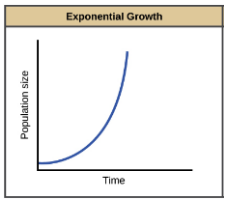
CHAPTER 1 Environmental Problems, Causes, & Sustainability

Core Case Study: Living in an Exponential Age



Describe exponential growth and what the graph would look like.

A quantity increases at a fixed % per unit of time. Growth starts slow but then begins to increase drastically.

Human population is experiencing exponential growth, therefore, we consume vast amounts of *food, water, raw materials, and energy*, and we produce huge amounts of *pollution and waste*.

What is the population likely to be in 2050 if we keep up this pattern? *9.3 billion*

Continued human exponential growth could lead to the following:

1. *Irreversible loss of 1/3 to ½ of the world's biodiversity*
2. *A change in the Earth's climate from increased burning of fossil fuels and clearing of forests.*

What Is an Environmentally Sustainable Society?

What is included in the "environment"? *includes all of the living and nonliving things that we interact with on a daily basis*

What does it mean to say that environmental science is an interdisciplinary study? *Integrates information and ideas from biology, chemistry, geology, geography, economics, demography, political science, philosophy, and ethics*

Ecology is a key subfield of environmental science. A major focus of ecology is the *study of how living things interact with their environment and with each other*.

What is environmentalism and how is it different from environmental science? *Environmentalism is a social movement that is dedicated to protecting the earth's life support systems that practice more in political and ethical arenas. Environmental science practices more in the science realm and research.*

What is sustainability? (This is very important!) *ability of the earth's natural systems, human cultural systems, and economies to survive and adapt to changing environmental conditions indefinitely.*

Key Components of Sustainability:

Natural Capital	Humans Degrade Natural Capital	Solutions
Natural Resources- *materials and energy in nature* Natural Services- *functions of nature* Nutrient Cycling *circulation of chemicals through organisms and back to the environment* Supported by Solar Capital- *energy from the sun*	*Humans degrade the environment by using resources faster than they can renew*	*Solutions are limited by current technology and political involvement*

The ultimate goal is an environmentally sustainable society, which is *one that meets the current and future basic needs of its people in a just and equitable manner without compromising future generations.*

How Can Environmentally Sustainable Societies Grow Economically?

What does it mean to say "per capita?" *per person*

What is economic development? *Uses economic growth to improve living standards*

Developed Countries	vs.	Developing Countries
US, Canada, Japan, Australia, New Zealand, and most of Europe		*Most of Africa, Asia, and Latin America Represents a majority of the world*
Highly industrialized, high per capita GDP		*Experiencing a higher population growth rate than developed countries*

More than ½ of the people in the world live in extreme *poverty*.
We should put more emphasis on environmentally sustainable *economic* development which involves *using political and economic systems to discourage environmentally harmful and unsustainable forms of economic growth.*
Looking at Figure 1-5, developed countries only have *18*% of the population, but have 88% of resource use and *75*% of pollution and waste.

How Are Our Ecological Footprints Affecting the Earth?

Define: Resource- *anything obtained from the environment to meet our needs and wants*

Conservation- *management of natural resources with the goal of minimizing waste and sustaining supplies for the future*

Perpetual Resource- *renewed continuously*

Renewable Resource- *can be replenished fairly quickly through natural processes*
Examples: forests, grasslands, fisheries, fertile soil

Sustainable Yield- *highest rate at which a renewable resource can be used indefinitely without reducing its available supply*

Environmental Degradation- *occurs when we exceed a renewable resource's natural replacement rate*

3 Types of Property or Resource Rights:

Private Property	Common Property	Open Access Renewable Resources
-individuals or firms own the rights to land, minerals, etc	*-rights to resources are held by large groups of individuals*	*-owned by no one and available for use by anyone at no charge*

What is meant by "tragedy of the commons"? *resources that are common or open access are vulnerable to degradation because no one is in charge of controlling its use "If I do not use this resource, someone else will. The little bit that I pollute is not enough to matter."*

Solutions:

1. Use shared resources at rates well below their estimated sustainable yields

2. Convert open access resources to private ownership

Define: Nonrenewable Resources- *exists in a fixed quantity or takes millions of years to replenish*

Examples- *coal, oil, aluminum, sand*

Reduce- *decrease use*
Reuse- *using a resource over and over in the same form*
Recycle- *processing waste into new materials*

Ecological Footprint- *amount of biologically productive and water needed to supply the people in a particular area with resources and to absorb and recycle the waste and pollution produced by those resources*

Per Capita Ecological Footprint- *average ecological footprint per person*

If the rest of the world consumed as much as the US, we would need *5* more Earths.

