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**This lecture will help you understand:**

- The meaning of the term environment
- The importance of natural resources
- That environmental science is interdisciplinary
- The scientific method and how science operates
- Some pressures facing the global environment
- Sustainability and sustainable development



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**Environment: the total of our surroundings**

- All the things around us with which we interact:
  - Living things
    - Animals, plants, forests, fungi, etc.
  - Nonliving things
    - Continents, oceans, clouds, soil, rocks
  - Our built environment
    - Buildings, human-created living centers
  - Social relationships and institutions

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## Humans and the world around us

- Humans change the environment, often in ways not fully understood
- We depend completely on the environment for survival
  - Increased wealth, health, mobility, leisure time
  - But, natural systems have been degraded
    - i.e., pollution, erosion and species extinction
  - Environmental changes threaten long-term health and survival
- **Environmental science** is the study of:
  - How the natural world works
  - How the environment affects humans and vice versa

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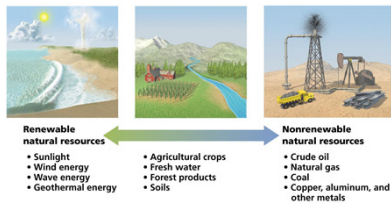
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## Natural resources: vital to human survival

**Natural resources** = substances and energy sources needed for survival



- **Renewable resources:**
  - Perpetually available: sunlight, wind, wave energy
  - Renew themselves over short periods: timber, water, soil
  - These can be destroyed
- **Nonrenewable resources:** can be depleted
  - Oil, coal, minerals

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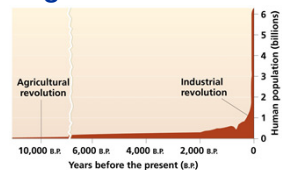
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## Global human population growth

- More than 6.7 billion humans
- Why so many humans?
  - Agricultural revolution
    - Stable food supplies
  - Industrial revolution
    - Urbanized society powered by fossil fuels
    - Sanitation and medicines
    - More food



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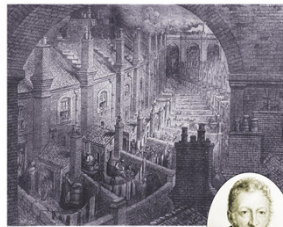
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## Thomas Malthus and human population

- Thomas Malthus
  - Population growth must be restricted, or it will outstrip food production
  - Starvation, war, disease
- Neo-Malthusians
  - Population growth has disastrous effects
  - Paul and Anne Ehrlich, *The Population Bomb* (1968)



(a) 18th-century London, England



(b) Thomas Malthus

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## Garrett Hardin's Tragedy of the Commons

- Unregulated exploitation leads to resource depletion
  - Soil, air, water
- Resource users are tempted to increase use until the resource is gone
- Solution?
  - Private ownership?
  - Voluntary organization to enforce responsible use?
  - Governmental regulations?

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## The "ecological footprint"

- The environmental impact of a person or population
  - Amount of biologically productive land + water
  - for raw materials and to dispose/recycle waste
- **Overshoot:** humans have surpassed the Earth's capacity



*We are using 30% more of the planet's resources than are available on a sustainable basis!*

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## Environmental science

... can help us avoid mistakes made by past civilizations.



*The lesson of Easter Island: people annihilated their culture by destroying their environment. Can we act more wisely to conserve our resources?*

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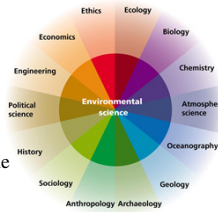
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## Environmental science: how does the natural world work?

Environment ← impacts → Humans

- It has an applied goal: developing solutions to environmental problems
- An interdisciplinary field
  - Natural sciences: information about the world
    - Environmental Science programs
  - Social sciences: values and human behavior
    - Environmental Studies programs



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## What is an “environmental problem”?

