Introduction to Environmental Science

In every deliberation, we must consider our impact on the next seven generations.
- The Iroquois Confederacy

Environmental Science

- Environmental science is the study of the interaction of humans with the natural environment.
- The environment includes all of the living and nonliving things that we interact with.
  - Climate
  - Soil and landforms
  - Water sources
  - Other living organisms

- Environmental science and the issues that it studies are complex and interdisciplinary, meaning it incorporates concepts and ideas from multiple fields of study.

Environmental History

- Humans have impacted the Earth since the very beginnings of civilization.
- In 2400 B.C., the agricultural fields of Sumeria had grain production similar to modern agriculture – about 30 bushels per acre.
- The Sumerians relied on irrigation, the artificial application of water from another source.
  - Tigris and Euphrates rivers.

- All water contains small amounts of minerals called salt, and that salt built up in the Mesopotamian soil over time.
  - Yields declined to half, then a fourth within a few hundred years.
  - By the 7th century A.D., slave labor had to be used to strip the upper salt layer from the soil so it could still be farmed.
  - By the 16th century, the Fertile Crescent of Mesopotamia was a salty wasteland.
- This is an example of two important concepts in environmental science:
  - The Law of Unintended Consequences, which states that the actions of people and governments always have unexpected effects.
  - Unsustainability, a condition that cannot continue at its current rate.

The Tragedy of the Commons

- An ecologist named Garrett Hardin wrote an essay called *"The Tragedy of the Commons"*, describing a major source of environmental conflict: resources that are not privately owned or regulated will often be depleted.
  - The self-interest of individuals takes priority over the best interests of the entire population.

- A small village consists mostly of farmers that raise and sell sheep at a nearby city. The only place for the sheep to graze is a commons in the center of the village.
  - A commons is an area that belongs to no individual; it is shared by the entire society.
- The villagers in this situation will have an incentive to obtain and graze as many sheep as possible, leading to overgrazing and barren lands.
- A second village has its grazing land divided into nine fenced sections, each of which is owned by a different family.
  - These families will carefully control the amount of grazing to ensure their land is usable in the long-term.

Sheep grazing, Hawf Protected Area, Yemen.
Picture by Sebastian Kennerknecht

7

- Climate change, air pollution, water pollution, and overfishing of international waters are all modern examples of the Tragedy of the Commons.

Norilsk, Russia
Source: ecojunk.wordpress.com

Zadar, Croatia
Source: Agence France-Presse

8

The Progressive Era

- In the United States, the environmental movement began with a series of conservation measures taken by President Teddy Roosevelt.
  - The goal was to prevent the destruction of commons – primarily unsustainable logging and hunting.
- National Parks are preserved areas that are relatively unaltered from their original state.
  - No fishing, logging, commercial hunting, or livestock grazing can occur.
- National Forests are federally-managed, but do allow commercial logging and recreational hunting and fishing.
- National Wildlife Refuges do not allow commercial activities, but may allow recreational hunting and fishing.

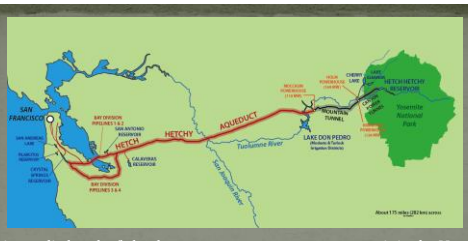
9

Hetch Hetchy Debate

- Years after the National Parks system was established, the city of San Francisco experienced an earthquake, followed by a massive fire.
- About 90% of the damage was due to the fire, which exposed the city's inadequate water supply.

"San Francisco 1906 fire 02 DA-SN-03-00958" by Harry Sterling Hooper.

10



- The city applied to the federal government to construct a reservoir in the Hetch Hetchy valley of Yosemite National Park.
- In order for the dam to be constructed, a law would have to be passed by Congress and signed by President Woodrow Wilson.

11

Environmental Ethics

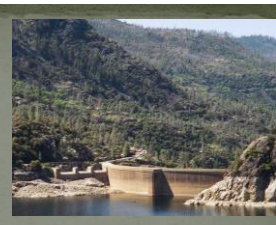
- The Hetch Hetchy debate led to the emergence of two major philosophies or environmental ethics; the moral relationship that humans have with the environment.