Case Study- China's New Affluent Consumers

Why is China now putting an immense pressure on the earth's natural capital? *Many are attaining middle class, affluent lifestyles, thus consuming more resource and creating more waste*

How has culture changed our ecological footprints?

Culture- *the whole of societies knowledge, belief, technology, and practices*

Homo sapien culture has changed drastically:

Hunter-Gatherer → Agricultural Revolution → Industrial Revolution → Information-Globalization Revolution

What Is Pollution and What Can We Do about It?

	Pollution	
Point Sources- *from a single, identifiable source* *Ex: smokestack, drainpipe, exhaust pipe*	Define- *anything in the environment that is harmful to the health, survival, or activities of humans or other organisms*	Nonpoint Sources- *dispersed and often difficult to identify* *Ex: pesticides blown from land, fertilizer runoff*

Types of Pollutants:	Biodegradable Pollutants	Nondegradable Pollutants
	harmful materials that can be broken down by natural processes (newspaper)	*harmful materials that natural processes can't break down (lead, arsenic)*

Pollutants have 3 types of unwanted effects:

1. *Disrupt or degrade life support systems*
2. *Damage wildlife, human health, and property*
3. *Create nuisances such as noise, odors, tastes, etc*

Solutions:

Pollution Cleanup- *cleaning up or diluting the pollutant after it has been produced*

Problems with Cleanup:

1. *Temporary Bandage*
2. *Removing pollutant in one part of the environment often creates pollution in another part*
3. *Costs too much to reduce harmful levels*

Pollution Prevention- *reduces or eliminates the production of pollutants*

Why Do We Have Environmental Problems?

5 Basic Causes of Environmental Problems:

1. Population Growth	*with 7 billion people on earth, our demand for resources has exploded, thus putting pressure on all of earth's natural systems; we are also increasing in affluence in many areas*
2. Unsustainable Resource Use	*we are using our natural resources beyond their sustainable yield leading to rapid environmental degradation*
3. Poverty	*desperate for short term survival; forests, soil, grasslands, fisheries, and wildlife are degraded at a rapid rate*
4. Excluding Environmental Costs from Market Prices	*prices do not include the environmental costs, cost of degradation, or health costs*
5. Not Knowing Enough About Nature	*we all have different views on the seriousness of environmental problems; poverty stricken areas are generally uneducated about long-term effects*

Case Study: The Environmental Transformation of Chattanooga, TN

Describe how Chattanooga is becoming a sustainable city.

-encouraged relocation of zero emission industries, replaced diesel buses with electric buses, expansive recycling program, revamped low income housing, built tourist attractions (TN Aquarium)

Individuals Matter:

How has Aldo Leopold contributed to the study of environmental science?

"The role of the human species should be to protect nature, not conquer it."
-leader of the conservation and environmental movements
-wrote the book Sand County Almanac

What Are Four Scientific Principles of Sustainability?

1. Reliance on Solar Energy- *warms the planet and supports photosynthesis*
2. Biodiversity- *variety of organisms, genes, ecosystems, and natural services*
3. Population Control- *competition places limits on growth*
4. Nutrient Cycling- *recycles chemicals that plants and animals need for survival*

CHAPTER 2 Science, Matter, Energy, and Systems

Core Case Study: Carrying Out a Controlled Scientific Experiment

Controlled experiments only test *1* variable at a time.

Describe how Bormann and Likens' experiment with deforestation is a controlled experiment. *Their experiment measured the effects of deforestation on the loss of water and soil nutrients. Dams were built so that all water and nutrients could be collected and measured for volume and content. The forested valley was the control group and the deforested area was the experimental group.*

What Is Science?

