Environmental Geology Chapter 1

Fall 2013

What is Environmental Geology?

Environmental Geology is "…the use of geologic information to help us solve conflicts in land use, to minimize environmental degradation and to maximize the beneficial results of our using our natural and modified environments."

What is Environmental Geology?

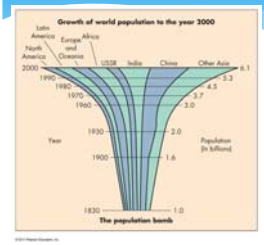
The application of geology to these types of problems includes the study of the following:

- Earth materials (type, utility, effects)
- Natural hazards (type, minimize impacts)
- Land evaluation (use, impact)
- Hydrologic processes (ground and surface water; pollution)
- Geologic processes

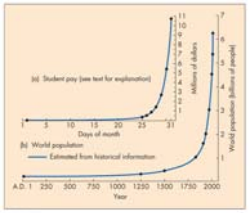
What is Environmental Geology?

Given the breadth of its interaction, Environmental Geology is "the earth science that studies the entire spectrum of human interactions with the physical environment."

Concept 1 – Human Population Growth



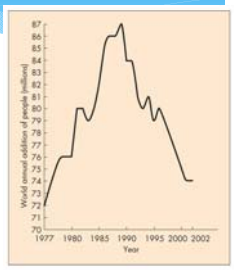
Exponential Growth…



Concept 1 – Human Population Growth

Population Growth in the Future

- Carrying Capacity – earth can only handle so many people before there are issues of degradation
- Earth is only sustainable habitat
- Population growth has slowed



Population Growth has slowed.

Concept 2 - Sustainability

Sustainability is:

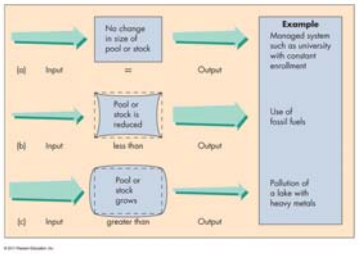
- Developing resources such that future generations will have equal access; or
- Economically viable development that is harmless to the environment and socially just; or
- A long-term concept that is possible for both renewable and non-renewable resources; or
- Using nonrenewable resources in such a way that recycling and substitution are important concepts.

Concept 3 – Earth as a System

The Earth is a series of interrelated systems (hydrosphere, lithosphere, biosphere, etc.)

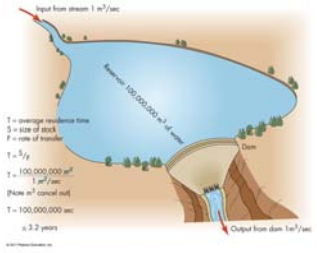
Concept 3 – Earth as a System

Input-Output Analysis



Concept 3 – Earth as a System

Average Residence Time



Concept 4 – Hazardous Earth Processes

Concept 4 – Hazardous Earth Processes

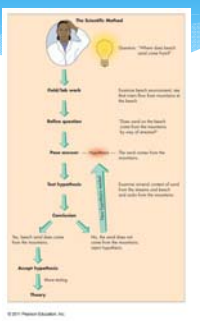
Natural Hazards that Produce Disasters becoming more common…

- Population increase = more people living in more hazardous situations
- Land use transformations (urbanization, deforestation)
- Increasing use of fossil fuels = more CO_2 = global warming (?) = greater intensity of storms, crop failure, etc.

Concept 5 – Scientific Knowledge and Values

What is Science?

Science is a way of knowing about the world through observation and experiment.



Concept 5 – Scientific Knowledge and Values

TABLE 1.3 Some Typical Rates of Geologic Processes

Slow Rates	Uplift that produces mountains. Generally, 0.5 to 2 mm per year (about 0.02 to 0.08 in. per year). Can be as great as 10 mm per year (about 0.39 in. per year). It takes (with no erosion) 1.5 million to 6 million years to produce mountains with elevations of 3 km (around 1.9 mi).
	Erosion of the land. Generally, 0.01 to 1 mm per year (about 0.004 to 0.039 in. per year). It takes (with no uplift) 3 million to 300 million years to erode a landscape by 3 km (about 1.9 mi). Erosion rates may be significantly increased by human activity such as timber harvesting or agricultural activities that increase the amount of water that runs off the land, causing erosion. Rates of uplift generally exceed rates of erosion, explaining why land above sea level persists.
	Incision of rivers into bedrock, producing canyons such as the Grand Canyon in Arizona. Incision is different from erosion, which is the material removed over a region. Rates are generally 0.005 to 10 mm per year (about 0.0002 to 0.39 in. per year). Therefore, to produce a canyon 3 km (around 1.9 mi) deep would take 300 thousand to 600 million years. The rate of incision may be increased several times by human activities such as building dams, because increased downcutting of the river channel occurs directly below a dam.
Intermediate Rates	Movement of soil and rock downslope by creeping in response to the pull of gravity. Rate is generally 0.3 to 1.2 mm per year (about 0.02 to 0.05 in. per year).
	Coastal erosion by waves. Generally, 0.25 to 1.0 m per year (0.82 to 3.28 ft per year). Thus, to provide 100 years' protection from erosion, a structure should be built about 25 to 100 m (about 82 to 328 ft) back from the cliff edge.
Fast Rates	Glacier movement. Generally, a few meters per year to a few meters per day.
	Lava flows. Depends on type of lava and slope. Generally, from a few meters per day to several meters per second.
	River flow in floods. Generally, a few meters per second.
	Debris avalanche, or flow of saturated earth, soil, and rocks downslope. Can be greater than 100 km (62 mi) per hour.
	Earthquake rupture. Several kilometers per second.

Concept 5 – Scientific Knowledge and Values

TABLE 1.4 Selected intellectual standards

- Clarity: If a statement is not clear, you can't judge whether it is relevant or accurate, and you may be misunderstood and your argument ignored.
- Assumptions: What assumptions are you making?
- Accuracy: Is a statement true? Can the statement be checked? How well does a measurement agree with the accepted value?
- Precision: Refers to degree of exactness to which something is measured. Can a statement or measurement be more specific, detailed, or exact?
- Relevance: Is a statement connected to the problem at hand?
- Depth: Did you adequately consider the complexities of a question?
- Breadth: Did you evaluate other points of view or examine it from a different perspective?
- Logic: Does a conclusion make sense and logically follow from the evidence?
- Significance: Is the problem an important one? Why? Why not?
- Timing: Did you present your statement or argument in the appropriate time framework (geologic, prehistoric, very recent, today)?
- Calculations: Did you check all the math?
- References: Did you use reliable sources?
- Conclusions: Did you gather your own data and come to your own conclusions?
- Fairness: Are there vested interests in the statement or argument and have other points of view been considered?

Modified after Paul, R., and L. Elder. 2003. Critical thinking. Dillon Beach, CA: The Foundation for Critical Thinking.

Concept 5 – Scientific Knowledge and Values

Why is solving environmental problems so difficult?

- Expediential growth (things can happen quickly)
- Lag time between change and result
- There is a chance if irreversible change
- Environmental unity – there are many connections that we may not be aware of

Concept 5 – Scientific Knowledge and Values

The Precautionary Principle – it is not necessary for 100% scientific certainty to take action (Example: Global Warming)

The question is – how much evidence is enough? This is a question of **Policy**, not **Science**.