


Lesson 2. Population Dynamics



**Or ...
Health, Disease &
Population Growth**

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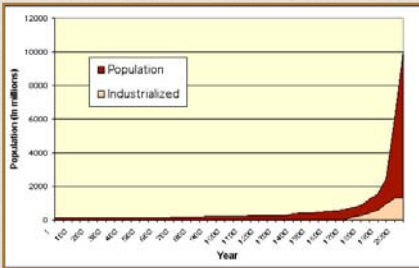
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Lesson 2 Overview

- ❖ Human population growth
- ❖ Limiting Factors
- ❖ Is Disease a limiting factor?
- ❖ Who is responsible for disease?
- ❖ Consequences of human population growth

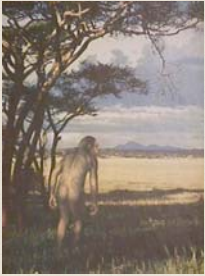
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World Population Trend



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Needs for Survival



Human life requires:

- Air
- Food
- Water
- Habitat

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Early Humans




❖ Hunting & gathering lifestyle provides:

- > A limited diet
- > For small bands
- > Use of a limited range
 - But, the range could change due to environmental or other pressures

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Advent of Agriculture



❖ Supported larger populations

❖ Farmers are stationary

❖ Motive for Trade

❖ Stockpiling food supplies

❖ Vulnerability of food supplies

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Consequences



- ❖ Water supplies
 - > Source(s)
 - > Contamination
- ❖ Sewage disposal
- ❖ Solid waste disposal
- ❖ Rodent food

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Animal Husbandry



- ❖ Close relationship
- ❖ Proximity to zoonotic (animal) diseases
- ❖ Food preparation and storage becomes an issue

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Zoonotic Diseases

Table 3.1 Examples of Diseases that Human Populations Probably Contracted from Domesticated Animals

Human Disease	Animal with most closely related pathogen
Measles	Cattle (Rinderpest)
Tuberculosis	Cattle
Smallpox	Cattle (cowpox), Etc.
Influenza	Pigs and Ducks
Pertusis	Pigs and Dogs
Malaria (falciparum)	Birds (Chickens & Ducks?)

Source: Diamond J. Gurs, *Germs and Steel*, 1997

Zoonotic Diseases

Table 3.2 Number of Diseases that Human Populations Share with Domesticated Animals

Poultry	26
Rodents	32
Horse	35
Pig	42
Sheep/Goats	46
Cattle	50
Dog	65

Source: McNeil WH. *Plagues and People*, 1977

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Cooperative Labor



- ❖ An assured food supply leads to:
 - > Larger populations possible
 - > Specialization
 - > Organization of society
 - > In turn leads to . . .

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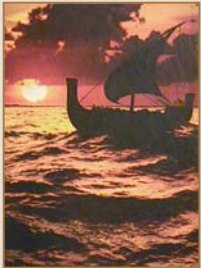
Development of Cities



- ❖ New Problems with
 - > Food Supplies
 - > Water Supplies
 - > Wastewater treatment/disposal
 - > Garbage disposal

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Trade



- ❖ Links previously unlinked peoples
- ❖ Leads to Trade Routes
 - > Roads
 - > River and Ocean travel
- ❖ Speeds and Facilitates spread of pathogens

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War



- ❖ Large concentrations of men
- ❖ Tends to follow Trade Routes
 - > Roads
 - > River and Ocean travel
- ❖ Speeds and Facilitates spread of pathogens

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Völkerwanderungen



- ❖ Movement of large people groups
- ❖ Europe from the collapse of the Roman Empire to the Middle Ages
- ❖ Contact with previously unknown
 - > Peoples, and
 - > Their pathogens

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Personal Actions



- ❖ Clothing
 - > Protects skin against the elements and some vectors
 - > Provides harborage for other vectors
- ❖ Religious Rites
 - > Concentrates people
 - > May encourage unsanitary practices
 - > Pilgrimages

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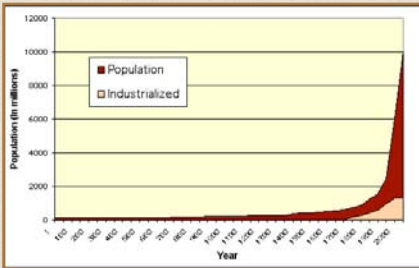
Urbanization