Steps to the Scientific Process

1. Identify a *problem.*
2. Propose a *hypothesis.*
3. Test the prediction with further *experiments.*
4. Accept or reject hypothesis
   a. Scientific Theory- *well tested and highly accepted hypothesis*
   b. Peer Review- *when scientists examine and critique the validity of work done by other scientists*

Define: Scientific Law- *well tested and highly accepted description of what we find happening again and again*

Paradigm Shift- *occasionally new discoveries can overthrow a previously accepted theory*

Science Focus: Easter Island

What is special about Easter Island? *This island represents a situation in which humans can seriously degrade their own life support system. Research shows that the Polynesians began living unsustainably by using the island's forest and soil resources faster than they could be renewed. Without the forest, the streams dried up, soil eroded, crop yields plummeted, and famine struck.*

What Is Matter?

Matter-	Element-	Compound-	Atom-	Atomic Theory-	Isotopes-
Anything that has mass and takes up space	*Substance that cannot be broken down into simpler substances*	*Combination of 2 or more elements*	*Smallest unit of matter*	*All elements are made of atoms*	*Element having the same atomic # but different mass*

pH-	Acidic-	Basic-
Measure of acidity based on amount of H^+ ions and OH^- ions -Each step in the pH scale changes the concentration of H+ ions by a factor of 10.	*More H^+ ions than OH^- ions Has a pH less than 7*	*More OH^- ions than H^+ ions Has a pH greater than 7*

Ions to Know:

Ion	Symbol	Ion	Symbol
Hydrogen ion	H^+	Chloride ion	Cl^-
Sodium ion	Na^+	Hydroxide ion	OH^-
Calcium ion	Ca^{2+}	Nitrate ion	NO^{3-}
Aluminum ion	Al^{3+}	Sulfate ion	SO_4^{2-}
Ammonium ion	NH_4^+	Phosphate ion	PO_4^{3-}

Compounds to Know:

Compound	Formula	Compound	Formula
Sodium Chloride	$NaCl$	Methane	CH_4
Carbon Monoxide	CO	Glucose	$C_6H_{12}O_6$
Carbon Dioxide	CO_2	Water	H_2O
Nitric Oxide	NO	Hydrogen Sulfide	H_2S
Nitrogen Dioxide	NO_2	Sulfur Dioxide	SO_2
Nitrous Oxide	N_2O	Sulfuric Acid	H_2SO_4
Nitric Acid	HNO_3	Ammonia	NH_3

Organic Compounds- *contain at least 2 Carbon atoms combined with atoms of 1 or more elements*	
1. Hydrocarbons	Example- *methane, natural gas, octane*
2. Chlorinated Carbons	Example- *DDT*
3. Simple Carbohydrates	Example- *glucose*

High Quality Matter	vs.	Low Quality Matter
Highly concentrated, typically found Earth's surface, great potential for use as a resource		*Not highly concentrated, deep underground, little potential for use as a resource*
Examples: *salt, coal, gasoline*		Examples: *solution of salt water, coal-fired plant emissions, car emissions*

How Can Matter Change?

Define: Physical Change-*chemical composition doesn't change; ex: ice melting*

Chemical Change- *change in arrangement of atoms; ex: burning coal*

Nuclear Change- *changes in the nuclei of atoms*

Radioactive Decay- *isotopes emit fast moving subatomic particles, high energy radiation, or both*

Nuclear Fission- *nuclei are split into lighter nuclei when struck by neutrons*

Nuclear Fusion- *two isotopes of light elements are forced together at extremely high temperatures until they fuse to form a heavier nucleus*

Law of Conservation of Matter- *when a physical or chemical change occurs, no atoms are created or destroyed; there is no "away" in nature*

What is Energy and How Can It Be Changed?

Energy- *capacity to do work or transfer heat*	
Kinetic Energy	Potential Energy
moving energy Ex: *wind*, Heat, *Electromagnetic* Radiation	*stored* energy Ex: *unlit* match, nuclear energy stored in nuclei

Energy Quality- *measure of an energy source's capacity to do useful work*	
High Quality Energy	Low Quality Energy
Concentrated and has a high capacity to do work *EX: high temperature heat, concentrated sunlight*	*Dispersed energy that has little capacity to do work* *EX: heat dispersed in the ocean or air*

Laws of Conservation of Energy	
First Law of Thermodynamics-	Second Law of Thermodynamics
"Energy cannot be created or destroyed; it can only change form."	*"Energy loses quality when it changes from one form to another."*

What Are Systems and How Do They Respond to Changes?

