



## Chapter 1

# Studying the State of Our Earth

How we can connect to  
humans to make a  
difference.

<https://www.cnn.com/2019/07/10/world/antarctica-ice-sheet-sea-levels-trnd/index.html>

# Environmental Science Offers Important Insights Into Our World and how We Influence It

1. **Social Consequence**

2. **Economic Consequence**

3. **Environmental Consequence**

Social consequence is a connection to human activities such as GMO's, climate change, pollution, resource depletion, species protection, global warming...etc

**We manipulate the environment MORE than any other species** (ex. Pfiesteria increase due to dumping waste (nutrients) into the river, causing loss of marine life)!!!



**Impact of Human on Earth...converting land from its natural state (ex). Housing development**



**Other events that increase human impact...advances in technology and use of tools for hunting.**





In 1880, fewer than 6,000 people lived in LA

**Figure 1.3a**  
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By 2009, LA had a population of 3.8 million people



**Figure 1.3b**  
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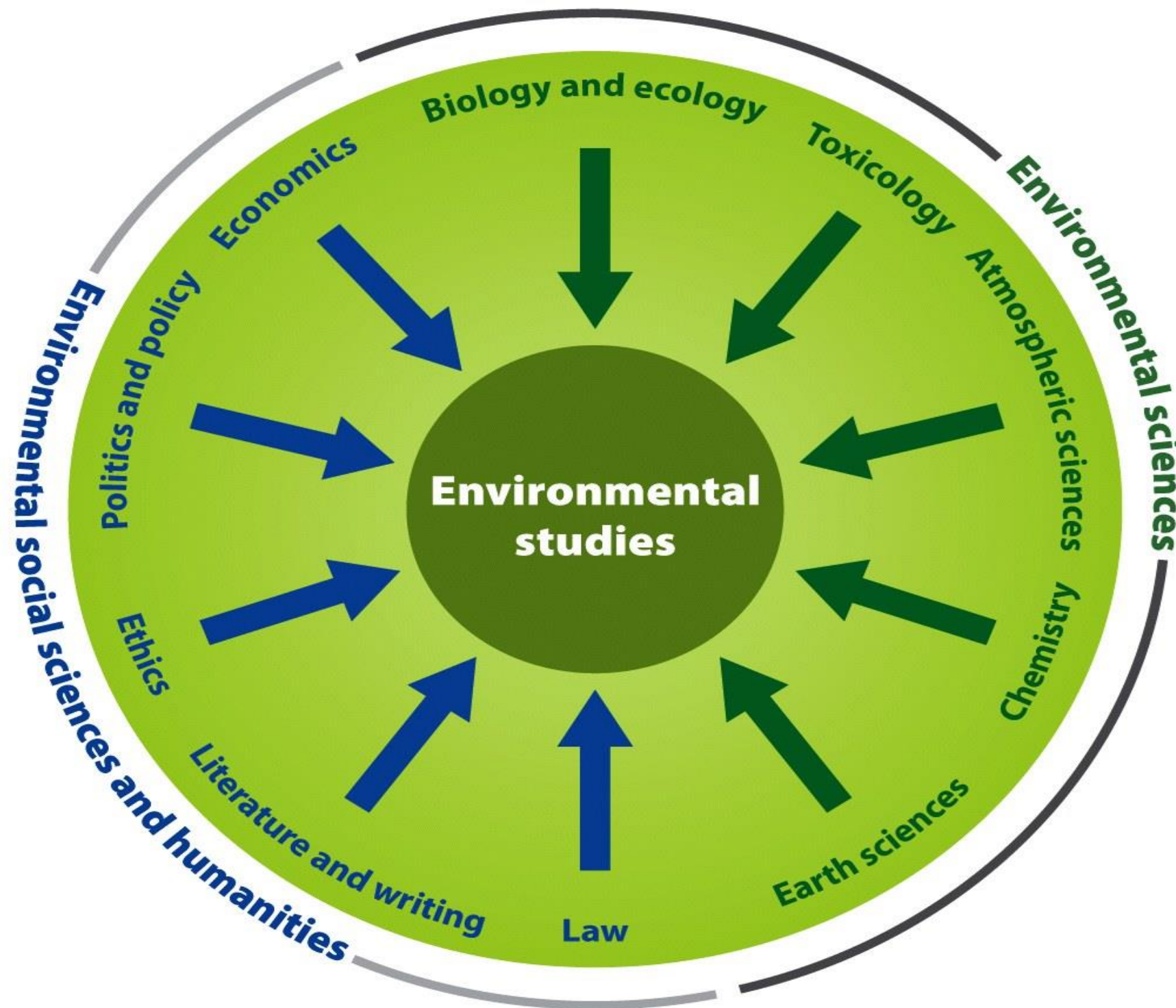


Figure 1.1  
Environmental Science  
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Social & lab-based science.

*As human activities continue to affect the environment, environmental science can help us understand the consequences of our interactions with our planet and make better decisions about our actions.*

**Environmental science**- the field that looks at interactions among humans and nature (methods of science).

**Challenge** is most research *does not have a baseline/control standard* to compare too. Ex. concentrations of CO<sub>2</sub> before humans existed

- **Environment**- a sum of all the conditions surrounding us that influence life.
- **Environmentalism** – is involved in a social movement
- **System**- a set of interacting components that influence one another by exchanging energy or materials.
- **Ecosystem**- the living and non-living components of a particular place on earth.

- **Biotic**- the **living part** of the Earth (animals, plants)
- **Abiotic**- the **non-living part** of the Earth (soil, air, water)
- **Environmental studies**- includes environmental science, **the study of interactions among human systems and those found in nature** along with other subjects such as environmental policy, economics, literature and ethics.



# Environmental Scientists Monitor Natural Systems for Signs of Stress

- **Ecosystem services**- environments provide life supporting services (*we take for granted in the States*) such as ....

- Clean water
- Timber for infrastructure
- Fisheries &/or game animals
- Good soil for agriculture

- **Sustainability**- living on the Earth in a way that allows us to use its resources without depriving future generations of those resources.