- ❖ Concentrates People
- ❖ Public Works
 - > More people = More projects
 - > Seasonal migration of workers
- ❖ Facilitates spread of pathogens

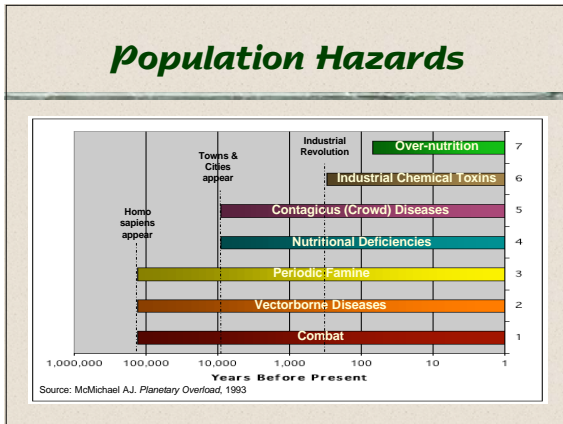
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World Population



The graph shows world population (in billions) on the y-axis (0 to 12,000) and year on the x-axis (1000 to 2000). The population curve shows a sharp exponential increase starting around 1800, reaching approximately 6 billion by 2000. The industrialized population curve shows a similar sharp increase starting around 1800, reaching approximately 1 billion by 2000.

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- ### Population Constraints
- ❖ Food Supply (Agriculture)
 - ❖ Water
 - ❖ Security (War or Conflict)
 - ❖ Fertility
 - ❖ Disease
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- ### Two Theses
- ❖ Disease is an important population constraint.
 - ❖ Unchecked population growth, combined with increasing levels of consumption and technology can threaten our environment.
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Thesis 1

Disease has played an important, but often unrecognized role in human development

"In the course of many years of pre-occupation with infectious diseases, . . . , we have become increasingly impressed with the importance -- almost entirely neglected by historians and sociologists -- of the influence of these calamities upon the fate of nations, indeed on the rise and fall of civilizations."

Hans Zinsser, 1935
In *Rats, Lice & History*

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Disease




- ❖ Infectious diseases evolved with human populations
 - Infectivity
 - Pathogenicity
 - Virulence
- ❖ Evolution continues

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Ancient Diseases

- ❖ *The Great Herbal* (~3,000 BCE)



- ❖ Plagues
 - E.g., The Ten Plagues of Egypt (~1,500 BCE)
- ❖ William McNeill, *Plagues & People*

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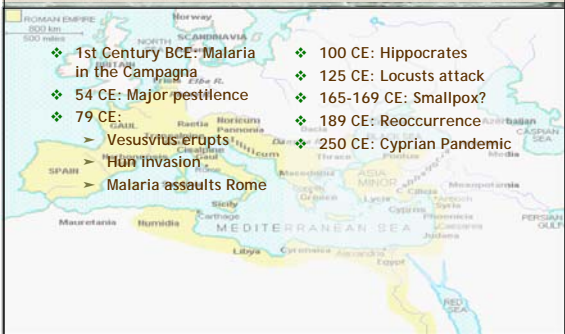
The Classical Period



- ❖ 1,141 BCE: Possibly first record of bubonic plague (1 Samuel 4)
- ❖ 900 BCE: The Great Pestilence
- ❖ 430 BCE: Typhus Outbreak in Greece


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The Roman Empire



- ❖ 1st Century BCE: Malaria in the Campagna
- ❖ 54 CE: Major pestilence
- ❖ 79 CE:
 - > Vesuvius erupts
 - > Hun invasion
 - > Malaria assaults Rome
- ❖ 100 CE: Hippocrates
- ❖ 125 CE: Locusts attack
- ❖ 165-169 CE: Smallpox?
- ❖ 189 CE: Reoccurrence
- ❖ 250 CE: Cyprian Pandemic

Europe: The Middle Ages



- ❖ 1250: Little Ice Age
- ❖ 1320s: Bubonic plague emerges
- ❖ 1347 - 1352: "The Black Death"
- ❖ 1600s: Bubonic Plague pandemic

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Medieval Europe



- ❖ Walled Towns
- ❖ Little trade
- ❖ Little learning
- ❖ Disease, hunger
- ❖ Primitive medical practices