Positive Feedback Loop- *causes a system to change further in the same direction*

Example: *decreasing vegetation leads to erosion and nutrient loss, which causes more vegetation to die, which causes more erosion and nutrient loss, and so on*

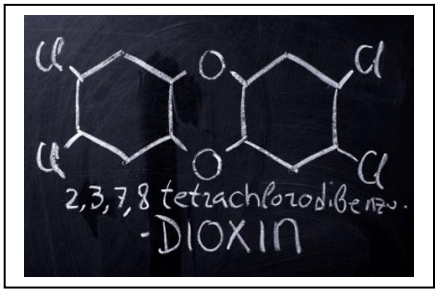
Negative Feedback Loop- *causes a system to change in the opposite direction; stabilizing*

Example: *thermostat in your home*

Tipping Point- *a threshold level that causes a fundamental shift in the behavior of a system*

Synergy- *occurs when two or more processes interact so that the combined effect is greater than the sum of their separate effects*

Example: *During the incineration of trash, chemical toxins can combine to form "super toxins," like Dioxin*



Dioxin is a synergistic chemical that comes from the incineration of waste. It is very toxic!

CHAPTER 20 Sustainable Cities

Core Case Study: The Ecocity Concept in Curitiba, Brazil

List 5 things that make Curitiba, Brazil an Ecocity:

1. *an efficient mass transit system*
2. *stores located on the bottom floors of apartment buildings*
3. *cars are banned in the center of downtown, so it is pedestrian friendly*
4. *recycles 70% of its paper and 60% of its metal, glass, and plastic*
5. *planted more than 1.5 million trees*

What Are the Major Population Trends in Urban Areas?

Define: Urbanization- *creation and growth of cities and their surrounding developed land*

Urban Growth- *the rate of increase of urban populations*

Urban areas grow in 2 ways:	4 major trends in urban population dynamics:
1. *Natural increase (more births than deaths)* 2. *Immigration mostly from rural areas to find jobs, food, housing, education, etc*	1. *Proportion of the global population living in urban areas is increasing* 2. *Urban areas are expanding rapidly in number and size* 3. *Urban growth is much slower in developed countries* 4. *Poverty is becoming increasingly urbanized, mostly in developing countries*

Case Study: Urbanization in the US

Between 1800- 2008, the population living in urban areas increased from 5% to *79* %, and this occurred in 4 phases:

1. *People migrated from rural areas to large central cities.*
2. *Many people migrated from large central cities to suburbs and smaller cities.*
3. *Many people migrated from the North and East to the South and West.*
4. *Some people have fled both cities and suburbs and migrated to developed rural areas.*

What are some issues the US is facing with urbanization?

Aging infrastructures, budget issues, decreasing public services, rising poverty

Define: Urban Sprawl- *growth of low-density development on the edges of cities and towns*

6 factors promoting urban sprawl in the US:	Undesirable impacts of urban sprawl:
1. *Ample land available for cities to spread outward* 2. *Federal govt. loans guarantees single-family housing for WWII veterans* 3. *Low-cost gas for commuting*	Land and Biodiversity: *Loss of cropland, forests, grassland, and wetlands; habitat fragmentation*

4. *Tax laws encouraged home ownership* 5. *Most state and local zoning laws favored large residential lots and separation of residential and commercial areas* 6. *Most urban areas consist of multiple political jurisdictions which rarely work together for developing a plan for growth*	Water: *Increased use of surface and groundwater, increased runoff and flooding, increased water pollution* Energy, Air, and Climate: *Increased energy use and waste, increased air pollution and greenhouse gas emissions, enhanced global warming* Economic Effects: *Decline of downtown business districts, increased unemployment, loss of tax base in central city*

Define: Megalopolis- *chain of roughly adjacent metropolitan areas; very large cities*

What Are the Major Urban Resource and Environmental Problems?