- **Environmental indicators- describe the current state of quality & health of the environment/natural systems (5 indicators)...**

- **Can be used to analyze and help us describe the current state/health of an natural environmental systems**



**TABLE 1.2** Five key global environmental indicators

Indicator	Recent trend	Outlook for future	Overall impact on environmental quality
1. Biological diversity	Large number of extinctions, extinction rate increasing	Extinctions will continue	Negative
2. Food production support	Per capita production possibly	Unclear leveling off	May affect the number of people Earth can support
3. Average global surface temperature and CO <sub>2</sub> concentrations	CO <sub>2</sub> concentrations and temperatures increasing	Probably will continue to increase, at least in the short term	Effects are uncertain and varied, but probably detrimental
4. Human population	Still increasing, but growth rate slowing	Population leveling off Resource consumption rates are also a factor	Negative
5. Resource depletion	Many resources are being depleted at rapid rates. But human ingenuity frequently develops "new" resources, and efficiency of resource use is increasing in many cases	Unknown	Increased use of most resources has negative effects

**Table 1.2***Environmental Science*

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# 1. Biological Diversity

- **Biodiversity**- the **diversity of life** formed in an environment
- **Biological diversity exist on 3 scales...**  
*genetic, species and ecosystem* diversity
- **\*\*\***these scales are important indicators of environmental health and quality



# Genetic Diversity

- A **measure of the genetic variation** among individuals in a population.
  - **Genetic biodiversity improves the ability of a population to cope with environmental change.**
- Populations with **high genetic diversity** are **better able to respond to environmental change (more productive)** than populations with lower genetic variation
- (ex.) **disease resistances** w/in a population of species – some individuals will survive to repopulate the species (less likely to become extinct)

# Species Diversity – critical indicator

- The number of species in a region or in a particular type of habitat.
  - Species serve as environmental indicators of problems on a global scale.
- **Species**– a group of organisms that is distinct from other groups in body form & structure, behavior or biochemical properties.
- Individuals in a species can breed and produce fertile offspring.
- Scientist have estimated **Earth's species range from 5-100 million** (currently approx. 2 million have been classified)



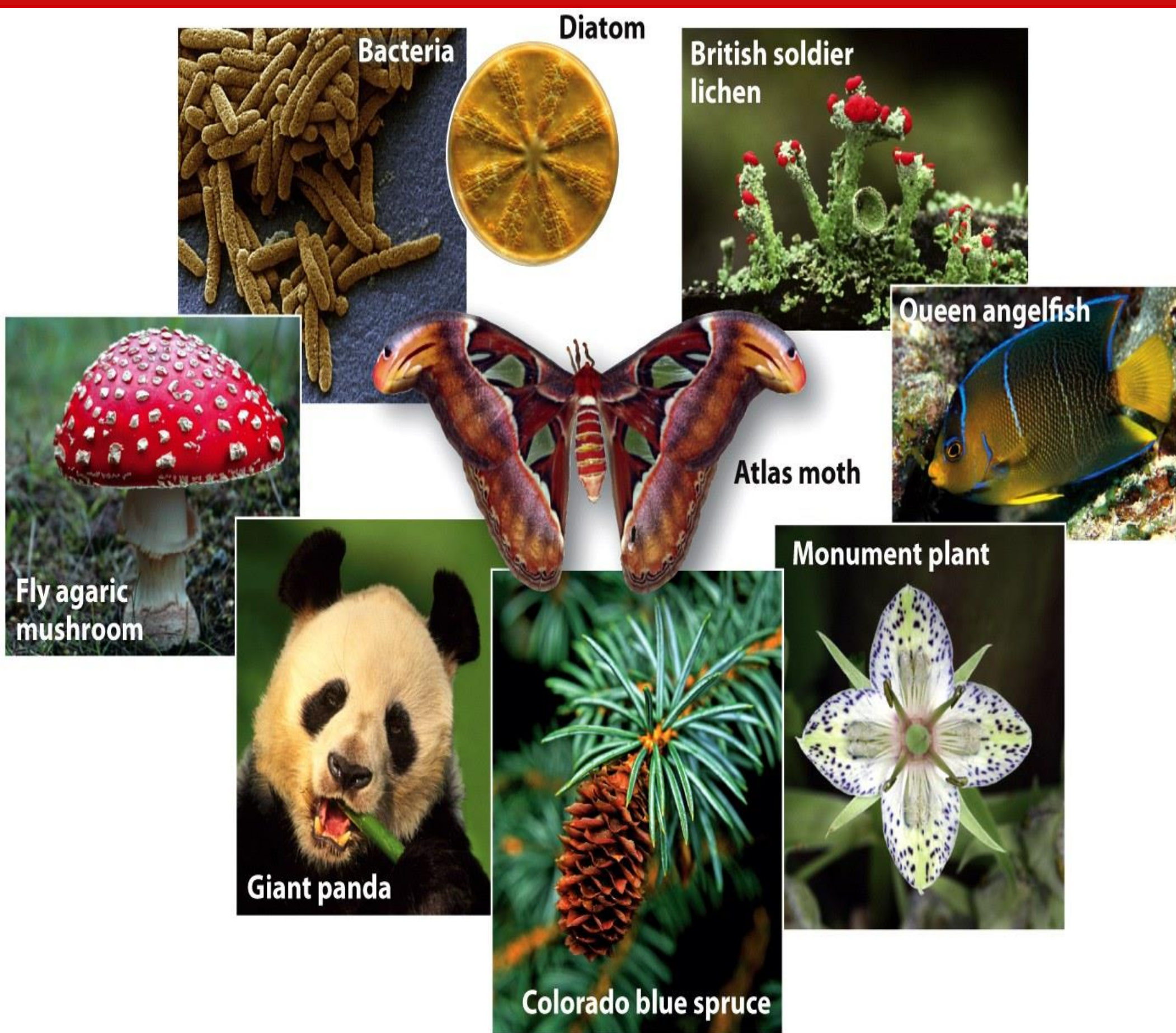
**Replacement Rate**...dependent on biological stress/conditions, **species may go extinct faster than new ones are evolved.**

**Speciation** – **evolution** of **new species** over time (very slow process)

**Background Extinction Rate** – average **rate at which species go extinct** over the long term

**Habitat destruction/degradation** (major cause of extinction today), **climate change, over-harvesting, introduction of new species**...etc are just a few causes of species endangerment and extinctions.