12

- Anthropocentrism is a human-centered philosophy that protects and promotes of human interests or well-being at the expense of all other factors.
  - Biggest advocate: Gifford Pinochet, the first chief of the U.S. Forest Service.

- Ecocentrists is a nature-centered philosophy that places intrinsic value on ecosystems regardless of their usefulness to humans.
  - Biggest advocate: John Muir, founder of the Sierra Club.

13



- Construction of the dam began in 1914. It is still in use today.
- Gifford Pinochet summarized the conservation ethic philosophy of planned, regulated utilization of environmental resources like this:

"Where conflicting interests must be reconciled, the question shall always be answered from the standpoint of the greatest good of the greatest number in the long run."

14

- Conservationists during the Progressive Era were the most concerned about resource depletion. They categorized natural resources into four groups:
- Inexhaustible resources cannot be used up.
  - Sunlight.
- Renewable resources can be replaced, but the process may take a long time.
  - Timber, soil.
- Nonrenewable resources cannot be replaced, as their formation took millions of years.
  - Coal, oil, natural gas.
- Recyclable resources can be used more than once.
  - Iron, aluminum, copper.

15

Modern Environmentalism

- A series of major environmental disasters through the early 20th century raised awareness of other environmental issues besides resource conservation.

16

- A dense smog from a zinc plant in Donora, Pennsylvania in 1948 sickened thousands.
- This was one of the deadliest incidents of air pollution, the introduction of particles or gases into the atmosphere that are harmful to living organisms.

17

- Radioactive fallout from nuclear bomb testing in the Marshall Islands exposed native islanders and Navy sailors to radioactive fallout.
  - This material was carcinogenic, meaning it increased the risk of cancer.

18

- A major oil spill near the city of Santa Barbara in 1969, coupled a fire on the Cuyahoga river that same year left powerful images of the effects of water pollution, the contamination of lakes, rivers, oceans, and groundwater.

19

- Rachel Carson published the book "Silent Spring" in 1962, documenting the effects that indiscriminate spraying of pesticides like DDT were having on the environment.
  - Many of these pesticides were persistent pollutants, meaning they resist normal environmental degradation.
  - Biodegradable pollutants will decompose over time.

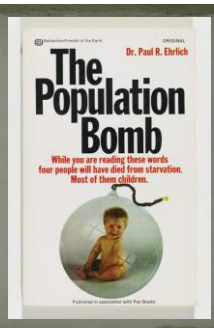
20

- Many species, such as the whooping crane, nearly disappeared completely from the wild due to overhunting and habitat loss. This raised awareness of the problem of extinction.
  - Elevated rates of extinction reduces the biodiversity, or variety of species found in a particular habitat or ecosystem.

21

- Rapid increases in the population size of countries like India and China caused fears of human overpopulation and famine, an extreme scarcity of food.
- One prediction from the book, The Population Bomb:

  "The battle to feed all of humanity is over. In the 1970s hundreds of millions of people will starve to death in spite of any crash programs embarked upon now. At this late date nothing can prevent a substantial increase in the world death rate..."



22

- In 1978, homes in the city of Love Canal, New York, were abandoned due to leakage from a massive chemical waste dump near the elementary school.
  - This was hazardous waste; compounds that are especially dangerous to the environment and human health.

23

Laws and Regulation

- A series of laws were passed in response to the modern environmentalism movement.
  - The Clean Air Act (1963), which restricts pollution of the atmosphere.
  - The Clean Water Act (1972), which restricts pollution of surface waters.
  - The Endangered Species Act (1973), which lists species at risk for extinction and plans for their recovery.
  - The Safe Drinking Water Act (1974), which regulates the testing and contents of municipal tap water.
  - The Resource Conservation and Recovery Act (1976), which describes rules for handling toxic and hazardous waste.
  - The creation of the Environmental Protection Agency (EPA) (1970), which is charged with enforcing these and other laws.