Advantages of Urbanization	*Cities are centers of economic development, innovation, education, technological advances, and jobs* *Urban residents tend to live longer and have a lower infant mortality rate- better access to medical care, family planning, and social services* *Environmental advantages- recycling is more feasible, reducing stress on wildlife, saves energy when relying on mass transit*
Disadvantages of Urbanization	Huge Ecological Footprints: *consume most of Earth's resources and produces most of the carbon dioxide emissions, high resource input of food, water, and materials resulting in high waste output* Lack Vegetation: *vegetation is destroyed to make way for roads, buildings, and housing therefore cities do not benefit from natural absorption of air pollution, oxygen output, and shade* Water Problems: *water demands increase, deeper well drilling, flooding due to a lot of impermeable surfaces and destroyed wetlands* Concentrated Pollution and Health Problems: *pollution levels are higher because pollution is produced in a smaller area and cannot be dispersed and diluted* Excess Noise: *urban dwellers are subject to noise pollution- any unwanted or harmful sound that interferes with hearing, causes stress, etc (sound pressure becomes painful at 120 decibels and deadly at 180 decibels)*

	Different Climate and Light Pollution: *cities are generally warmer, rainier, and cloudier; the enormous amount of heat generated by factories, lights, air conditioners, etc. create an urban heat island surrounded by a cooler suburb; light pollution affects some plants and animals*

Define: Slums- *areas dominated by tenements and rooming houses where several people may live in a single room*

Shantytowns- *shacks are built on the outskirts of town*

Squatter Settlements- *people take unoccupied land without permission for survival*

What can governments do to address these problems? *Slow migration from rural to urban by improving educational opportunities, health care, and family planning; designate land for squatters and provide clean water and sanitation*

Case Study: Mexico City- World's 2nd most populous city

Why is this an urban area in crisis?

Severe air pollution, many are unemployed, overcrowded, high crime, lack of sanitation

How Does Transportation Affect Urban Environmental Impacts?

If a city cannot spread outward, it must grow *upward*.

Define: Compact Cities- *high density like Hong Kong, Tokyo where people get around by foot, bike, or mass transit, many high rise apartment buildings*

Dispersed Cities- *city is more spread own because of plentiful land, cheap gasoline, and a network of highway systems*

Car-Centered Cities- *ample land is available for outward expansion resulting in urban sprawl, passenger vehicles are the main mode of transportation*

Advantages of Motor Vehicles	*Mobility, convenient, economic gain for car industries, helps create urban sprawl*
Disadvantages of Motor Vehicles	*Many deaths from crashes, increased greenhouse gases, increased photochemical smog, congestion*

How can automobile use be reduced?

Suggested that users pay directly for health and environmental costs of driving a car, tax on gasoline to cover harmful effects, build better infrastructure for walking and biking, raise parking fees

How Important Is Urban Land Use Planning?

Define: Land Use Planning- *to determine the best present and future use of land*

-most land use planning encourages future population growth and economic development regardless of environmental and social consequences

Zoning- *parcels of land are designated for certain uses; used to control growth and protect certain areas from development, however developers can easily get the zone modified for their purpose*

Smart Growth-*a way to encourage more environmental sustainable development; encourages clustered, mixed use neighborhoods*

Examples of Smart Growth Tools:	Limits and Regulations- *limit building permits, add greenbelts around the city, public review of new development* Zoning- *encourages mixed used of housing and small businesses, concentrate development along mass transit lines* Planning- *ecological land use planning, env impact analysis, state and national planning* Protection- *preserve existing open space, buy new open space, buy development rights that prohibit certain types of development* Taxes- *tax land not buildings, tax land on value of actual use* Tax Breaks- *for owners agreeing not to allow certain types of development, for cleaning up and developing brownfields* Revitalization and New Growth- *revitalize existing towns, build well-planned new towns within cities*

How can open space be used and preserved? *Urban Growth Boundaries to increase housing density inside the boundaries; unintended consequences- encourages low density housing and urban sprawl*

How Can Cities Become More Sustainable and Livable?

Describe what a cluster development looks like.

High density housing units are concentrated on one portion of a parcel and the rest of the land is used for commonly shared open space (live, work, play communities)

New Urbanization is a new trend in developments (aka old villageism). Principles of this type of development are:

- *Walkability- most stores and recreational activities located within 10 minute walk of homes and apartments*
- *Mixed Use and Diversity- provides a mix of pedestrian friendly shops, offices, and homes to encourage people of all ages and races to move in*
- *Quality Urban Design- emphasizes beauty, aesthetics, and architect*
- *Environmental Sustainability- based on development and minimal env impact*
- *Smart Transportation- well designed train and bus systems connecting neighborhoods, towns, and cities*