Decrease in species in **one particular ecosystem** may be an environmental problem there (**small scale**).

Species losses in **several ecosystem** can indicate a **larger-scale** environmental problems

# Species Diversity on Earth



# Ecosystem Diversity

- A measure of the **diversity of ecosystems or habitats** that exist in a particular region.

A greater number of healthy and productive (reproduction) ecosystem means a healthier environment overall

## 2. Food Production

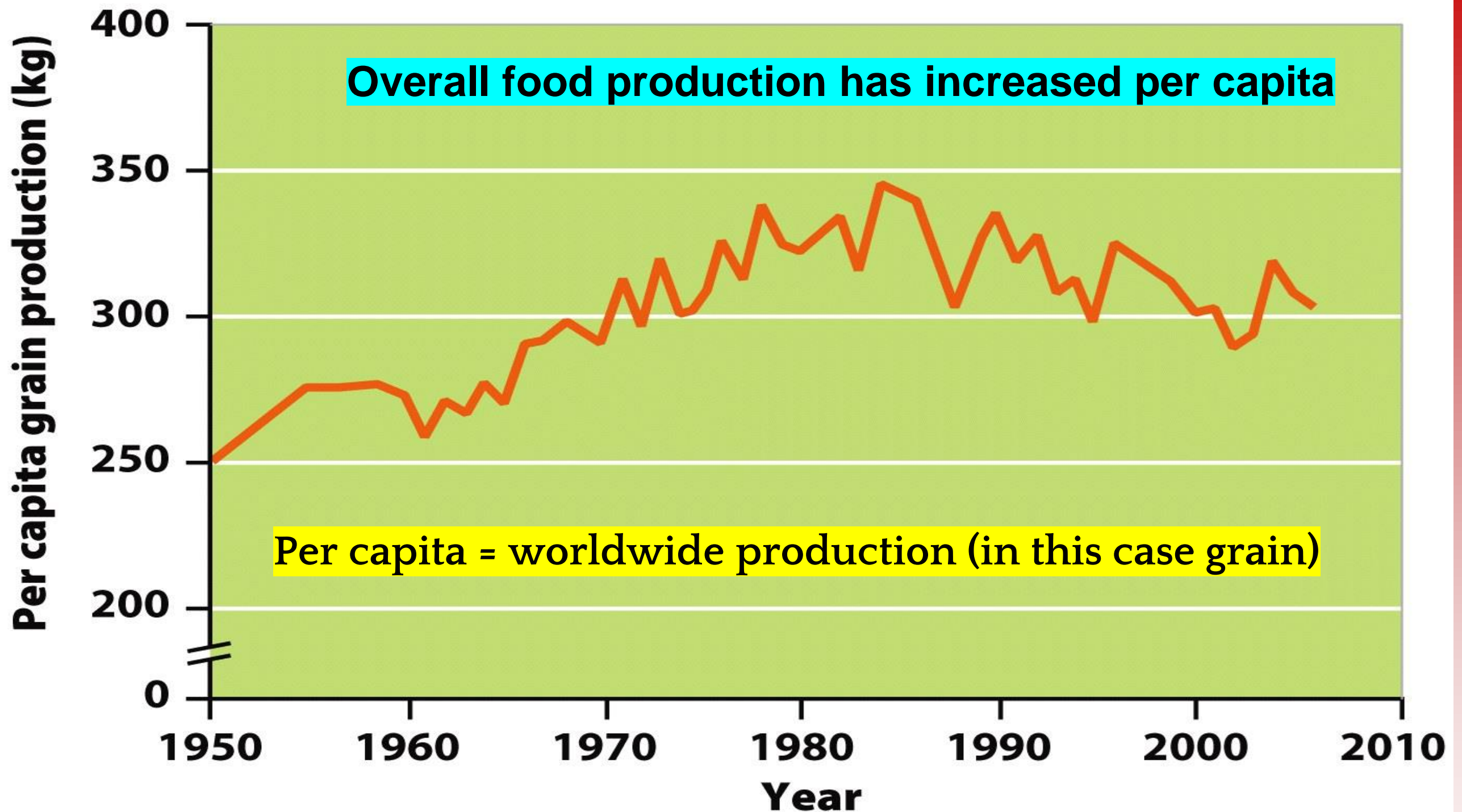
- Our ability to **GROW & DISTRIBUTE** food to nourish the human population

**Healthy soil** supports abundant & continuous food production

- We use science and technology to increase the amount of food we can produce on a given area of land.

The **cultivation of crop** (grain) are influenced by many factors such as...**climatic conditions, amount/quality of land (disease, IPM), irrigation, human labor...etc.**





**Figure 1.6**  
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**In 2008, food shortages around the world lead to higher food prices and in some places riots.**

Some government policies discourage food production and encourage farmers to grow crops for fuels such as ethanol and biodiesel

# 3. Average Global Surface Temperatures and Carbon Dioxide Concentrations

- A **stable Climate** allows for biodiversity & food production possible!!!
- **Greenhouse gases**- gases in our planets atmosphere that act like a blanket, **trapping heat** near Earth's surface (*too much too soon, can hurt us by warming the planet*)
- The most important greenhouse gas is **carbon dioxide**.
- Anthropogenic- caused by human activities.



