EENS 204	Natural Disasters
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Natural Disasters & Assessing Hazards and Risk	

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Hazardous Processes

- Most hazardous process are also Geologic Processes.
- Geology is the study of the Earth and its history.
- Geologic Processes effect every human on the Earth all of the time, but are most noticeable when they cause loss of life or property. Such life or property threatening processes are called natural hazards. If the process that poses the hazard occurs and destroys human life or property, the a natural disaster has occurred. Among the natural hazards and possible disasters to be considered are:
  - Earthquakes
  - Eruptions of Volcanoes
  - Tsunamis
  - Landslides
  - Subsidence
  - Floods
  - Droughts
  - Hurricanes
  - Tornadoes
  - Asteroid Impacts
- All of these processes have been operating throughout Earth history, but the processes have become hazardous only because they negatively affect us as human beings. **Important Point** - ***There would be no natural disasters if it were not for humans. Without humans these are only natural events.***
- Risk is characteristic of the relationship between humans and geologic processes. We all take risks everyday. The risk from natural hazards, while it cannot be eliminated, can, in some cases be understood in a such a way that we can minimize the hazard to humans, and thus minimize the risk. To do this, we need to understand something about the processes that operate, and understand the energy required for the process. Then, we can develop an action to take to minimize the risk. Such minimization of risk is called ***hazard mitigation***.
- Although humans can sometimes influence natural disasters (for example when poor levee design results in a flood), other disasters that are directly generated by humans, such as oil and toxic material spills, pollution, massive automobile or train wrecks, airplane crashes, and human induced explosions, are considered technological disasters, and will not be considered in this course.

- Some of the questions we hope to answer for each possible natural disaster are:
  - Where is each type of hazard likely to be present and why?
  - How often do these hazards develop into disasters?
  - How can each type of disaster be predicted and/or mitigated?

Assessing Hazards and Risk

As discussed before, natural disasters are produced by processes that have been operating since the Earth formed. Such processes are beneficial to us as humans because they are responsible for things that make the Earth a habitable planet for life. For example:

- Throughout Earth history, volcanism has been responsible for producing much of the water present on the Earth's surface, and for producing the atmosphere.

- Earthquakes are one of the processes responsible for the formation of mountain ranges which help to determine climate zones on the Earth's surface.

- Erosional processes, including flooding, landslides, and windstorms replenishes soil and helps sustain life.

Such processes are only considered hazardous when they adversely affect humans and their activities.

Types of Hazards

Natural Hazards

Natural Hazards and the natural disasters that result can be divided into several different categories:

- Geologic Hazards - These are the main subject of this course and include:
  - Earthquakes
  - Volcanic Eruptions
  - Tsunami
  - Landslides
  - Floods
  - Subsidence
  - Impacts with space objects

- Atmospheric Hazards - These are also natural hazards but processes operating in the atmosphere are mainly responsible. They will also be considered in this course, and include:
  - Tropical Cyclones
  - Tornadoes
  - Droughts
  - Severe Thunderstorms
  - Lightening

- Other Natural Hazards - These are hazards that may occur naturally, but don't fall in to either of the categories above. They will not be considered to any great extent in this course, but include:

- Insect infestations
- Disease
- Wildfires

Natural Hazards can also be divided into ***catastrophic hazards***, which have devastating consequences to huge numbers of people, or have a worldwide effect, such as impacts with large space objects, huge volcanic eruptions, world-wide disease epidemics, and world-wide droughts. Such catastrophic hazards only have a small chance of occurring, but can have devastating results if they do occur.

Natural Hazards can also be divided into ***rapid onset hazards***, such as Volcanic Eruptions, Earthquakes, Floods, Landslides, Severe Thunderstorms, Lightening, and wildfires, which develop with little warning and strike rapidly. Slow onset hazards, like drought, insect infestations, and disease epidemics take years to develop.