Green cities emphasize the following goals:

Build and design cities for people, not cars
Use solar and locally available renewable energy and design buildings to heat and cool as naturally as possible
Depend largely on recycled water that is purified to use again and again
Prevent pollution and reduce waste
Recycle, reuse, and compost at least 60% of all MSW
Promote urban gardens and farmer's markets

Core Case Study: Studying a Volcano to Understand Climate Change

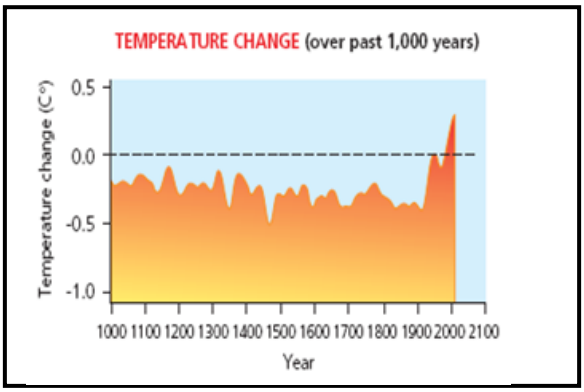
1. In 1991, Mount *Pinatubo* erupted, which allowed scientists to further study global *climate* change.
2. Scientists studied that amount of *SO_2* released by the volcano to determine if pollutants would indeed change the climate of the Earth on a larger scale. It does.

How Might the Earth's Temperature and Climate Change in the Future?

For the past 900,000 years the Earth has experienced period of global *cooling* and global *warming*. For the past 1,000 years the temperature has been *stable*, but has begun to rise in the last century when people began *clearing forests and burning fossil fuels*.

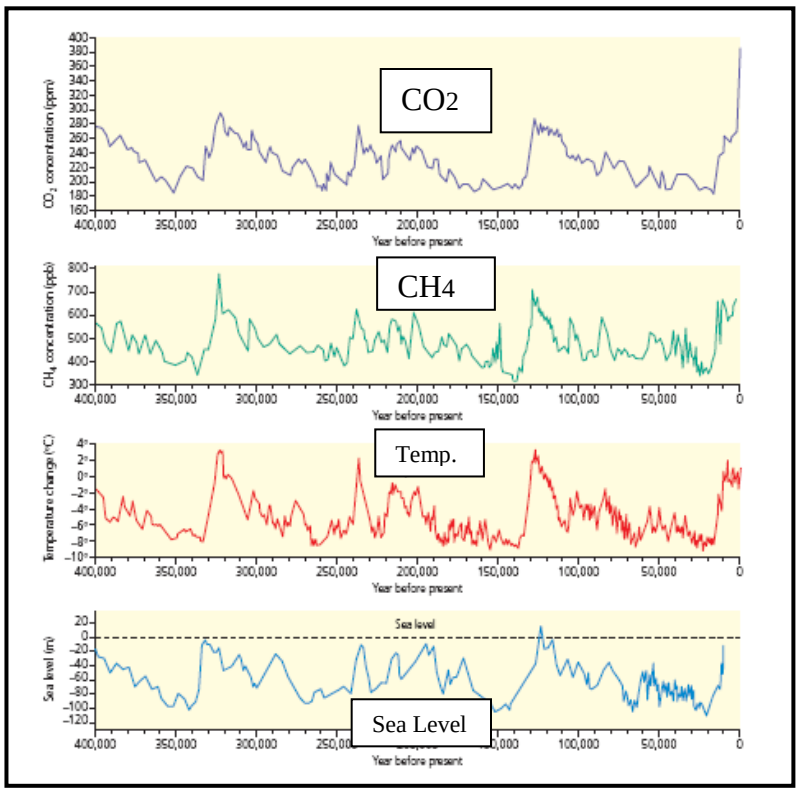
How are past temperatures determined?

- Radioisotopes in *rocks and fossils*
- Bubbles of ancient *air* in ice cores
- Temperature taken at different depths in Earth
- Historical records



Life on Earth wouldn't be possible without the natural *Greenhouse Effect*:

- *warms* the Earth's lower atmosphere and surface due to greenhouse gasses like *CO_2, water vapor, and CH_4* that trap heat from the sun



The problem is when we have *too many* greenhouse gases and *human* activities have led to this increase.

