

Topic: Human Population

Key Facts: Total Population: 7.6B. US pop.: 326M; China pop.: 1.4B; India pop.: 1.35B
B = Billion; M = Million

Total Fertility Rate (TFR): Average # of babies woman has in lifetime; has declined drastically since 1950

Trend: Highest in developing countries, lowest in developed. **Highest:** 5+ in Africa, global was 2.8 and developed was 1.5.

Replacement level Fertility Rate (RFR): How many children a woman needs to have to replace her and spouse. Should be 2 but slightly higher due to infant mortality. Developed countries is 2.1; developing countries 2.5+

Crude Birth Rate/Death Rate: # of individuals born/dead per 1000 per year

Demographic momentum: Population increasing after TFR<RFR due to huge pre-reproductive and reproductive individuals.

Density Dependent Factors: competition, predation, parasitism

Density Independent Factor: weather, climate, volcanoes, fires & floods

Age structure diagram (or population pyramid): Two-sided histogram for males and females at different age groups. There are three general patterns for the diagrams. Age groups: Pre-reproductive age (0-14); Reproductive age (15-44); Post-reproductive (45+)

The Tragedy of the Commons: We have an overpopulation problem. Ecosystems are degrading. Resources are using up. Species are going extinct. Optimal population should be at about 1-2B. Author believes that people don't have freedom to breed without limit. Government must intervene to stop population growth.

KEY TERMS

Calculations

Population change = (CBR + I) - (CDR+E)

*Note: Population change is per 1000. To change to percent change, move the decimal place one place to the left.

Doubling time = 70 / Percentage Change

Note: **DO NOT** change the percent to decimal. Simply drop the % sign for the calculation. **This equation can be used in other contexts too!**

INDICATORS OF A POPULATION'S HEALTH

- Life expectancy
- Infant mortality

These both quickly let you glance at a population to determine in seconds developing or developed and potential issues the population may face.

FACTORS AFFECTING BIRTH RATE

Need of children in workforce
Education in women
Importance of women in society
Access to birth control
Religious beliefs in birth control
Infant mortality rate
Age of marriage/bearing first child

FACTORS AFFECTING DEATH RATE

Availability/affordability of healthcare
Availability of food
Weather, volcanoes, floods
Safe water supplies

IMPORTANCE OF URBANIZATION

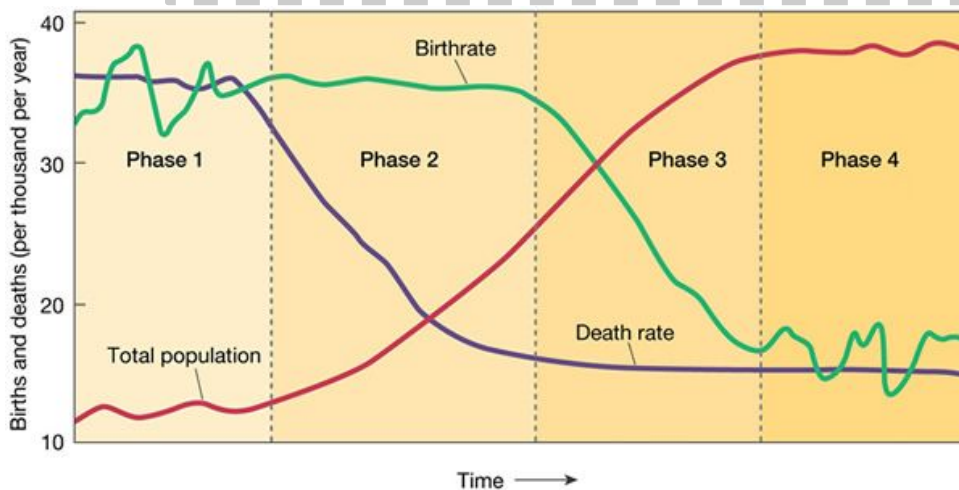
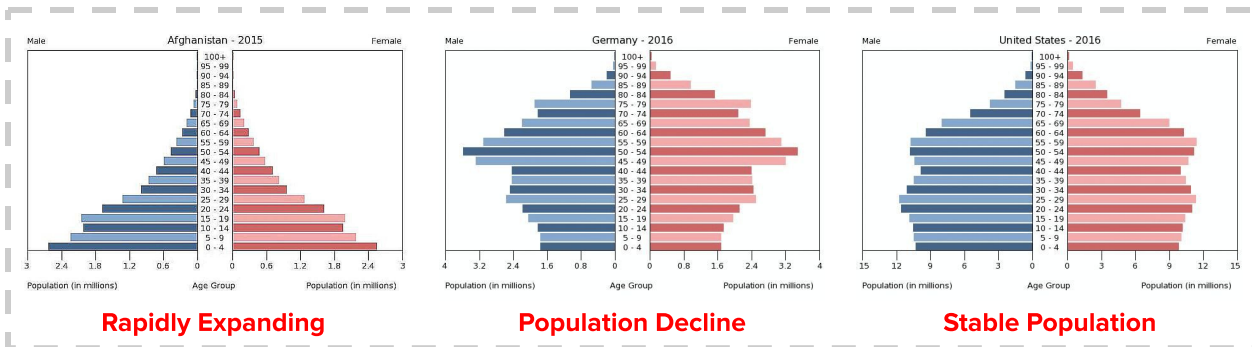
- Providing family planning
- Access to birth control & abortion
- Providing education and work opportunities