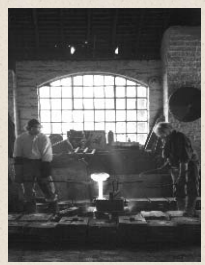
The 19th Century



- ❖ Age of Optimism
- ❖ Industrialization
- ❖ Rising Prosperity
- ❖ Trade
- ❖ Colonialism

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19th Century (Continued)



- ❖ Exploitation of natural resources
- ❖ Waste Generation
- ❖ Pollution
- ❖ Occupational hazards
- ❖ Chronic diseases

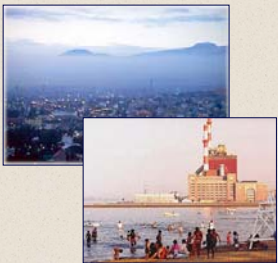
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Elsewhere in the World

- ❖ 1331: China: Bubonic Plague
- ❖ ~1519: Smallpox conquers Mexico
- ❖ 1520: Malaria arrives in North America
- ❖ 1620: Pilgrims land Plymouth Rock
- ❖ 1630: Measles hits Massachusetts
- ❖ 1740: Smallpox arrives in the Pacific Northwest

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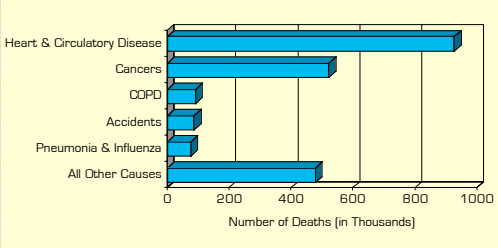
The 20th Century



- ❖ Increasing industrialization
 - > Increases to match population/demands
 - > Increased waste and pollution
 - > Global impacts

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Late 20th Century Diseases




Cause	Number of Deaths (in Thousands)
Heart & Circulatory Disease	~950
Cancers	~550
Other Causes	~500
Accidents	~100
Pneumonia & Influenza	~100
COPD	~100

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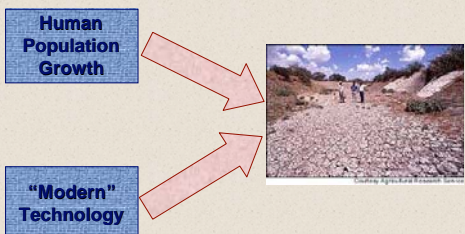
Thesis 2

Environmental threat results from:

1. Increased Population
2. "Modern" Technology



Threats to the Environment



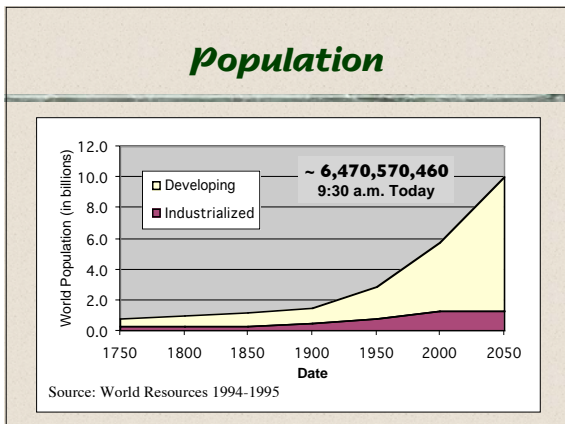
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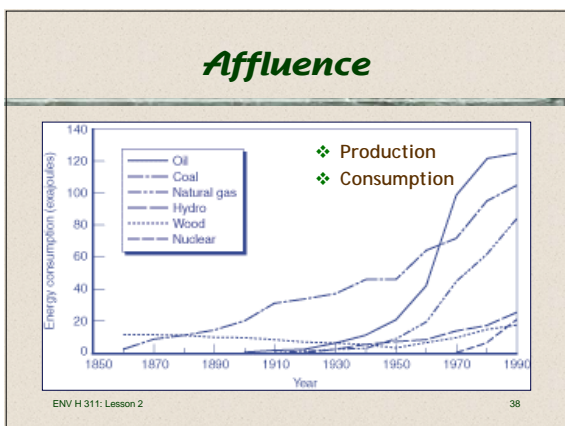
Environmental Threat



I = P x A x T

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The Basic Question

- ❖ Are there limits to growth? . . .
- ❖ Both in terms of:
 - the total number of people that can be supported on this planet, and
 - the use of materials and environmental resources necessary to sustain them.