- Mainly due to agriculture, *deforestation*, and burning *fossil fuels.*
- At our current rate of emission of CO_2 we will have a concentration of *560ppm* by 2050, and according to research the *tipping* point is *450* ppm.
  - * Top 2 CO_2 emitting countries: *China and the US*
- Data from *ice* cores also shows that 60% of *methane* emissions is due to *human* activity from extracting fossil fuels, *landfills*, and livestock.
- Nitrous Oxide levels have also increased due to use of Nitrogen *fertilizers (released in the air during the decomposition process)*.

Evidence that Supports Climate Change:
1. Between 1906-2000, average global surface temp has increased by *1.3°F* 2. Greenhouse gas emissions has risen *70*% since 1970 3. *Arctic* temps have risen twice as fast in the past 50 years 4. *Glaciers* and floating sea ice are melting 5. Rainfall patterns are changing 6. Sea level has risen by *4-8* inches

What Role Does the Ocean Play?

- Oceans absorb *half* of all of the *CO_2* released and help moderate temperature
- Some Carbon is converted to *carbonate* salts that are buried in the sediments for millions of years
- *Solubility* of CO_2 decreases with *warmer* temperatures
- As water heats, the CO_2 isn't *absorbed* as easily and could amplify global warming= *positive* feedback loop
- Higher levels of CO_2 increases the *acidity* of the ocean, which decreases the ability of *corals* to make calcium carbonate shells

****Bottom Line: Temperature, acidity, and ability to absorb CO_2 from atmosphere are changing as a result of human activities**

What are Some Possible Effects of a Warmer Atmosphere?

Browning of the Earth:	Ice and Snow are Melting:	Sea Levels are Rising:
Permafrost is Likely to Melt:	Ocean Currents Changing:	Extreme Weather:

Threat to Biodiversity:	Agriculture:	Health:

What Can We Do to Slow Climate Change?

Why this complex problem is difficult to tackle:

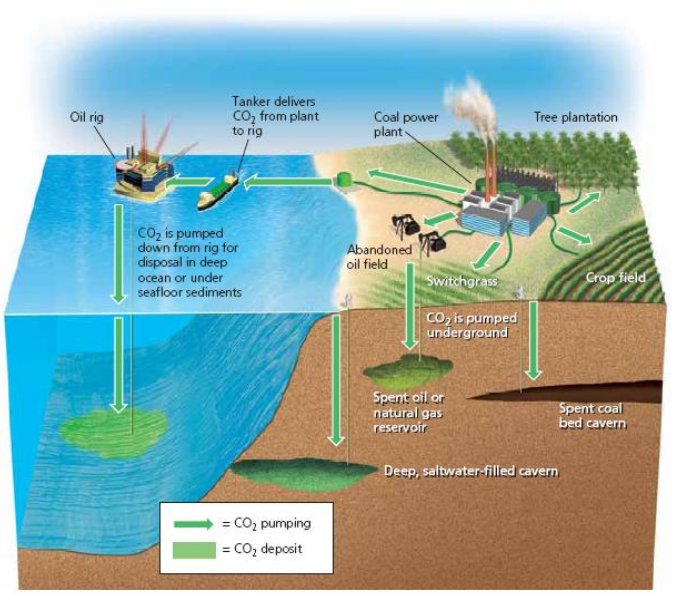
1. The problem is *global*- much international cooperation
2. Effects of climate change will last a long time- CO_2 stays in atmosphere *120 years*.
3. It is a long term *political* issue.
4. Impacts of climate change are not spread *evenly* across the globe.
5. Phasing out fossil fuels will change our lifestyles, & disrupt *economies* and lifestyles.

Solutions: Three Major Prevention Strategies-

1. Improve energy *efficiency* to reduce fossil fuel use.
2. Shift from nonrenewable *C* based fossil fuels to a mix of Carbon *free* renewable energy resources.
3. Stop cutting down tropical *rainforests*.