Typical Population Control Strategy

Incentives through rewards, tax credits, subsidies
Example: Russia, USA, Singapore

Sanction through penalties
Example: China (losing gov subsidy)

Education: Family planning, birth control, condoms



Phase 1: Pre-industrial Stage; High CBR & CDR. Population stable.

Phase 2: Transitional Stage; High CBR but decreasing CDR; Rapid rise in human population. Most rapid rate of pop. increase.

Phase 3: Industrial Stage; Low CDR and decreasing CBR; Pop. still growing but the growth is slower. Heading toward stabilization.

Phase 4: Post-industrial stage. Low CBR & CDR. Pop. stabilized or in a decline.

Population Control Example: China

One-child policy (1979-2016)
Two-child policy (2016-Present)
Significantly reduced fertility rate and increase GDP per capita.

Problems: (1) Aging population;
(2) Increased welfare expense by gov;
(3) Shrinking workforce; (4) gender imbalance (cultural); (5) abortion rate

Population Control Example: India

Male and female sterilization (failed)
Use of contraception (failed)
Culture, religion, and ineffective policy implementation are the reasons for failure.

TFR > RFR. India will become the most populous country in the near future.

Topic: Air Pollution

Key Facts: Indoor air pollution is more severe and deadly than outdoor air pollution. Indoor air pollution occurs more often in rural areas where indoor burning is common. Modern buildings can also suffer from indoor air pollution as well.

Primary pollutant: Pollutants being discharged into the troposphere (e.g.: CO₂, NO_x, SO₂)

Secondary pollutant: Pollutant formed from rxn b/t primary pollutant and other chemicals (e.g. SO₃, H₂SO₄, O₃)

Thermal inversion: The lack of mixing/convection due to density difference (warm, lower density air already positioned on top)

Nitrogen oxide (NO_x): Includes nitric oxide (NO) and nitrogen dioxide (NO₂)

Ozone: Stratospheric ozone is good. It helps block harmful UVA and UVB from the Sun. Tropospheric ozone is bad. It's an irritant.

KEY TERMS

CLEAN AIR ACTS

1973: National Ambient Air Quality Standards
NAAQS Set 6 criteria air pollutants:
CO, NO₂, SO₂, particulates, Ozone, Lead

1990 (SO₂ cap and trade program)

HAP stands for hazardous air pollutant enlisted by EPA, 187 total.