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Limits to Growth ?

- ❖ Malthus & Ricardo
- ❖ Club of Rome
- ❖ Garret Hardin
 - *Tragedy of the Commons*
- ❖ Lester Brown
 - *World Watch*
- ❖ James Lovelock (Gaia)

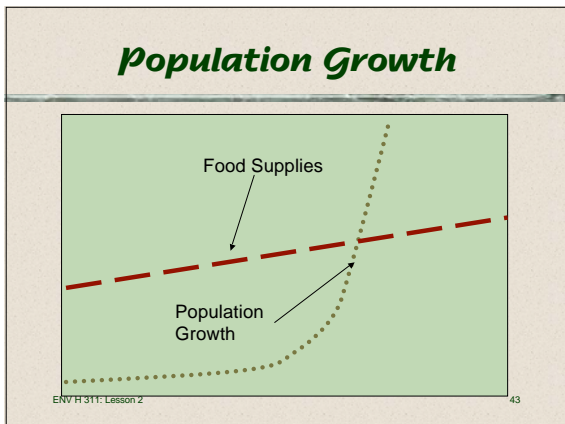
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Thomas Malthus




- ❖ Lived 1766-1834
- ❖ *An Essay on the Principle of Population* (1798)
- ❖ Population Growth is exponential
- ❖ Increase in food supplies is arithmetic.

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David Ricardo



- ❖ British economist
- ❖ Diminishing returns on land cultivation.
- ❖ Suggested the impossibility of a "general glut"
 - > an excess supply of all goods -- in an economy.

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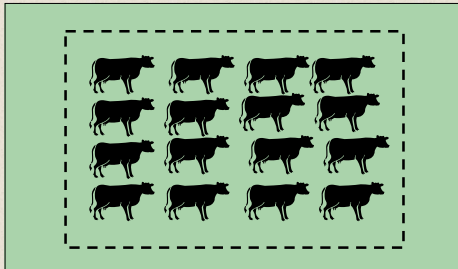
Garret Hardin



- ❖ 1968 essay, *Tragedy of the Commons*
- ❖ In a crowded world with less than perfect humans, free resources will be overused.
- ❖ Ruin is inevitable unless controls are put in place.

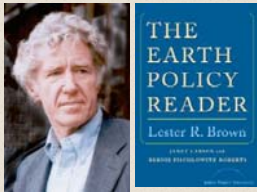
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The "Commons"



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Lester Brown



- ❖ Started the World Watch Institute devoted to the analysis of global environmental issues.

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The Club of Rome



Meadows DH, Meadows DL, Randers J, Behrens W. *The Limits to Growth: A Report to The Club of Rome* (1972).

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Basic Concepts

The Limits to Growth
Lane Co. Council of Governments, c. 1970

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Questions



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Club of Rome

- ❖ Exponential Growth
- ❖ Five key trends
 - Population Growth
 - Food Production
 - Resource Consumption
 - Industrial Production
 - Pollution

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Conclusions of TLG Model

- ❖ Within 100 years, society will run out of non-renewable resources leading to a precipitous collapse of the economic system decreased food production and increasing death rate.
- ❖ A piecemeal approach to solving the problem will not work
- ❖ Overshoot and collapse can only be avoided by limiting population and pollution.

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Criticism of the Limits to Growth

- ❖ Pessimistic Assumptions
- ❖ Technological Advances
- ❖ Social and Political Factors
- ❖ The Predictions Haven't Happened Yet

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The Optimist's View

- ❖ . . . 200 years ago almost everywhere human beings were comparatively few, poor and at the mercy of the forces of nature, and 200 years from now, we expect, almost every-where they will be numerous, rich and in control of the forces of nature [p. 1].
 - Kahn H. The Next 200 Years: A Scenario for America and the World, 1976.