24

Post-Environmentalism

- Many of those same environmental issues persist today, but are increasingly complex to deal because they are spread throughout the entire world, not just a single country.
  - Global warming
  - Population control
  - Water scarcity
  - Resource depletion
  - Loss of biodiversity

25

The Demographic Divide

- One of the biggest challenges is dealing with environmental issues in developing countries that have not yet fully industrialized.
- Compared to developed countries, developing countries tend to have:
  - Lower gross domestic product (GDP), a measure of the monetary value of the goods and services produced.
  - Higher total fertility rates, the number of children born to an average woman.
  - Lower life expectancy, the number of years an average person will live.
  - Fewer environmental regulations and worker protections.

26

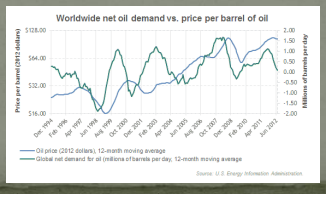
	U.S.	Japan	India	Haiti
Life Expectancy	79	83	66	62
Total Fertility Rate (births per woman)	1.93	1.39	2.56	3.35
Gross Domestic Product Per Person	$49,040	$34,830	$4,500	$1,490
Energy Use Per Person (Kilowatt-Hours)	13,240	7,841	698	31
Carbon Dioxide Produced Annually Per Person (Tons)	17.0	9.3	1.7	0.2

- While developed countries have a slower population growth rate, they have a much higher rate of consumption, the rate of use of natural resources.

27

Economics and the Environment

- Economic principles has a huge influence in environmental decision-making.
- Supply and demand predicts that the cost of a resource will increase when demand is high or supply is low.



28

- Another important economic idea is the cost-benefit analysis. This questions whether the benefit of doing something justifies the economic cost.
- Many companies use labor in developing countries as a way to reduce their own costs of production and the final price tag of their products.
  - The workers in these countries often face dangerous working conditions. These are hidden costs not reflected in what we pay for the item.

A collapsed garment factory in Savar, Bangladesh. Source: AP

29

- A good example is the 1984 explosion of a pesticide factory located near the town of Bhopal, India.
  - Environmental regulations, worker protections, and government inspections were minimal.
- Chemicals that leaked into the air resulted in an immediate death toll in the thousands.
  - A total of 558,125 injuries were reported to the Indian government.
- A settlement of $470 million was reached by Union Carbide and the Indian government, although originally $3.3 billion was claimed.

30

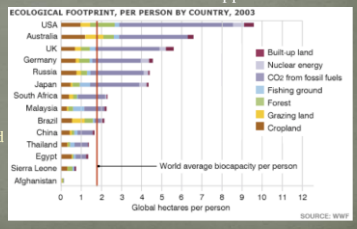
- In 2004, on the 20th anniversary of the Bhopal disaster, the Yes Men performed an elaborate prank to increase awareness of the still-unremediated Union Carbide site.

https://www.youtube.com/watch?v=LiWlvBrogeI

31

Ecological Footprint

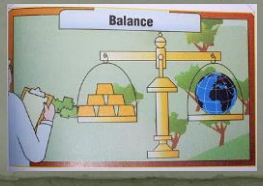
- The impact of a person on the environment is expressed as ecological footprint, an estimate of the amount of land needed to support their lifestyle.
  - If the developing countries industrialized and matched the resource consumption rate of the United States, an estimated 3 Earths would be needed.



32

Environmental Worldviews

- There are three perspectives in how we should deal with issues of pollution, resource overconsumption, and loss of biodiversity.
- The planetary management worldview takes the perspective that humans should manage the Earth's resources to achieve the maximum benefit.



33

- The stewardship worldview also believes that humans should manage the Earth, but in a more ethical and sustainable way.
  - Also anthropogenic, but with more of an emphasis on living such a way that human needs can be met indefinitely. This is called sustainability.

34

- The environmental wisdom worldview believes that we are totally dependent on nature and should preserve nature as much as possible to maintain our own species.
  - An ecocentric worldview that emphasizes sustainability for all species.

The Wat Pa Luang Ta Bua Temple in Thailand, where orphan Bengal tigers and their offspring are cared for.

35

- Each of these worldviews acknowledges that the Earth is a closed system, meaning matter does not enter or leave it in large amounts.
  - Resources are finite.
  - Wastes do not "go away".
- These understandings form the basis for understanding and solving each of the issues within environmental science.

Earthrise, taken by astronaut Frank Borman in 1968, during the Apollo 8 mission.

36