HAP

PRIMARY OUTDOOR AIR POLLUTANTS FROM FOSSIL FUEL

Carbon dioxide (CO₂) - colorless & odorless

Carbon monoxide (CO) - **HIGHLY TOXIC**, colorless & odorless

Nitric oxide (NO) - colorless & odorless, precursor of tropospheric ozone

Nitrogen dioxide (NO₂) - **brown** fume

Sulfur dioxide (SO₂) - precursor of sulfuric acid (acid rain)

Particulate matter (PM) - Two major classes: PM2.5 & PM10; fine particles

Aerosols - Chemical similar to PM in size; e.g. ammonium nitrate (NH₄NO₃)

Mercury (Hg) - discharged from coal burning; exists in the form of CH₃Hg

Lead (Pb) - formerly a major pollutant from gasoline combustion

PRIMARY INDOOR AIR POLLUTANTS

Carbon dioxide (CO₂) - colorless & odorless; usually from cooking

Carbon monoxide (CO) - **HIGHLY TOXIC**, formed when burning w/out sufficient oxygen

Formaldehyde - "new" smell from furnitures and calls

Radon-222 - decay product from uranium-238

Asbestos - formerly used for insulation and fire prevention; fine and abrasive particles

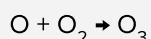
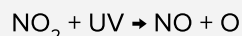
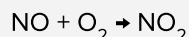
Particulates - Dusts, pollens, mites

Cigarette smoke - Causes lung cancer, cardiovascular disease, unpleasant smell

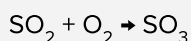
Volatile organic compounds (VOCs) - including methane, benzene, formaldehyde

Key Rxns that You MUST Know

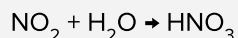
Formation of Tropospheric Ozone (O₃) & photochemical smog



Formation of Sulfuric Acid (H₂SO₄)



Formation of Nitric Acid (HNO₃)



Secondary Pollutants



Photochemical Smog by Vehicles
(Think Ozone and NO_x)

Solutions

Use public transportation
Drive hybrid/electric cars
Bike/Walk/Carpool
Drive more fuel efficient cars

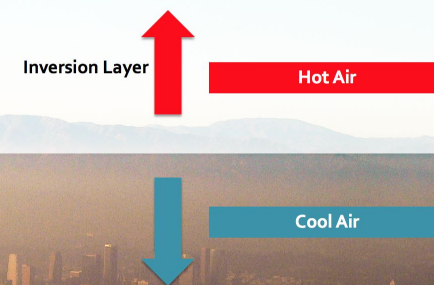


Industrial Smog by Coal Power Plant
(Think SO₂, Hg, Pb, and soot)

Solutions

Use renewable energy
Adopt clean coal technology
Use more efficient appliances

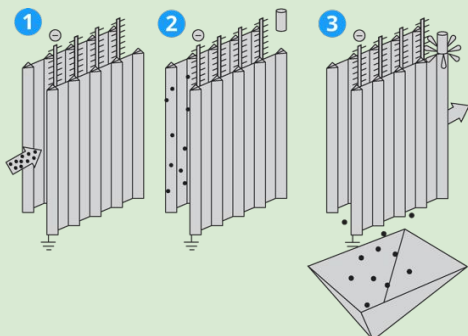
Thermal Inversion



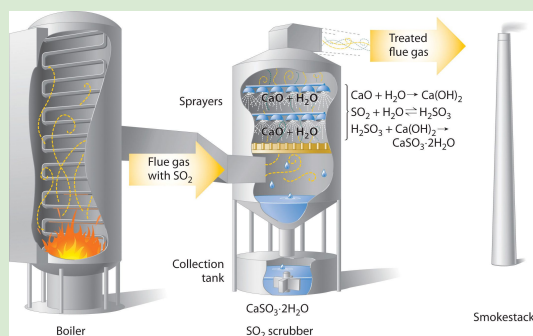
E.g. Los Angeles, Las Vegas, Salt Lake City

Clean Coal Tech

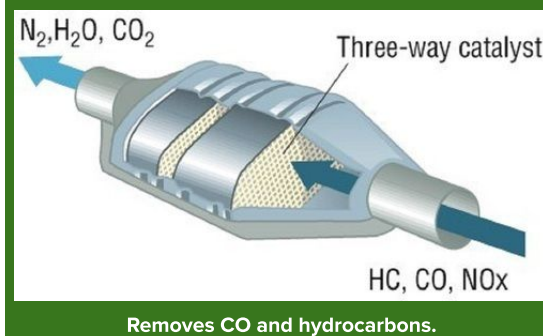
Electrostatic Precipitator



Wet Scrubber



Cleaner Car Exhaust: Catalytic Converter



Topic: Water

Most of the water available is either saline or frozen.
Estuaries and wetlands have the highest average NPP. Open ocean has the highest net NPP.
Mangroves can survive in saltwater while other tree species cannot.