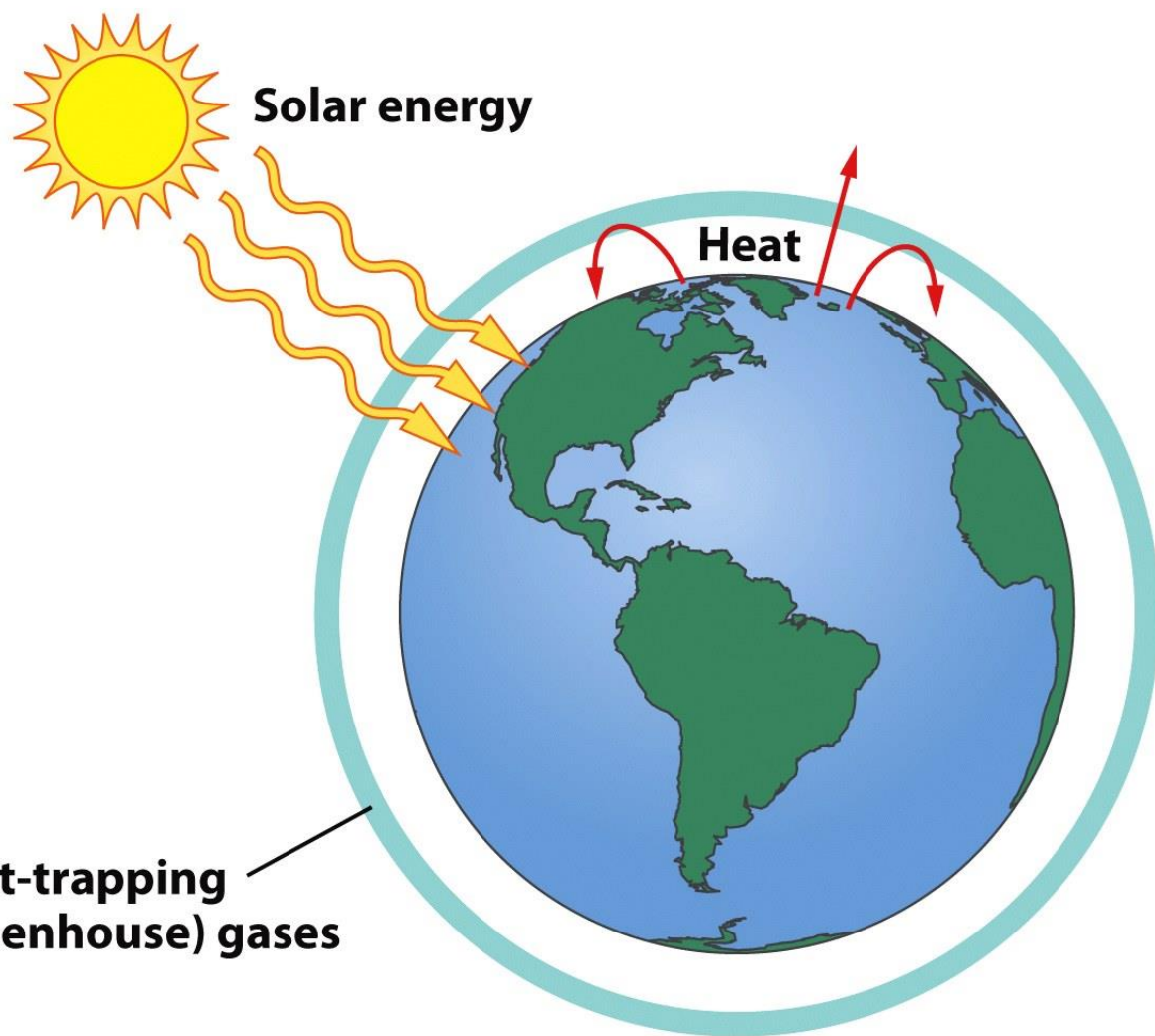


Figure 1.7  
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In the past 2 centuries, CO<sub>2</sub> and greenhouse gases have risen...scientists believe it is **driven by humans (anthropogenic)** caused by combustion of fossil fuels & net loss of forests and other habitats that would take up and store the CO<sub>2</sub>

Many refer to this as **GLOBAL WARMING!!** (drastic changes in climate)