Anthropogenic Hazards

These are hazards that occur as a result of human interaction with the environment. They include ***Technological Hazards***, which occur due to exposure to hazardous substances, such as radon, mercury, asbestos fibers, and coal dust. They also include other hazards that have formed only through human interaction, such as acid rain, and contamination of the atmosphere or surface waters with harmful substances, as well as the potential for human destruction of the ozone layer and potential global warming.

Effects of Hazards

Hazardous process of all types can have primary, secondary, and tertiary effects.

Primary Effects occur as a result of the process itself. For example water damage due to a flood, and collapse of buildings due to an earthquake, landslide, hurricane, or tornado.

Secondary Effects occur only because a primary effect has caused them. For example, fires ignited by earthquakes or volcanic eruptions, disruption of electrical power and water service as a result of an earthquake or flood, and flooding caused by a landslide moving into a lake or river.

Tertiary Effects are long-term effects that are set off as a result of a primary event. These include things like loss of habitat caused by a flood, permanent changes in the position of river channel caused by flood, crop failure caused by a volcanic eruption etc.

Vulnerability and Susceptibility

Vulnerability refers to not only the possible physical effects of a natural hazard, but the way it affects human life and property. Vulnerability to a given hazard depends on:

- Proximity to a possible hazardous event
- Population density in the area proximal to the event
- Scientific understanding of the hazard
- Public education and awareness of the hazard
- Existence or non-existence of early-warning systems and lines of communication

- Availability and readiness of emergency infrastructure
- Construction styles and building codes
- Cultural factors that influence public response to warnings

In general, less developed countries are more vulnerable to natural hazards than are industrialized countries because of lack of understanding, education, infrastructure, building codes, etc.

Poverty also plays a role - since poverty leads to poor building structure, increased population density, and lack of communication and infrastructure.

Human intervention in natural processes can also increase vulnerability by

1. Development and habitation of lands susceptible to hazards, For example, building on floodplains subject to floods, sea cliffs subject to landslides, coastlines subject to hurricanes and floods, or volcanic slopes subject to volcanic eruptions.

2. Increasing the severity or frequency of a natural hazard. For example: overgrazing or deforestation leading to more severe erosion (floods, landslides), mining groundwater leading to subsidence, construction of roads on unstable slopes leading to landslides, or even contributing to global warming, leading to more severe storms.

3. Affluence can also play a role, since affluence often controls where habitation takes place, for example along coastlines, or on volcanic slopes. Affluence also likely contributes to global warming, since it is the affluent societies that burn the most fossil fuels adding CO_2 to the atmosphere.

Assessing Hazards and Risks

Hazard Assessment and Risk Assessment are not synonymous!

Hazard Assessment consists of determining the following

- when and where hazardous processes have occurred in the past.
- the severity of the physical effects of past hazardous processes (magnitude).
- the frequency of occurrence of hazardous processes.
- the likely effects of a process of a given magnitude if it were to occur now.
- and, making all this information available in a form useful to planners and public officials responsible for making decisions in event of a disaster.

Risk Assessment involves not only the assessment of hazards from a scientific point of view, but also the socio-economic impacts of a hazardous event. Risk is a statement of probability that an event will cause x amount of damage, or a statement of the economic impact in monetary terms that an event will cause. Risk assessment involves

- hazard assessment, as above,
- location of buildings, highways, and other infrastructure in the areas subject to hazards
- potential exposure to the physical effects of a hazardous situation
- the vulnerability of the community when subjected to the physical effects of the event.

Risk assessment aids decision makers and scientists to compare and evaluate potential hazards,

set priorities on what kinds of mitigation are possible, and set priorities on where to focus resources and further study.

Prediction and Warning

Risk and vulnerability can sometimes be reduced if there is an adequate means of predicting a hazardous event.

Prediction

Prediction involves:

- A statement of probability that an event will occur based on scientific observation
- Such observation usually involves monitoring of the process in order to identify some kind of ***precursor event(s)*** - an anomalous small physical change that may be known to lead to a more devastating event. - Examples:
    - Hurricanes are known to pass through several stages of development: tropical depression - tropical storm - hurricane. Once a tropical depression is identified, monitoring allows meteorologists to predict how long the development will take and the eventual path of the storm.
    - Volcanic eruptions are usually preceded by a sudden increase in the number of earthquakes immediately below the volcano and changes in the chemical composition of the gases emitted from a volcanic vent. If these are closely monitored, volcanic eruptions can be often be predicted with reasonable accuracy.