FACTS

KEY TERMS

Cultural eutrophication: Excessive supply of nutrients by humans leading to toxic algal bloom; Usually from inorganic fertilizers.
Bioaccumulation: The accumulation of fat soluble toxins in an individual's body
Biomagnification: The amplification of toxic concentration from one trophic level to a higher trophic level
Dissolved oxygen (DO): Important criterion for aquatic species survival. Pollution and toxic bloom will drastically decrease DO.
Life zones: Analogous to biomes in terrestrial ecosystem
Phytoplankton: Microscopic plant species (producers) dwelling at the top of water surface; major contributor of DO in water
Zooplankton: Microscopic herbivores or omnivores
Aquifer: Group water storage; confined & unconfined; Largest: Ogallala Aquifer
Nektons: Stronger swimmers (whales, sharks, etc)
Benthos: Bottom dwellers (clams)

COMMON WATER POLLUTANTS AND THEIR SOURCES

Nitrates (NO_3^-) & Phosphates (PO_4^{3-}) - Inorganic fertilizers

Mercury (Hg) - Coal-burning power plants

Crude Oil - Oil spill from drilling

Mining waste - Coal mine (acidic waste) and metal mine (basic waste)

Warm water - Heat-producing power plants (coal, gas, geothermal); Thermal Pollution

Drugs and medications - Failure to be removed from water treatment plan

Invasive species - Release of nonnative species; ex. Zebra mussels in Great Lakes

Dioxins - a result of combustion processes such as waste incineration or burning fuels
DIOXINS IS HIGHLY TOXIC! IT CAN CAUSE CANCER, IMMUNE SYS DISEASES, ETC.

Ecological Services

Climate moderation
Nutrient cycling
Waste treatment
Flood control
Groundwater recharge
Habitats for aqua. & terr. species
Genetic resources and biodiversity
Scientific Information

Water Measurements

Temperature
Turbidity
pH
Dissolved O_2
Nitrates
Phosphates
Fecal coliform
Salinity
 CO_2

Saltwater Life Zones

Coastal Zones

Estuaries
Wetlands
Mangrove Swamps
Intertidal zone
Barrier Islands
Coral Reefs

Open Ocean

Euphotic zone (top)
Bathyal zone
Abyssal zone (bottom)

Freshwater Life Zones

Lakes

Littoral (near coast)
Limnetic (top & middle)
Profundal
Benthic (bottom)

Rivers

Source zone (high)
Transition zone
Floodplain zone (near SL)

WATER TREATMENT PLANT

PRELIMINARY

Screening: removal of large solids

PRIMARY | PHYSICAL TREATMENT

Primary sedimentation: Let most solids settle
Solid sludge will be dried and disposed.

SECONDARY | BIOLOGICAL TREATMENT

Aeration tank: Provide oxygen to let bacteria remove harmful agents.
Additional sludge will settle and discharged.
Chlorine or ozone is used to disinfect water.

TERTIARY | CHEMICAL TREATMENT

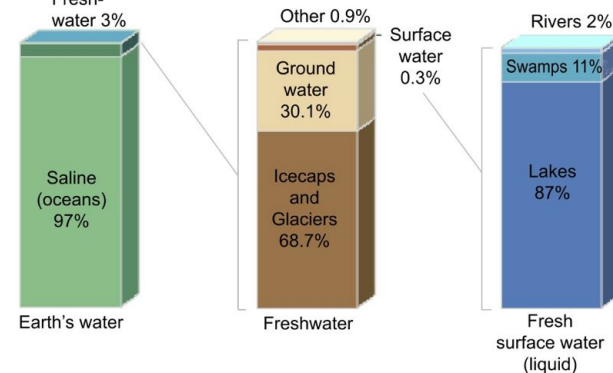
Removal of nitrates and phosphate

INVASIVE SPECIES FOUND IN THE GREAT LAKES

Sea lamprey
Eurasian ruffe
Alewife
Zebra mussels
Asian Carp



Distribution of Earth's Water



USE OF FRESHWATER

70% Agriculture; 20% Industrial;
10% Domestic (Primary use: flushing toilets)