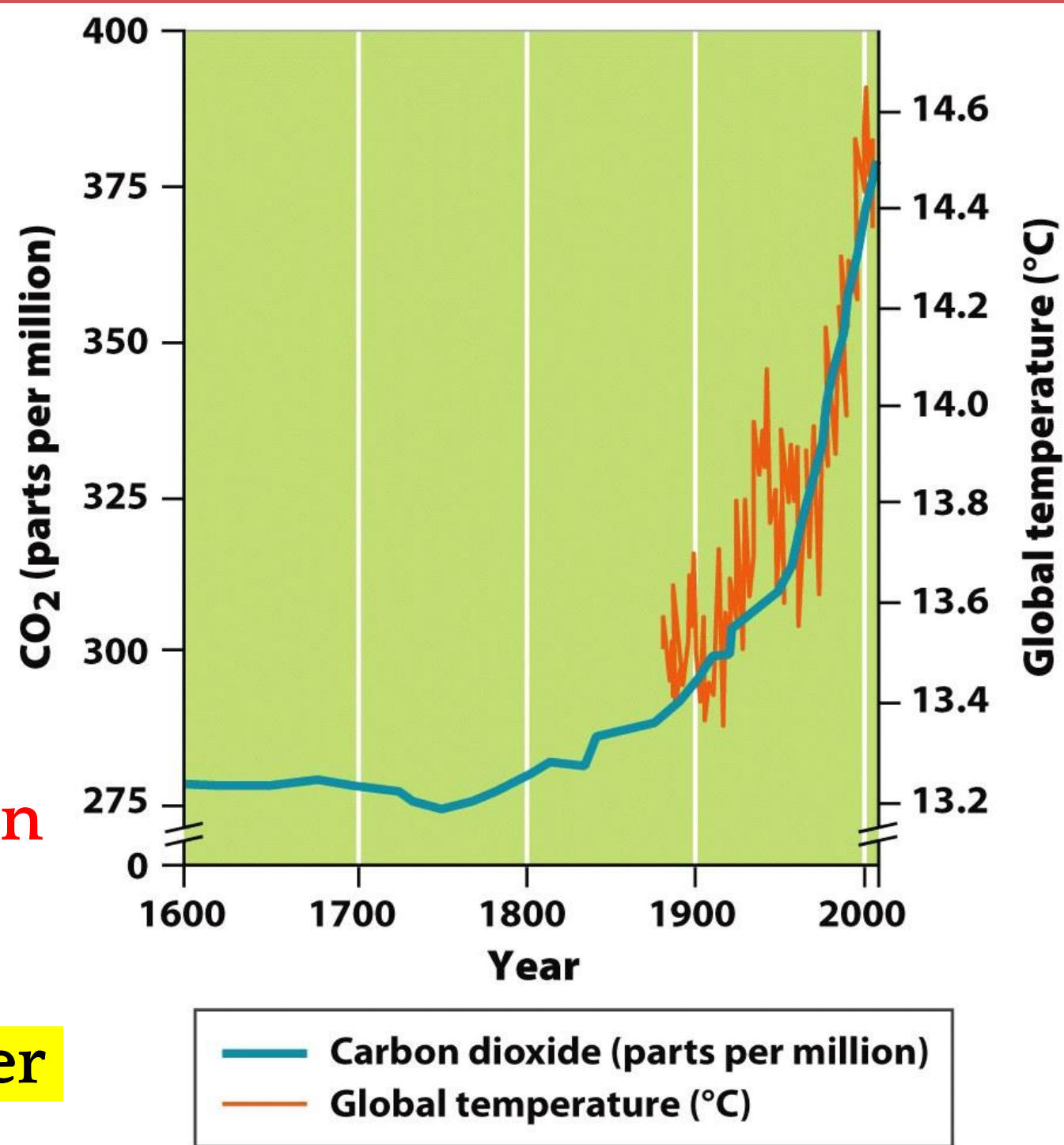


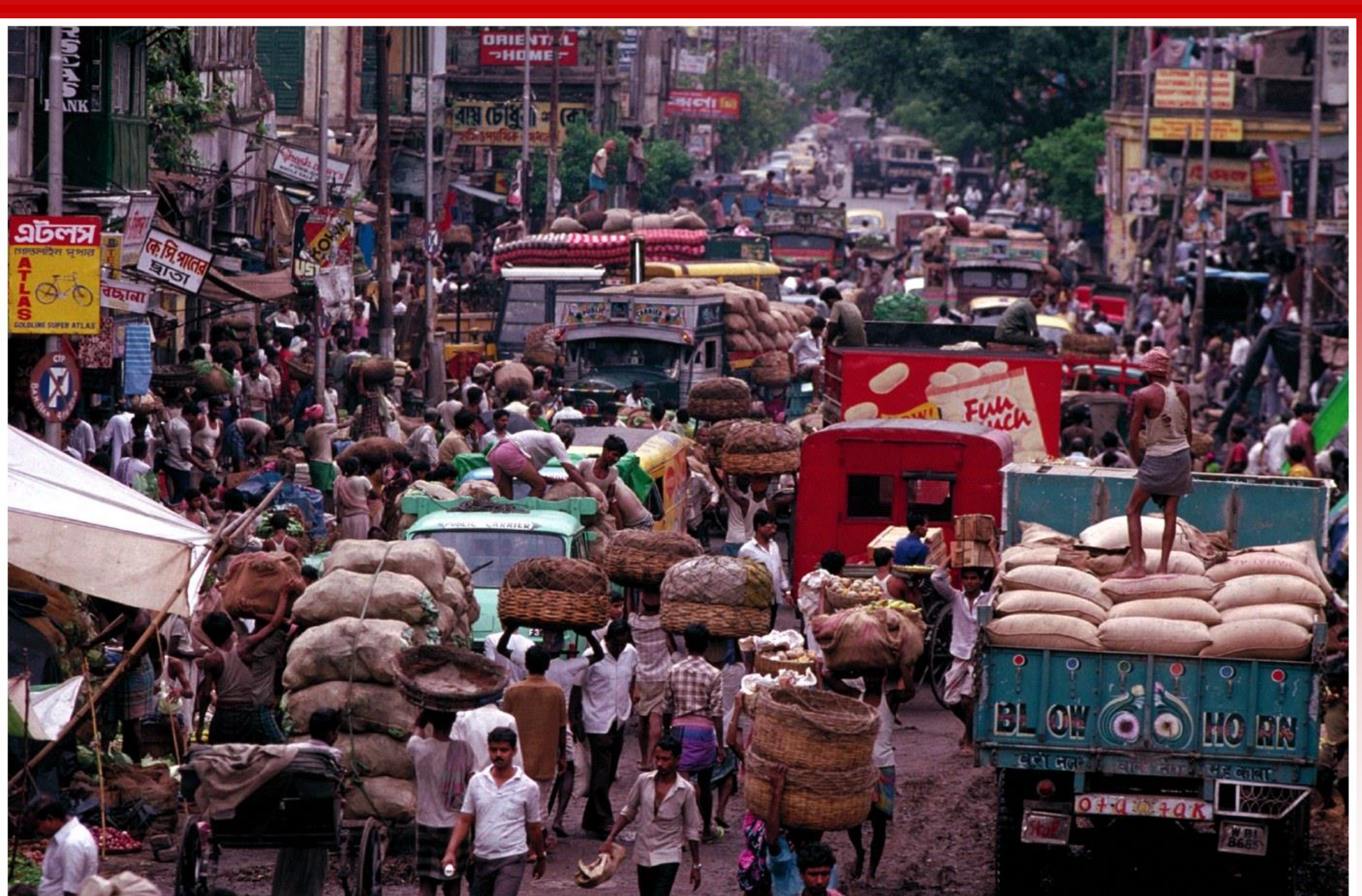
Figure 1.8  
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## 4. Human Population

- The current human population is **7.8 billion (2020)**
- The world population is estimated to reach **9.9 billion in 2050** (according to Population Reference Bureau)
- **Over a million additional people is added to the Earth every 5 days.**

Increasing world population requires a demand on natural systems (**ecological footprint**)... **food, shelter, water & other resources** (depending upon develop vs. developing nations)