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Food


- ❖ Food production is climbing
 - Food/capita is relatively steady in most of the world
 - In Africa food/capita is falling
 - In Europe food/capita is rising
- ❖ 1.5 billion hectares of land under cultivation in 1990
- ❖ 4.0 billion possibly available
- ❖ All would be needed by 2050



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Water

- ❖ Only 10,000 km³ out of 40,000 km³ of fresh water is accessible.
- ❖ 3,000 km³ is polluted and undrinkable
- ❖ Current use ~ 4,000 km³
- ❖ In many places water tables are falling
- ❖ Desalinization of sea water is possible but requires energy



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Natural Resources

- ❖ Oil Reserves:
 - 1971: 16.7 billion barrels/year
 - 1989: 21.4 billion barrels/year
- ❖ Coal Reserves = at least 100 years
- ❖ Metals & Chemicals
 - Abundant: Iron, Aluminum, Titanium
 - Problematic: Copper, Lead, Mercury
- ❖ Extraction efficiency and costs
- ❖ Recycling & efficient use



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Industrialization


- ❖ Is growing exponentially (GNP)
- ❖ Use energy, materials, water
- ❖ Creates pollution
- ❖ Two options:
 - Industrial growth needs to stop
 - New technologies needed to decrease resource needs and pollution



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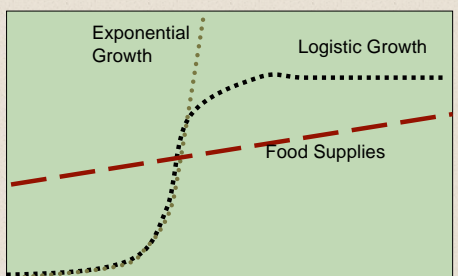
Pollution

- ❖ Pollution increases with
 - population growth, and
 - Industrialization
- ❖ Environmental pollution continues to climb.
- ❖ Health effects are subtle and difficult to measure



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Logistic Population Growth



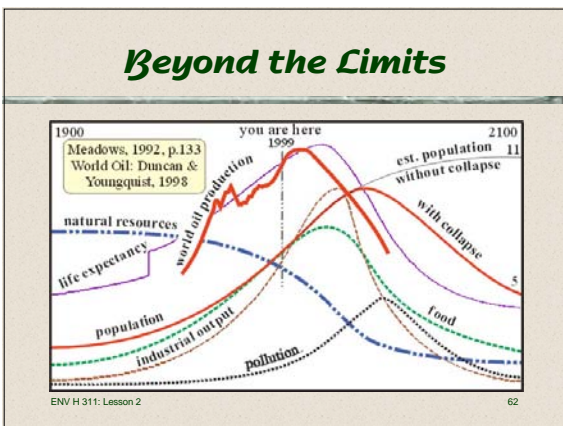
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Technological "Fixes"


- ❖ High-tech farming
- ❖ Solar power
- ❖ Recycling
- ❖ High efficiency production

"Necessity is the mother of invention"

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An Another Twist



- ❖ The Gaia Hypothesis
- ❖ James Lovelock. "Gaia: A New Look at Life on Earth," 1979.
 - Biota not only adapts to its environment, but is also constantly adapting its environment to itself.

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Lesson Summary

- ❖ Human population growth
 - Factors affecting population growth
 - Especially disease
- ❖ Co-evolution of humans and their disease agents
- ❖ $I = P \times A \times T$
- ❖ Are there "Limits to Growth"?

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For Additional Study

- ❖ Readings:
 - Levison D, Mertz E. Health Effects of Population Growth, *Health & Environment Digest*, February 1997 (10(9):65-75.
 - Diamond, Jared, *Guns, Germs and Steel*, W. W. Nolrton & Company, New York, 1997.
 - McMichael, Anthony J., *Human Frontiers, Environments and Disease*, Cambridge University Press, , 2001.

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For Additional Study

- ❖ Video:
 - *Was Malthus Right? Population and Resources in the 21st Century*, Films for the Humanities, 1999
 - *Paul Ehrlich and the Population Bomb*, Films for the Humanities, 1999
- ❖ Web sites:
 - <http://home.nycap.rr.com/history/populate.html>
 - http://www.wri.org/wri/wr-96-97/hd_txt1.html
- ❖ Readings:
 - Meadows DH, Meadows DL, Randers J. "Beyond the Limits to Growth," *In Context*, 1992, No. 32.
 - Epstein PR. Is Global Warming Harmful to Health?, *Scientific American*, 283(2):50-57

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For Additional Study

❖ Video:

- *Principles of Ecology* (Part 3 on cities), Films for the Humanities, 1995
- *Health in the City*, WHO,

❖ Web sites:

- http://www.wri.org/wri/wr-96-97/hd_txt1.html

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Next Lesson

Epidemiology

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