- The perception of what constitutes a problem varies between individuals and societies
- Ex.: DDT, a pesticide
  - In developing countries: welcome because it kills malaria-carrying mosquitoes
  - In developed countries: not welcome, due to health risks



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## Environmental science is not environmentalism

### •Environmental science

- The pursuit of knowledge about the natural world
- Scientists try to remain objective

### •Environmentalism

- A social movement dedicated to protecting the natural world



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## The nature of science

### • Science:

- A systematic process for learning about the world and testing our understanding of it
- A dynamic process of observation, testing, and discovery
- The accumulated body of knowledge that results from this process

### • Science is essential

- To sort fact from fiction
- Develop solutions to the problems we face

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## Applications of science

Policy decisions and management practices



(a) Prescribed burning

Technology



(b) Methanol-powered fuel-cell car  
Energy-efficient methanol-powered fuel cell car from DaimlerChrysler

Restoration of forest ecosystems altered by human suppression of fire

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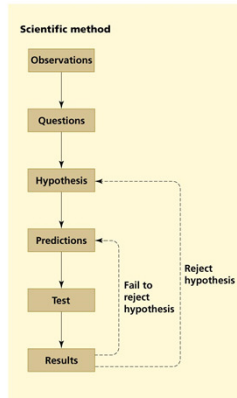
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## The scientific method

- A technique for testing ideas with observations
- Assumptions:
  - The universe works according to unchanging natural laws
  - Events arise from causes, and cause other events
  - We use our senses and reason to understand nature's laws



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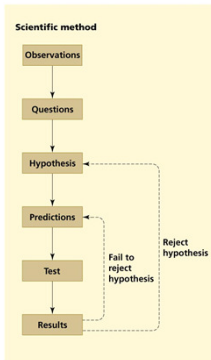
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## The scientific method



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- A scientist makes an **observation** and asks **questions** of some phenomenon
- The scientist formulates a **hypothesis**, a statement that attempts to explain the scientific question.
- The hypothesis is used to generate **predictions**, which are specific statements that can be directly and unequivocally **tested**.
- The test **results** either support or reject the hypothesis

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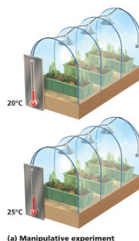
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## Experiments test the validity of a hypothesis

**Manipulative experiments** yield the strongest evidence

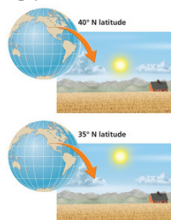
- But, lots of things can't be manipulated



(a) Manipulative experiment

**Natural or correlational** tests show real-world complexity

- Results are not so neat and clean, so answers aren't simply black and white



(b) Natural experiment, or correlational study

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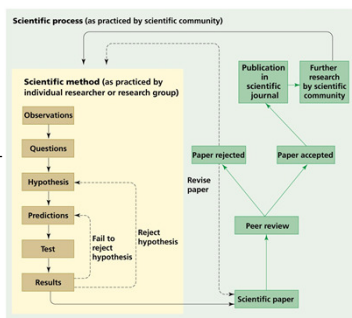
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## The scientific process is part of a larger process

- The scientific process includes peer review, publication, and debate
- A consistently supported hypothesis becomes a **theory**, a well-tested and widely accepted explanation
- With enough data, a **paradigm shift** – a change in the dominant view – can occur



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## Population & consumption

- Human population growth exacerbates all environmental problems
  - *The growth rate has slowed, but we still add more than 200,000 people to the planet each day*
- Our consumption of resources has risen even faster than our population growth.
  - Life has become more pleasant for us so far
  - However, rising consumption amplifies the demands we make on our environment.

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## Ecological footprints are not all equal

- The ecological footprints of countries vary greatly
  - The U.S. footprint is almost 5 times greater than the world's average
  - Developing countries have much smaller footprints than developed countries



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### We face challenges in agriculture

- Expanded food production led to increased population and consumption
- It's one of humanity's greatest achievements, but at an enormous environmental cost
  - Nearly half of the planet's land surface is used for agriculture
    - Chemical fertilizers
    - Pesticides
    - Erosion
    - Changed natural systems

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### We face challenges in pollution

- Waste products and artificial chemicals used in farms, industries, and households



*Each year, millions of people die from pollution*

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### We face challenges in climate

- Scientists have firmly concluded that humans are changing the composition of the atmosphere
- The Earth's surface is warming
  - Melting glaciers
  - Rising sea levels
  - Impacted wildlife and crops
  - Increasingly destructive weather

*Since the Industrial Revolution, atmospheric carbon dioxide concentrations have risen by 37%, to the highest level in 650,000 years*

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### We face challenges in biodiversity

- Human actions have driven many species extinct, and biodiversity is declining dramatically
  - We are at the onset of a mass extinction event



*Biodiversity loss may be our biggest environmental problem; once a species is extinct, it is gone forever*

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### The Millennium Ecosystem Assessment

- The most comprehensive scientific assessment of the condition of the world's ecological systems
- Major findings:
  - Humans have drastically altered ecosystems
  - These changes have contributed to human well-being and economic development, but at a cost
  - Environmental degradation could get much worse
  - Degradation can be reversed, but it requires work