METHODS TO OBTAIN FRESHWATER

Lakes, reservoirs, aquifer & river
Desalination (Middle East, U.S., Singapore)
- Reverse osmosis or distillation

FACTS ABOUT GROUNDWATER

Takes long time to recharge
Withdrawal rate > recharge rate
Currently considered as nonrenewable
Also known as **fossil water**
Susceptible to pollution from fertilizers, pesticides

IMPACT OF AQUACULTURE

Pollution from feeds and fish species
Use of antibiotics and hormones
Crowded space leads to spread of disease
Major source of fish supply from fish farms

CLEAN WATER ACT (1972)

Focused on regulating discharges from traditional point source facilities (municipal sewage plants and industrial facilities), e.g. runoff from streets, construction sites, farms, etc. This act does not deal with groundwater or quantity problems.

SAFE DRINKING WATER ACT (1974)

Requires EPA to regulate pollutants that will cause negative public health effects. It requires protection of drinking water and its sources such as rivers, lakes, reservoirs, springs, and groundwater wells.

Topic: Toxicity and Waste

"The dose makes the poison." – Summary of classic toxicology maxim.

Quote

Estimated Decomposition Rate

Paper	Leaves	Orange peel	Milk carton	Plastic bag
				
2-4 Weeks	1-3 Months	3-6 Months	5 Years	10-20 Years
Alum. Can	Plastic Pkg Ring	Plastic Bottle	Glass Bottle	Styrofoam
				
200-400 Years	400-500 Years	400-500 Years	500+ Years	Never

KEY TERMS

LD50 (Lethal dose-50): the dosage of a toxin it takes to kill 50% of the population

Threshold level: dosage level that begins to show negative effects

Threshold toxin: a toxin that shows a negative affect only after a certain (threshold) dosage; e.g. oxygen, water

Non-threshold toxin: a toxin that shows a linear direct response to toxin with dosage exposure; e.g. Lead (Pb), benzene

Carcinogens: chemicals that can cause cancer; e.g. Nicotine, asbestos, formaldehyde, radon-222

Mutagens: chemicals that leads to DNA mutations; e.g. Bromine, benzene

Teratogens: chemicals that cause birth defects; e.g. Mercury (Hg)

Persistent Organic Pollutants (POPs): powerful toxins that are known to bioaccumulate and biomagnify; e.g. DDT, DDE, PCBs, dioxins, furans

Acute effect: physiological effect from short exposure to high levels of toxin

Chronic effect: physiological effect from long-term exposure to low levels of toxin

Common Water Pollutants and Their Sources

Nitrates (NO_3^-) & Phosphates (PO_4^{3-}) - Inorganic fertilizers

Mercury (Hg) - Coal-burning power plants

DDT - pesticides that were used in agriculture; banned in the U.S. in 1973

BPA - act as an endocrine disruptor that behaves like estrogen at low doses.

DDT, DDE, PCBs - endocrine disruptor that affects thyroid hormones

Crude Oil - Oil spill from drilling

Mining waste - Coal mine (acidic waste) and metal mine (basic waste)

MTBE - Methyl tertiary-butyl ether; a stabilizing additive used for gasoline. Carcinogen.

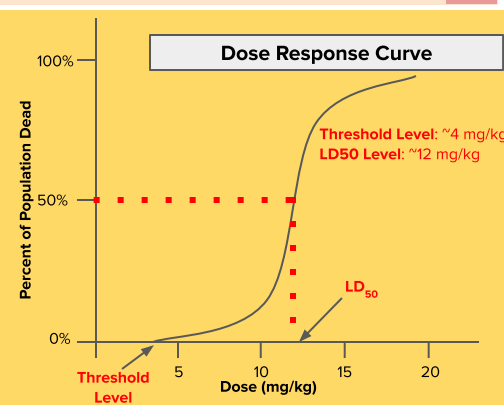
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DIOXINS IS HIGHLY TOXIC! IT CAN CAUSE CANCER, IMMUNE SYS DISEASES, ETC.



