EOSC 114 - Natural Disasters

Learning Goals for the Whole Course

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.

Learning Goals for each Lecture

These are a work in progress. Thank you for your patience. Learning goals are also given at the start of the lecture. The exam questions will test these learning goals.

Module: **Fragile System**	
Class	**Learning Goals** *By the end of this period, you should be able to:*
FS 1 **Welcome**	• List the components of the atom. • List the 1st, 2nd and 3rd most common elements in the earth, ocean, and atmosphere. • Define fluid, viscosity, and compressibility and how they relate to the phases of matter. • Explain what density is & how it relates to stratification. • List the metric prefixes and their values from Tera to Pico
FS 2	• List 5 types of energy important to disasters, and describe what causes them to vary. • Explain how the force of gravity affects motion and energy. • Define force and work. • Explain how disasters are associated with concentration or dilution of energy.

	• Explain (with examples) how energy conservation applies to natural disasters. • Explain why disaster scales are based on the Order-of-Magnitude concept, and interpret graphs with logarithmic scales
FS 3	• Compare and contrast risk, perception of risk, hazard, and vulnerability. • Recognize how poor humans are at judging risk. • Recognize how your perceptions skew your ability to judge risk. • Relate natural-disaster risk & intensity to frequency, return period, and consequences (costs). • 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.

Module: **Earthquakes**	
Class	**Learning Goals** *By the end of this period, you should be able to:*
EQ 1	• Describe the layering of the Earth (composition and strength) and relate this to the operation of plate tectonics and earthquakes • Describe the global distribution of earthquakes and how the frequency of earthquakes changes with magnitude • Explain how any rock can be brittle and elastic and plastic (even all at the same time), link brittle and ductile deformation to where earthquakes happen • Compare and contrast between the 3 types of plate tectonic boundaries (divergent, convergent, and transform) and their sub-types (i.e., different combinations of oceanic and continental plates) • Distinguish between the three main types of faults (normal, reverse, strike-slip) and identify the stresses that cause each • Describe which faults are the most common type at each type of plate boundary, and which plate boundaries produce the largest earthquakes and why
EQ 2	• Describe what an earthquake is: • What happens within the lithosphere? What do we feel at the surface? • Explain what elastic rebound is and why it is important • Understand concepts of • stress causing strain • elastic vs. plastic vs. brittle deformation

	• Describe the motion and speed that different types of elastic waves travel through the Earth or over its surface: • Body waves [compression (P) and shear (S)] • Surface waves (Rayleigh and Love) • Explain why shear waves cannot propagate through fluids while compressional waves can • Determine the location of an earthquake using data from 3 or more seismograms • Describe the ways we measure the size of an earthquake and the difference between Magnitude and Intensity
EQ 3	• Explain how magnitude scales describe ground motion (shaking amplitude) • Compare and contrast earthquake magnitude (Richter/Local and Moment) and intensity (Mercalli) scales • List and describe various hazards related to earthquakes • Understand the importance of building design and ground conditions in earthquake damage to buildings and infrastructure • Understand the basics of how buildings can be designed or retrofitted to better resist earthquakes (and reduce casualties and costs) • Explain liquifaction and resonance and how those processes can affect buildings and other structures
EQ 4	• Problems in Predicting Earthquakes • Understand that earthquake prediction is difficult and why • Difference between prediction and forecasting • Local Earthquakes and Survival Strategies • Identify fault zones and earthquake return periods for earthquakes in the Vancouver (and Cascadia) region. • Describe the evidence for the Cascadia subduction zone generating large megathrust earthquake beneath southwest BC, Washington, and Oregon • Be aware of large and local earthquakes (when are we expecting an earthquake in BC?) • **Describe what to do in the event of an earthquakes (survival techniques) *** you really want to know this stuff! *****

Module: **Volcanoes**	
Class	**Learning Goals** *By the end of this period, you should be able to:*
Volcanoes 1	• Identify key properties (density, viscosity, silica content, & temperature) of different types of magma. • Explain why magma erupts or not. • Describe the different types of eruptions and how they are related to magma properties. • List the different categories of volcanic rocks and explain the differences between the magmas they cooled from. • Explain why some magmas erupt explosively (as pyroclastic material) and some magmas erupt effusively (as lava). • Explain the differences between pahoehoe and a'a lavas
Volcanoes 2	• Explain the global distribution of volcanoes. • List the three types of plate boundaries and the different types of volcanoes that occur at each plate boundary. • Describe the type of volcano that occurs at hot spots. • Describe the morphology, dominant rock type and typical eruption style of the different types of volcanoes • Describe the tectonic setting of Southern British Columbia (Cascadia) and determine the dominant type of volcano that occurs here
Volcanoes 3	• Explain what lava flows, fire fountains, lava bombs and volcanic ash are and how they form • Explain what controls volcanic explosivity. • Describe the different types of volcanic eruptions and how they are related to magma properties • Use the VEI to rank the size of explosive eruptions
Volcanoes 4	• Explain what is meant by hazard and risk • Describe the particular hazards associated with pyroclastic flows, lahars, dome collapses, sector collapses, lateral blasts and toxic gases. • Describe the hazard potential of specific volcanic events • List the volcanic hazards, and their risks, that may affect Vancouver
Volcanoes 5	• Learn to interpret a volcanic hazard map. • Understand how risk is assessed.