**Figure 1.9**  
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# Kolkata, India



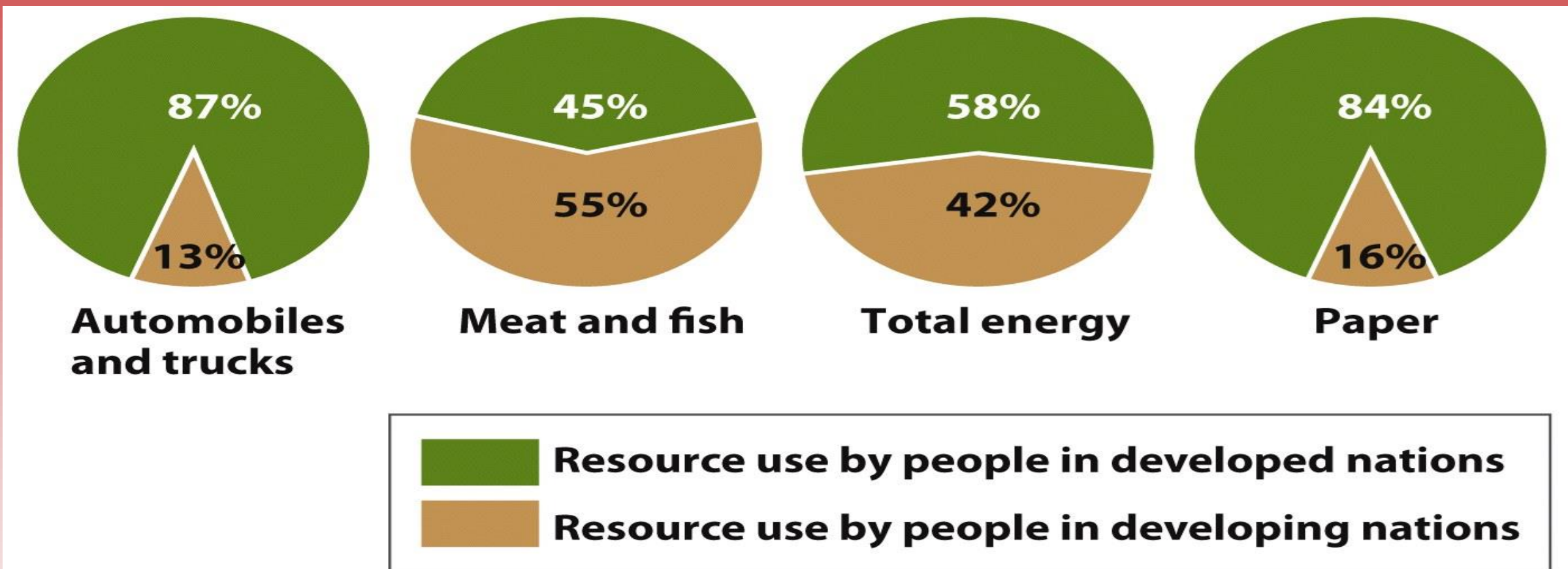
## 5. Resource Depletion

- As the human population grows, the resources necessary for our survival become increasingly depleted.
- Some natural resources such as coal, oil and uranium are *limited and cannot be renewed or reused* (**Non-renewable** – Fossil Fuels)
- Other natural resources like aluminum or copper, also exist in *limited amounts but can be recycled* (**Non-renewable** but recyclable)

Timber=**renewable** due to re-planting and harvesting



- **Development-** improvement in human well-being through **economic advancement**. As economies develop, resource consumption also increases.



**Figure 1.10**  
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Developed nations such as U.S., Canada, Australia, most of European countries and Japan hold 20% of the global population but consume (look above)....

The poorest 20% of the worlds population consume 5% or less of these resources...Haiti, Ethiopia, Tanzania

# Human Well-Being Depends on Sustainable Practices

- **Sustainable Development**- development that **balances current human well-being and economic advancement with resource management** for the benefit of future generations.
- **Overuse of resources** by the people is the primary cause for the demise of most civilizations (*"tragedy of the commons"*)
- (ex.) **Easter Island** – once filled with trees, grasses...etc, humans settled in and **overused the resources** (*deforestation- clear cutting trees*) which caused a massive **destruction of the land** (*loss of soil...decrease of food production*), **collapsing the civilization**.



*Basic Human needs*: air, water, shelter and food

In order to live sustainably:

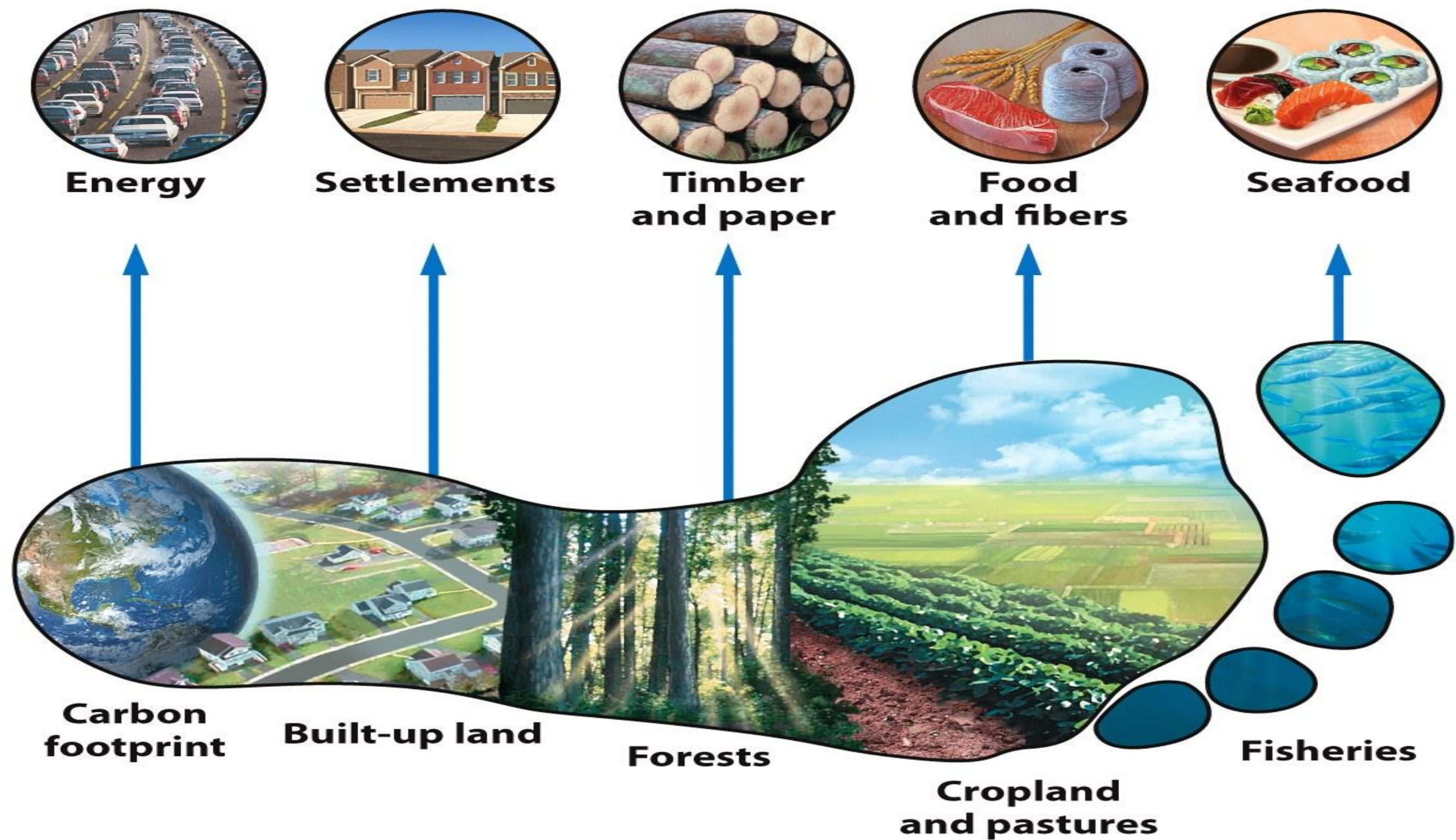
1. Environmental systems must not be damaged beyond their ability to recover.
2. Renewable resources must not be depleted faster than they can regenerate.
3. Nonrenewable resources must be used sparingly