Toxicological synergy: Combination of toxins may greatly amplify or reduce the harmful effects. e.g. Cadmium + copper = extremely lethal!

ORIGINS OF WASTE

75% Mining and oil/gas production;
13% Agriculture; **9.5%** Industry;
1.5% Municipal; **1%** Sewage sludge

DRAWBACKS OF USING LD50

- Data are from usually from mice testing. It may not be accurate to humans.
- Genetic difference is not being accounted for.
- Restricted to orally administered toxins
- Organisms with a larger body mass tend to have a higher tolerance. Mice may not give accurate reference to humans.

PRIORITY OF WASTE TREATMENT

Reduce, Reuse, Recycle 1

Incineration (generate electricity) 2

Landfill 3

1 LANDFILL (BURYING)

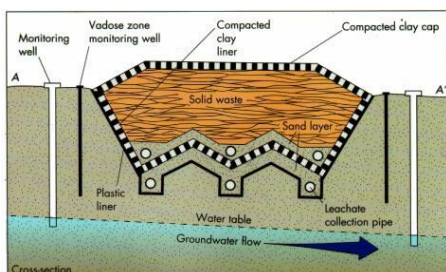
55% of Trash

Sanitary landfill (Modern)

- Covered by clay and soil daily to prevent odor emission and lined with multiple layers of synthetic liner to prevent leachate contamination to surrounding environment
- Built with methane & leachate collection

Open dump (Old)

- Strong odor, methane pollution, leachate contamination, pest problem



2 INCINERATION

13% of Trash

It is great...

- The heat released can be used for electricity generation.
- It takes much less space than landfill.

It is horrible...

- The emission from burning includes CO, particulates, toxic ash, heavy metals



3 RECYCLING

33% of Trash

It is effective...

- It reduces the demand of raw materials.
- It reduces the demand of landfill.
- It is a sustainable use of materials.

It is not effective...

- Trash contamination in recyclables requires additional cost for manual removal.
- The operating cost is still high unless there is government financial assistance.



Toxic Substances Control Act (1976)

If the EPA finds any of these chemicals threatening to the environment or a human-health hazard, they can ban the chemicals from being manufactured or imported into the United States.

STOCKHOLM CONVENTION (2001)

In 2001, countries agreed to reduce or eliminate the production, use, and/or release of 12 key POPs. However, due to their persistence, the negative impact of POPs is still causing deaths worldwide.

Hazardous Materials Transportation Act ('75)

The Hazardous Materials Transportation Act of 1975 (HMTA) empowered the Secretary of Transportation to designate as hazardous material any "particular quantity or form" of a material that "may pose an unreasonable risk to health and safety or property."

Topic: ENERGY

Key Facts: Except geothermal energy, the **Sun** is the ultimate source of energy.

Primary pollutant: Pollutants being discharged into the troposphere (e.g.: CO₂, NO_x, SO₂)

Secondary pollutant: Pollutant formed from rxn b/t primary pollutant and other chemicals (e.g. SO₃, H₂SO₄, O₃)

Greenhouse gas: Gas that can absorb heat or infrared (e.g. CO₂, CH₄)

Acid rain: Secondary pollutants created by SO₂ or NO₂

Mercury: A neurotoxin and teratogen emitted from coal-burning power plants; capable of bioaccumulation and biomagnification

KEY TERMS

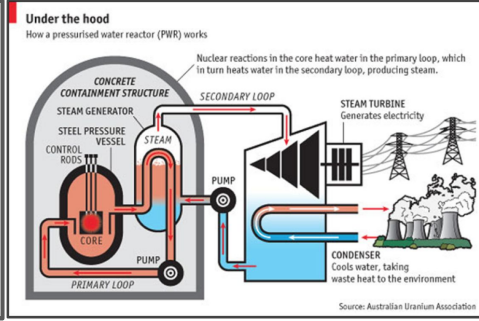
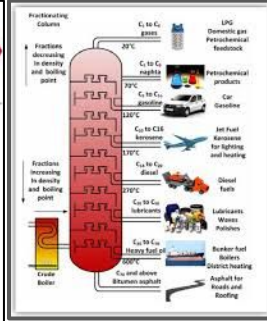
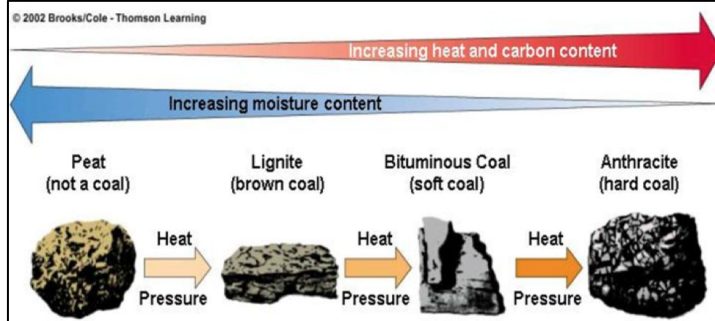
CLEAN AIR ACTS

