EPSC 185 - Natural Disasters:

Sept 8th 2015

Introduction:

-dis (unfavourable) astros (stars): to ancient peoples, disasters were precipitated by the stars

Earthquakes: local to regional (impact on a spatial scale)
Floods: local to regional
Hurricanes: regional
Tsunamis: regional to global
Climate Change: local, regional, global

the impact of a disaster can be local to global, but one disaster that is felt locally or regionally can trigger another disaster whose impact is felt regionally or even globally (ie. earthquake that happens in the ocean near islands (impact felt at both ocean and islands) can trigger a tsunami whose impact can be felt on a global scale, if destructive enough)

-different disasters are felt differently because they contain different levels of energy due to different lifespans (ie. second long lightning strike compared to 10 day long hurricane), different radius (ie. metres long lightning strike compared to hundreds of km long hurricane), as well as the force they produce (the worlds largest earthquake had the same force as the average hurricane and the earthquake did not last as long)

-Hazard: potential threat to humans and their welfare
-Risk: probability of loss (deaths, injuries, damage, disruption of economic activity) as a result of a particular natural event
-Vulnerability: the potential loss or damage as a result of a particular natural event (0=no damage. 1=total loss)

Earthquakes:

-earthquakes can occur in areas that are not along active plate boundaries bc these areas were formed on rift zones (the rift suggests that there was some sort of plate boundary at one point in time)

-Divergent plate boundary: plates are moving apart
-Convergent plate boundary: plates are moving together
-Transform plate boundary: plates sliding past each other
-Subduction zone: one plate literally slides under the other

Divergent margin: lithosphere is melting and the two plates are being pushed apart by magma (pushes up between the two plates and creates new material/crust) → earthquakes and volcanoes prominent in these areas → Red Sea example of one of these areas (will get larger w time → two plates were close together but are drifting apart)

Convergent Margin (Subduction): plate literally goes down, is subducted, beneath the less dense plate

1. oceanic vs. continental: oceanic plate is denser, subducts under the continental plate

2. oceanic vs. oceanic: the older, denser plate subducts under the younger, less dense one
3. continental vs. continental: the two plates collide and form mountains

→ instead of new materials being created, the two plates are either consumed (anything involving an oceanic plate) or colliding (continental/continental)
→ sometimes huge outpourings of lava during subduction underwater can result in underwater mountain ranges
→ Juan De Fuca: convergent margin example → on the west coast (vancouver) JDF plate dives beneath north america plate → zone is known for producing large earthquakes and volcanoes
→ most powerful earthquakes occur along convergent plate boundaries bc of the subduction (when a plate goes under, huge amounts of friction build up w/ potential for lots of damages/energy)

Transform Margins:
-offsets (like in JDF/pacific/NA plates) slide past each other → San Andreas fault is a transform plate boundary responsible for many earthquakes in California

Subduction Zones:
→ Pacific Ring of Fire: zone where a lot of earthquakes occur bc it's a hugely active subduction zone(highest probability of earthquakes occurring-large/powerful earthquake potential)
-where an oceanic plate subducts a continental plate, the largest and most powerful earthquakes are generated → they often have aftereffects that have a global impact (2011 earthquake in Japan causing the tsunami)
→ Cascadia: a locked subduction capable of producing a magnitude 9 earthquake. subducting plate has become stuck, but it won't stay stuck forever and will slip significantly during the next earthquake → last earthquake here was in the year 1700 and was M9 aka the pacific northwest is due for another huge one soonish.

Seismic Hazard:
→ the growth of cities is high in developing cities, and many are within 100km of a fault. this makes them more susceptible to earthquakes of mag. 7 or greater.
→ seismic hazard is basically a place's potential for a devastating earthquake
→ In San Francisco there's a high probability of an earthquake of magnitude above 6.7 occurring before the year 2036 bc there are many fault lines in this area (San Andreas, San Gregoro etc)

Faults:
→ rupture/crack in the earth's crust
→ normal fault (vertical): one plate moves up, one moves down as the plates kinda slide apart)
→ reverse/thrust fault (vertical): horizontal compression, plates once again move up and move down, but are pushed together instead of sliding apart (mountain ranges often formed this way)
→ strike slip fault (horizontal): found in transform plate boundaries → two pieces of crust slide against each other
→ right lateral (dextral → upper block goes to the right) or left lateral (sinistral → upper block goes to the left)
-Earthquakes are a result of movements along a fault line

Elastic Rebound Theory:

-movement on two plates (two sides of fault) but fault has not broken (no movement - yet). so stress builds until rock eventually ruptures and there's an earthquake (fault moves). Theoretically, after the rupture, rocks

return to their original shape and stress level. However there are far too many variables for this to be a perfect theory
-Parkfield in California (google it????)