Living sustainable means **acting in a way such that activities that are crucial to human society can continue** (ways to conserve & find alternatives to nonrenewable resources as well as protecting the environment to supply renewable resources (ex. selective cutting, regrowth occur)).

# The Ecological Footprint

- A measure of **how much a person consumes**, expressed in area of land (method used to assess the **impact of a person/country on world resources...human population**).
- The output from the total amt of land require to support a person's lifestyle.
- The **lifestyle a nation practices** (developed vs. developing) will determine the effects of human activities on the planet and cultivate sustainable practices.  
(ex). Meat consumption is a lifestyle choice





**Figure 1.14**  
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We can calculate the ecological footprint of the food we eat, the water and energy we use, and even the activities we perform that contributes to climate change



According to Global Footprint Network, if every person on Earth lived the average lifestyle of people in the U.S., we would require the equivalent of 5 Earths to sustain us.

Currently, we need more than one Earth to continue our lifestyle trend.



**Figure 1.15**  
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# The Scientific Method

1. Observations & Questions

2. Hypothesis

(educated claim)

- A Null Hypothesis is a statement that can be proved wrong.

Greatest value of the scientific method is to allow findings to be reproduced and tested

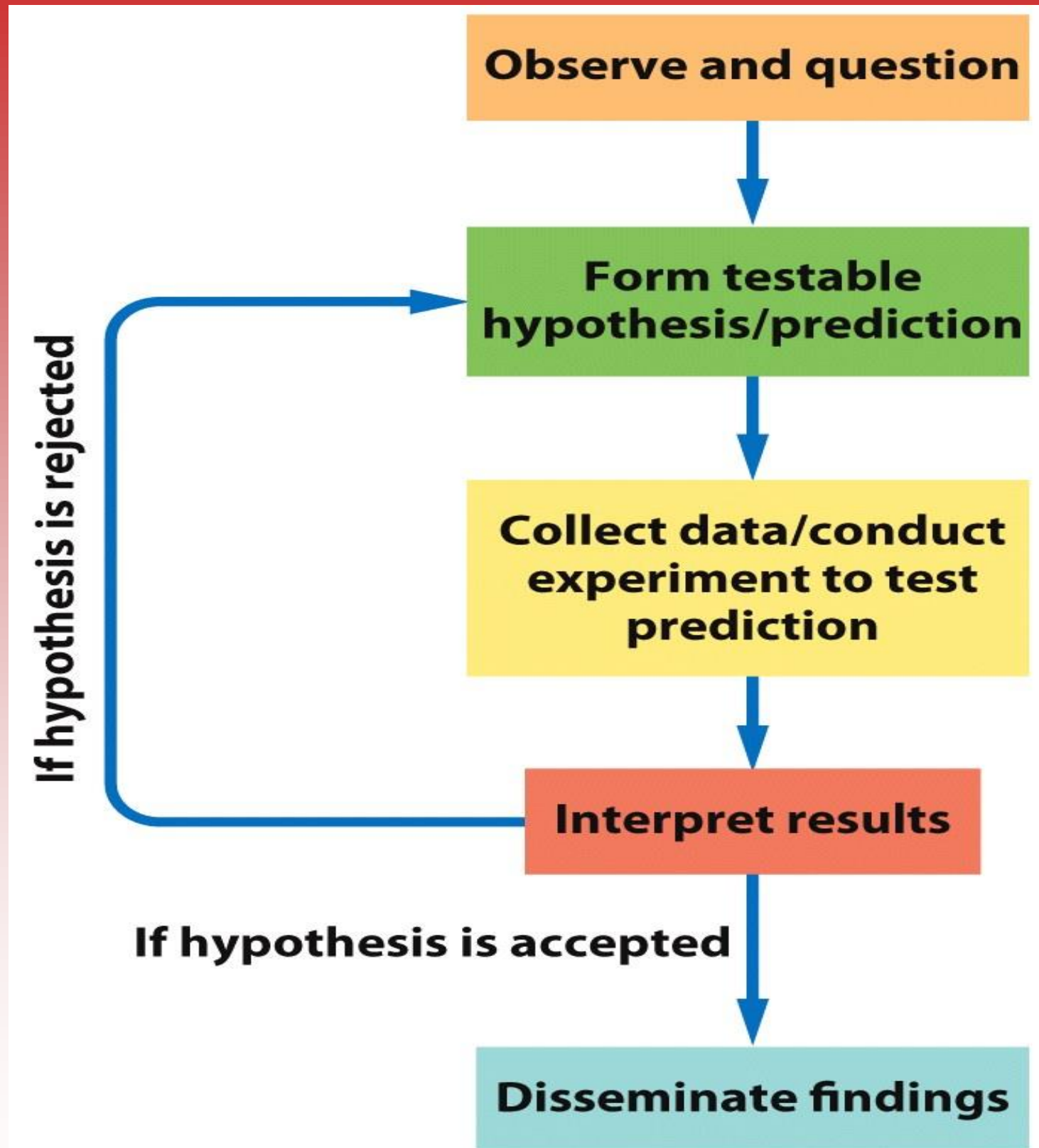


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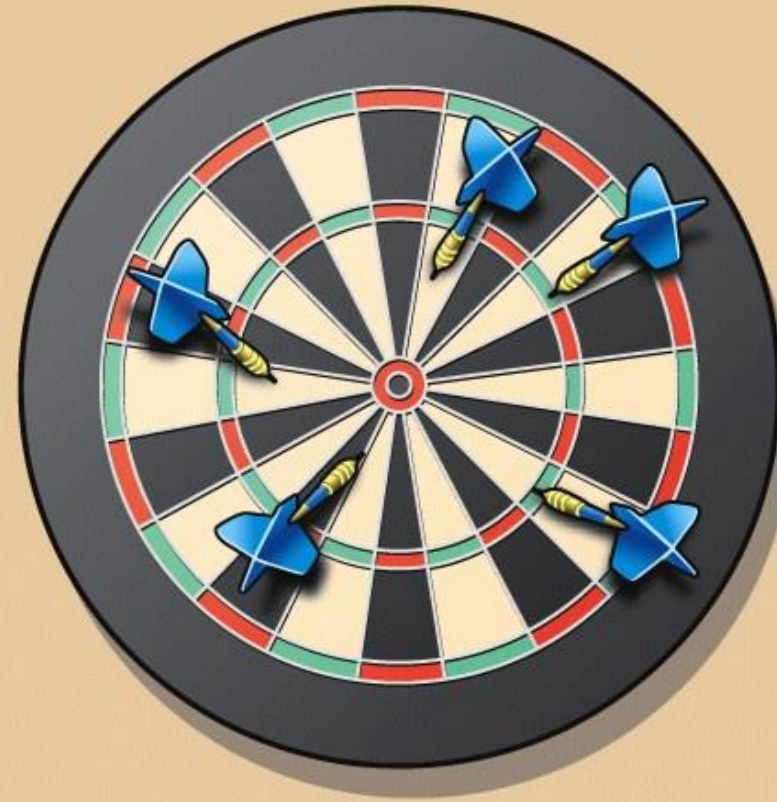
# 3. Collecting Data

- **Replication**- repeating the measurement many times
- **Sample size**- the number of times the measurement is repeated.
- **Accuracy**- how **close** a measured value is to the actual or **true value**.
- **Precision**- how close to one another the **repeated measurements** are.
- **Uncertainty**- how much the measure differs from the true value.





**Low accuracy**  
**High precision**



**High accuracy**  
**Low precision**



**High accuracy**  
**High precision**

**Figure 1.17**

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## 4. Interpreting Results

- Once results have been obtained, analysis of the data begins.
- This process involves **two types of reasoning.....**
  1. **Inductive reasoning**- the process of **making** general statements **from** specific facts or examples.
  2. **Deductive reasoning**- the process of **applying** a general statement **to** specific facts or situations.
