where to live and work, who to vote for, how best to utilize your tax dollars. These will require you to synthesize your knowledge of disasters with broader societal issues.

(These goals will be tested in the crucible of your own life.)

- Evaluate the satisfaction of our overall course goals.
- Compare the info you gained by the end of this course to the info you wanted at the beginning of term. Decide how you can get the remaining info.
- Determine if any additional EOSC & ATSC courses can serve your needs.
- Know how to prepare for the final exam, utilizing various course resources including the Learning Goals in this table.

See *goals-Feb2009.xlsx* for correlated module and course level goals, with Bloom's level and comments.