	• List the different volcano monitoring techniques and the instruments that are used and explain what they are used for • Evaluate the hazards to Vancouver associated with an eruption from Mt Baker.

Module: **Landslides**	
Class	**Learning Goals** *By the end of this period, you should be able to:*
LS 1	• Explain how the impact of landslides depends on 1) population density, 2) economic infrastructure, and 3) population preparedness. • Explain why British Columbia has the highest frequency of landslides in Canada and what we should expect as our population expands into the mountains. • Distinguish between the 3 main failure modes (falls, flows, and slides) and how they are influenced by geology. • Categorize, identify, and name a variety of different landslides
LS 2	• Define Angle of repose • Assess the balance between the strength of the slope and the destabilizing forces acting on it (Factor of Safety) • Compare and contrast landslide causes and landslide triggers. • List and describe several external causes of landslides
LS 3	• List and describe several internal causes of landslides • List several landslide triggers • Compare and contrast several key triggers and causes of landslides and how they affect the force balance equation (i.e. Factor of Safety) • Explain how liquefaction landslides develop in sensitive marine clays • List and describe the site conditions (Causes and possible Trigger) that lead to the development of the Oso Landslide in Washington State
LS 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. • Identify the appropriate mitigation strategy for a variety of risk situations.

Module: **Storms**	
Class	**Learning Goals** *By the end of this period, you should be able to:*
Storms 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.
Storms 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.
Storms 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.
Storms 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.
Storms 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**	
Class	**Learning Goals** *By the end of this period, you should be able to:*
Waves 1	• Identify key properties of waves. • Explain how waves move matter and energy. • Describe the forces that generate and eliminate waves. • Use these properties to determine wave speed and behaviour in either shallow or deep water. • Describe changes in wave behavior as they shoal
Waves 2	• Explain the factors that determine the roughness of the sea • Explain how waves interact (constructive & destructive interference) • Explain how rogue waves are generated • Explain seiche (saysh) & natural resonant frequency (or period) of a basin • Relate wave interference and resonance to marine hazards
Waves 3	• Describe what is a tsunami • Explain how tsunamis differ from wind-driven waves • Explain why tsunamis come ashore so violently • Explain why tsunamis are devastating in some semi-enclosed bays (i.e. Hilo Bay, resonance) • Describe how tsunamis can be generated (e.g. earthquakes vs. volcanoes) • Describe the risks from a tsunami at the BC coast, (e.g. from a megathrust earthquake) • Identify warning signs, and know how to respond
Waves 4	• Determine when a wave will break • Differentiate between breaker types • Predict which breaker type will be found on a given beach • Describe how coastlines affect waves and how waves affect coastlines

Waves 5	• Compare and contrast the effects of manmade structures on coastal processes. • Relate these changes to risks for coastal communities. • Describe how storm surges are generated. • Identify where and how the maximum surge occurs in a hurricane.

Module: **Impacts**	
Class	**Learning Goals** *By the end of this period, you should be able to:*
Impacts 1	**Extinctions** • Be able to understand the concept of a biosphere and Earth System Science and that the biosphere has evolved over time • Be able to use Principles of Superposition, Original Horizontality, Lateral Continuity, and Cross-Cutting Relationships to distinguish between the oldest and youngest portions of geological sections • Describe the concept of faunal succession and the use of fossils in correlation and in the subdivision of Earth history • Recognize the qualities that make fossils useful in biostratigraphy • Appreciate the scale of changes that can occur over geological time scales • List some of the major subdivisions /ages of the geological time scale and appreciate the relative scale between the Phanerozoic and the Precambrian • Understand how extinction events are linked to the structure of the geological time scale
Impacts 2 &3	**Mass extinction events** • Define the characteristics of a mass extinction • List the 'big 5' mass extinction events and their order through time • Distinguish between broad extinction producing phenomena. • Discuss the significance and magnitude of the P/T event • Discuss the causes and effects of the P/T event • Describe the late Ordovician and Permo-Triassic extinction • Describe the character of K/Pg extinction • Discuss the evidence used to support the impact theory for the K/Pg extinction • Describe the location and probable nature of the K/Pg impactor • Describe the initial and long-term effects of the K-Pg impact and their environmental consequences • Consider other potential causes of the K/Pg environmental collapse
Impacts 4	**Impacts & Humans** • Describe the type and location of potential impactors and rate of

	meteoroid influx • Explain why impact craters appear to be rare on Earth • Describe the hypothesis proposed by Raup and Sepkoski • List and describe some recent impacts and "near misses" • Understand the risk associated with an impact hazard • List possible mitigation strategies and appraise their relative effectiveness

Module: **Fragile System, Pt 2**	
Class	**Learning Goals** *By the end of this period, you should be able to:*
FS2	• 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.