- **Disseminating (Publish) Findings:** Scientists present papers at conferences and **publish the results of their investigations.** This allows other scientists to repeat the original experiment and verify or challenge the results.

- **Theory-** a hypothesis that has been repeatedly tested and confirmed by multiple groups of researchers and is widely accepted.
- **Natural law-** When a theory has been tested multiple times and there are no known exceptions (most certain/concrete evidence, no dispute)  
Ex. Newton's 3 Laws

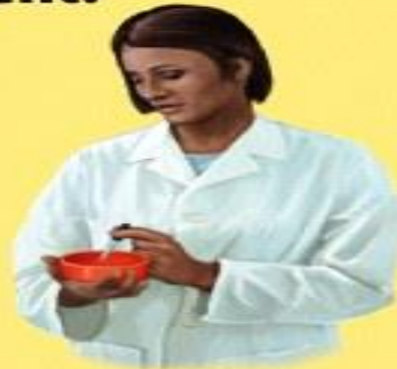
• Observation...Hypothesis...Theory...Law



**Question: Do organophosphate pesticides have detrimental effects on the central nervous system?**

**Null hypothesis: Chlorpyrifos has no observable negative effects on the central nervous system.**

**Conduct experiment:**  
**1 mg/kg chlorpyrifos**



**Experimental group**



**Control group  
(normal food)**

**Measure enzyme activity in order to test for the effect of chlorpyrifos on the brain.**

**Results (enzyme activity):**  
**Reduced**

**Normal**

**Interpret results: Under these conditions, feeding chlorpyrifos to young rats reduces the activity of a key brain enzyme. The null hypothesis is disproved.**

**Controlled experiment-** an experiment conducted in the controlled conditions of a laboratory (standard)

**Natural experiments-** when a natural event, such as a volcano/earthquake/pesticides...etc, acts as an **experimental treatment** in an **ecosystem**.

**Figure 1.18**

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**Mount St. Helens Pre-eruption, 1979**



**Figure 1.19a**  
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**Mount St. Helens Post-eruption, 1982**



**Figure 1.19b**  
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**Figure 1.19c**  
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**Mount St. Helens, 2009  
Begins to show forest  
regrowth...this disaster  
created a natural expt.  
For understanding  
large-scale forest  
regrowth**



# Experimental Science Presents Unique Challenges

- There is **no "control"** (group) planet to compare the Earth with.
- It is difficult to decide what is better or worse for the environment than something else.
- Environmental science has so many interacting parts, it is not easy to apply one system to another...**UNDERSTAND THE PROBLEM, TO CREATE A SOLUTION!!!**
- **Human well-being is a concern because people that are unable to meet their basic needs are less likely to be interested in saving the environment.**