Forecasting

Sometimes the word "forecast" is used synonymously with prediction and other times it is not.

- In the prediction of floods, hurricanes, and other weather related phenomena the word forecast refers to short-term prediction in terms of the magnitude, location, date, and time of an event. Most of us are familiar with weather forecasts.
- In the prediction of earthquakes, the word forecast is used in a much less precise way - referring to a long-term probability that is not specific in terms of the exact time that the event will occur. For example: Prior to the October 17 1989 Loma Prieta Earthquake (also know as the World Series Earthquake) the U.S. Geological Survey had forecast a 50% probability that a large earthquake would occur in this area within the next 30 years. Even after the event, the current forecast is for a 67% probability that a major earthquake will occur in this area in the next 30 years.

Early Warning

A warning is a statement that a high probability of a hazardous event will occur, based on a prediction or forecast. If a warning is issued, it should be taken as a statement that "normal routines of life should be altered to deal with the danger imposed by the imminent event".

The effectiveness of a warning depends on:

- The timeliness of the warning
- Effective communications and public information systems to inform the public of the imminent danger.
- The credibility of the sources from which the warning came.

If warnings are issued too late, or if there is no means of disseminating the information, then there will not be time enough or responsiveness to the warning. If warnings are issued irresponsibly without credible data or sources, then they will likely be ignored. Thus, the people responsible for taking action in the event of a potential disaster will not respond.

Response and the Role of Scientists, Public Officials, and Average Citizens to Assessments, Predictions, and Warnings

Everyone, including you, has a responsibility to understand the effects of a natural hazard and respond to assessments, predictions, and warnings. Thus, one of the most important aspects of disaster management and planning is education. Not everyone can be expected to completely understand everything about a potential natural disaster. Therefore, one of the most important links between all involved is effective communication between various groups of people. Still, we can divide some of the responsibilities as follows:

- Responsibilities of Scientists and Engineers
    - Hazard Assessment. Scientists have the greatest ability to determine where natural hazards exist, and the effects of such hazards when an event occurs.
    - Prediction. Scientists have access to monitoring of processes that enable prediction. They should be able to communicate probabilities to appropriate public officials for dissemination to the general public.
    - Reduction of Risk. Scientists and engineers should make information known to public officials about ways to reduce vulnerability and risk, by suggesting zoning regulations and building codes to public officials.
    - Early Warning - Scientists with access to monitoring and hazard information should help develop early warning systems to effectively communicate such warnings to Public Officials responsible for communicating the warning to the general public.
    - Communication - Scientists need to be able to present the information available in form that is understandable to all concerned.
- Responsibilities of Public Officials
    - Risk Assessment- Public Officials need to understand hazard assessments and develop risk assessments Decide where and how resources are to be expended to minimize risk.
    - Planning and Code Enforcement - Public officials need to work with scientists and engineers to help reduce vulnerability by making planning decisions (zoning laws) and building codes that help reduce risk and vulnerability.

- Early Warning - Public officials have the primary responsibility to inform the public about imminent dangers based on predictions and warnings issued by scientific community.

- Response - Public officials have the primary responsibility of maintaining an infrastructure that can deal with the emergencies created by a natural disaster. Need to develop plans for evacuation, emergency response, rescue, and recovery.

- Communication - Public officials must be able to communicate effectively with scientific community and the general public to disseminate information.

- You (Citizens)
  - Understanding of Hazards - General public needs to be aware of the effects of natural hazards on their communities, to have some understanding of what might occur in the event of a disaster.

  - Understanding of Early Warning Systems - General Public must be informed about what their response should be when a warning is issued.

  - Communication - At least in the U.S., we can communicate with public officials either directly or through the ballot box, to ensure that public officials make available the necessary information and effectively carry out their responsibilities for hazard and risk reduction.

References

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