** Effectiveness of these strategies would be enhanced by reducing *population* and reducing *poverty*.

Output Strategies for Reducing Climate Change:



Solutions

1. Massive *tree* planting on degraded land in the tropics.
2. Plant fast growing perennial plants like switchgrass- stores CO_2 in *soil* to be harvested for *biofuels*.
3. Carbon Capture & Storage (CCS)- removing CO_2 from *smokestacks* and pumping it deep into *coal beds* or abandoned oil or gas fields
   - -CCS is expensive and could raise prices
   - -require large inputs of *money* to operate= counterproductive
   - -earthquakes, war, etc could cause a *leak*; even a small leak would be disastrous

Random Suggestions:

1. Inject sulfate particles into *stratosphere* - reflects *sunlight* to cool troposphere
2. "Re-ice" the *Arctic*
3. Deep sea *pipes* to bring up nutrients for algal blooms which can take in *CO_2*

What Can the Government Do to Slow Climate Change?

1. Strictly regulate *CO_2* and *methane* pollutants.
2. Carbon *taxes*
3. *Cap and Trade* Approach
4. *Subsidies* to businesses who use green technologies
5. Technology transfer to *developing* countries

*Kyoto Protocol- a treaty to slow climate change (2005)

-required countries to cut emissions of CO_2, CH_4, and N_2O by 5.2% of their 1990 levels by 2012. Did it work?

-countries can *trade* greenhouse gas emissions- the "cap and trade" system

-174 countries agreed to this. The US *did not*.

*George W. Bush decided not to comply because he felt it would harm the *economy* and he did not like how rapidly developing countries (like *China*) were exempt.

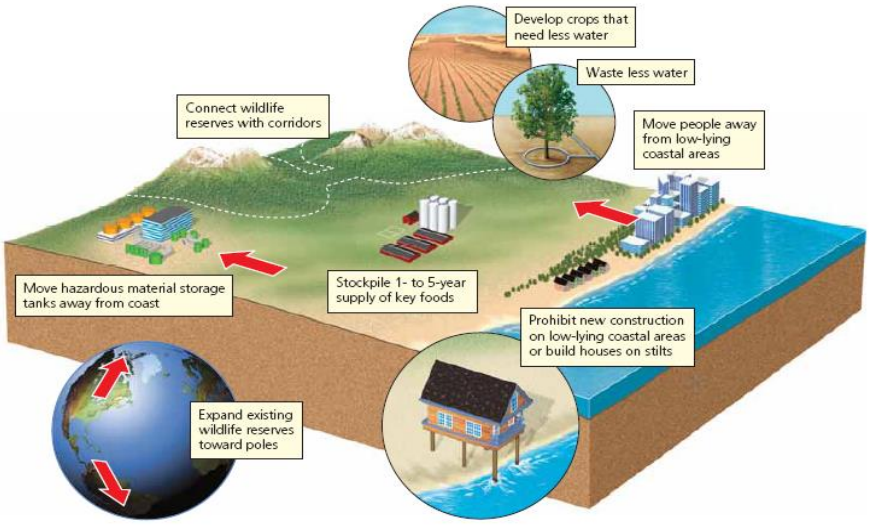
"Dreaming of a White Christmas!" © Seppo Leinonen www.seppo.net

Who's been successful?

- ✓ *Costa Rica* aims to be the first carbon *free* country. They currently generate 78% of their electricity from renewable *hydroelectric* power and 18% from *wind* and *geothermal* energy!
- ✓ Some US States are tired of waiting on the federal government to take charge.

- Portland, Oregon- 1st city to cut greenhouse gas emissions back to *1990* levels.
  - The city promotes energy efficient *buildings* and use of electricity from *wind* and *solar* sources.
  - Has built many bicycle trails & has greatly expanded *mass transit*.
  - This has actually produced an economic *boom* and has saved the city $*2million*/year in energy costs!
- California- 12th largest producer of greenhouse gases (GHG) in the world!
  - 2006- CA passed a law to cut GHG to *25%* below 1990 levels by 2020.
  - Set fuel efficiency and carbon emissions standards and let the free market find the best ways to meet standards- EPA refused this request. CA and 17 other states are now suing the federal government to allow states to set tougher CO_2 emission standards.
- Companies and Schools are reducing their Carbon Footprints
  - DuPont, IBM, Toyota, & Walmart have cut GHG emissions

Preparing for the Harmful Effects of Climate Change:



Global climate models say we must make a *50-85%* cut in GHG emissions by 2050 to prevent Earth from heating up more than 3.6°F, which will likely be difficult to do. Therefore, analysts have compiled a list of things we need to do to prepare for the long-term effects of climate change. See picture to the left.