-focus= hypocentre of earthquake (origin) → seismic waves radiate out from focus
-epicentre= where most things are felt on the surface.

Measuring Earthquakes:

Richter Scale
-measures the amplitude of ground shaking
-logarithmic scale → a difference of 1 on the richter scale represents a magnitude 10x difference (for ground motion. for energy, its 33x)

Moment Magnitude
-measures the size of earthquakes in terms of the energy released
-seismic moment: M_0 = rock rigidity x area of slip x fault slip
-moment magnitude: $M_w = ⅔ \times \log(M_0) - 10.7$

Mercalli Index
-measures the effect of earthquakes on structures such as buildings → each column is synonymous w a number on the Richter scale, but are affected by factors such as building composition, proximity to the earthquake and depth of the earthquake

-destructiveness is based on: earthquake magnitude, distance to epicentre, depth, strength of building, nature of soil or bedrock on which foundations are built, and other local conditions
-damaging earthquakes can be commonly shallow (deeper earthquakes will not do as much damage to the surface as a shallow earthquake can)
-nature of the earth (soil vs. clay vs. landfill) that structures are built on → foundations built on landfill, for example, are very vulnerable (unstable foundations)

-Earthquake in San Francisco 1906 Mag 7.8 epicentre near San Francisco → 400 mill in damage (billions today) → 700 reported killed, underestimate tho, probably more like a few thousand.
-this earthquake was a result of a strike slip fault (right lateral) → end result was offset up to 300km
-this earthquake caused a mass breakout of fires around the city (gas mains break etc)
-earthquake was followed by a period of relative seismic quiet → worries people bc that could mean another one is building up

-big earthquakes can be followed by decades of seismic quiet
-earthquakes the size of the 1906 event tend to appear every several hundred years (200 ish)
-in the short term, San Francisco is most at risk for a Mag 6-7 earthquake

-rapid development along San Andreas fault in San Francisco → problematic because these developments are vulnerable to landslides and earthquakes

Consequences of earthquakes:

Liquefaction:
→ wet, unsolidated soils and sediments are highly vulnerable → ground can actually flow/move when the ground shakes → typically built in/on landfill areas
Tsunamis:
→ ocean waves caused by earthquakes, landslides etc.
→ can be devastating at great distances from epicentre.
→ if an earthquake happens along pacific northwest coast, a tsunami can potentially be felt anywhere around the pacific
Aftershocks:
→ typically occur after a major earthquake
→ may be thousands of aftershocks for a period of months or years afterward → they generally decrease with time and are typically located around the fault (afterfault)
→ aftershocks are important because they help determine where the fault is
Landslides:
→ ground vibrations + shaking can cause landslides in mountainous areas (again, typically occur along the fault)
Fires:
→ ground shaking ruptures power and gas lines + damage to water mains make fires difficult to fight

Hurricanes:

Where and when do they occur?
Physical mechanisms for formation and intensification
Life cycles of hurricanes
Hazards of hurricanes
Coastal flooding and erosion

-deadliest hurricanes/tropical cyclones have occurred in Bay of Bengal (Bangladesh) → top 10 situated in Asia
-the reason for this is because the population density in Asia is so much greater than North America + more people live closer to sea level → elevation of storms can surge to 20-30 feet
-deadliest storm in Atlantic Basin (our region) occurred in 1780, with 22000 deaths (compared to over 300 000 in Asia). deadliest US storm: Galveston Hurricane, 1900, 8000 killed
-eye of the hurricane: centre of hurricane, generally relatively quiet → anything in area a few km from eye of hurricane suffers the worst of the hurricane

-when a hurricane hits an area with lots of assets + a greater population density, the damage done will be very significant

-Hurricane Andrew was a wake up call for insurance companies → the amount of damage that was done exceeded that of most insurance companies (essentially, they went broke and had to figure out a new system → reinsurance industries → wealthy insurers that give insurance companies money to stay in business.

A hurricane is: warm core, low pressure system → no temperature contrasts in hurricanes. develops over tropical or subtropical waters + has organized circulation of at least 120 km/h (74 mph)

warm core: warm air moves over the ocean and warm water vapour rises into the atmosphere. as it rises, it cools, and condenses into liquid drops → condensation releases heat into the atmosphere, causing the air to become lighter. warmed air continues to rise and more warm, moist air from the ocean takes its place.