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### Our energy choices will affect our future

- The lives we live today are due to fossil fuels
  - Machines
  - Chemicals
  - Transportation
  - Products
- Fossil fuels are a one-time bonanza; supplies will certainly decline

*We have used up 1/2 of the world's oil supplies; how will we handle this imminent fossil fuel shortage?*

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### Sustainable solutions exist

- We must develop solutions that protect both our quality of life and the environment
- Organic agriculture
- Technology
  - Reduces pollution
- Biodiversity
  - Protect species
- Waste disposal
  - Recycling
- Alternative fuels



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### Are things getting better or worse?

- Many people think environmental conditions are better
  - **Cornucopians:** Human ingenuity will solve any problem
- Some think things are much worse in the world
  - **Cassandras:** predict doom and disaster
- How can you decide who is correct?
  - Are the impacts limited to humans, or are other organisms or systems involved?
  - Are the proponents thinking in the long or short term?
  - Are they considering all costs and benefits?

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### Sustainability: a goal for the future

- How can humans live within the planet's means?
  - Humans cannot exist without functioning natural systems
- **Sustainability**
  - Leaves future generations with a rich and full Earth
  - Conserves the Earth's natural resources
  - Maintains fully functioning ecological systems
- **Sustainable development:** the use of resources to satisfy current needs without compromising future availability of resources

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## Will we develop in a sustainable way?

- The **triple bottom line**: sustainable solutions that meet
  - Environmental goals
  - Economic goals
  - Social goals
- Requires that humans apply knowledge from the sciences to
  - Limit environmental impacts
  - Maintain functioning ecological systems



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## Conclusion

- Environmental science helps us understand our relationship with the environment and informs our attempts to solve and prevent problems.
- Identifying a problem is the first step in solving it
- Solving environmental problems can move us towards health, longevity, peace and prosperity
  - Environmental science can help us find balanced solutions to environmental problems

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## QUESTION: Review



The term “environment” includes

- a) Animals and plants
- b) Oceans and rivers
- c) Soil and atmosphere
- d) All of the above are included in this term

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**QUESTION: Review**



Which of the following is correct about the term “environmentalism”?

- a) It is very science-oriented
- b) It is a social movement to protect the environment
- c) It usually does not include advocacy for the environment
- d) It involves scientists trying to solve environmental problems

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**QUESTION: Review**



Adding various amounts of fertilizer to plants in a laboratory is a \_\_\_\_\_ type of experiment

- a) Correlative
- b) Natural
- c) Manipulative
- d) Rare

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**QUESTION: Review**



What is the definition of “sustainable development”?

- a) Using resources to benefit future generations, even if it means lower availability now
- b) Letting future generations figure out their own problems
- c) Using resources to satisfy current needs without compromising future availability
- d) Letting each country decide what is its best interest

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### QUESTION: Weighing the Issues



Which do you think is the best way to protect commonly owned resources (i.e., air, water, fisheries)?

- a) Sell the resource to a private entity
- b) Voluntary organizations to enforce responsible use
- c) Governmental regulations
- d) Do nothing and see what happens

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### QUESTION: Weighing the Issues



Do you think the rest of the world can have an ecological footprint as large as the footprint of the United States?

- a) Yes, because we will find new technologies and resources
- b) Yes, because the footprint of the United States is not really that large
- c) Definitely not; the world does not have that many resources
- d) It does not matter; it's not that important

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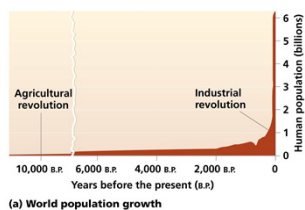
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### QUESTION: Interpreting Graphs and Data



According to this graph, what has happened to the population over the last 500 years?



- a) It has grown exponentially
- b) It has grown linearly
- c) It has decreased
- d) It has slowed down recently

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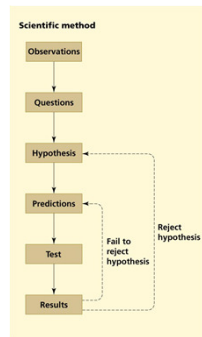
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### QUESTION: Interpreting Graphs and Data



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What happens if test results reject a hypothesis?

- a) The scientist formulates a new hypothesis
- b) It shows the test failed
- c) The hypothesis was supported
- d) The predictions may not have been correct

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