1973: National Ambient Air Quality Standards
NAAQS Set 6 criteria air pollutants:
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1990 (SO₂ cap and trade program)

WHAT YOU MUST KNOW...

- The pros and cons for each energy sources
- Environmental damages from nonrenewable energy
- Grades of coal (lignite, subbituminous, bituminous, anthracite)
- The ecological damages from ANWR oil drilling
- China is the leading country in wind power and hydropower in production.
- China and the U.S. have the most coal.
- CO₂ emission from fossil fuel combustion.
- The structure of nuclear power plant
- The generic structure and parts of steam-powered power plants
- Limitation of each renewable energy source
- The separation of products from crude oil through fractional distillation
- Half life definition and calculation from nuclear isotope
- Calculations w/ energy units (BTU, kcal, Joules, etc.)
- Energy efficiency calculations



NONRENEWABLE ENERGY

COAL

STEAM-POWERED TURBINE GENERATOR

LARGEST RESERVES: CHINA & UNITED STATES

It is the most polluting fossil fuel, mostly used for electricity. Combustion of fossil fuel releases CO₂, SO₂ (leading to acid rain), mercury, and particulates. It is the leading cause of mercury in aquatic species. Mining of coal leads to widespread habitat destruction and pollution in air and water. Meanwhile, it is abundant with high net energy ratio.

OIL

LARGEST RESERVE: SAUDI ARABIA

There are two kinds of oil: conventional (Middle East/OPEC) and unconventional (Canada/USA). Conventional Oil: Cheap, fast, and efficient to extract. Unconventional Oil: Costly and more polluting. Major risk of oil spill. Crude oil can be refined to different useful products, such as fuel, plastic, vaseline, using fractional distillation method. **However, it is expected to run out within 100 years.**

GAS

STEAM-POWERED TURBINE GENERATOR

LARGEST RESERVE: RUSSIA

It is composed of primarily methane. It is difficult to transport, which makes it a less favorable fossil fuel. Natural gas is, however, much cleaner than oil and coal, producing only CO₂ and water as byproducts. Extraction method: fracking/hydraulic fracturing.

U-235

STEAM-POWERED TURBINE GENERATOR

EXTREMELY LONG HALF LIFE: 700K years half life

It is NOT a fossil fuel! It is considered nonrenewable because there is a finite amount of uranium-235 on earth. It does not emit CO₂ during the electricity generation process but it requires extensive energy for mining. WE DO NOT HAVE A LONG TERM SOLUTION FOR NUCLEAR WASTE.

RENEWABLE ENERGY

HYDRO

TURBINE GENERATOR

POLLUTING BEHIND THE SCENES

No CO₂ emission during electricity generation. But proved to be a major CO₂ and CH₄ emission source from decomposition in upstream areas. It leads to displacement of people upstream of the reservoir and disruption of aquatic ecosystem in the downstream. Some fish, like Salmon, would not be able to spawn. China has the most dams and the most generation capacity from hydropower. Some dams are built at seismic zone, such as the Three Gorges Dam (China).

WIND

TURBINE GENERATOR

ONSHORE VS. OFFSHORE?

The cleanest and most popular renewable energy. It could lead to noise pollution but they are usually located away from urban areas. Onshore wind turbines are cheaper but the wind speed limits its production capacity. Minimum wind speed for wind turbines to operate is 15 mph. Offshore turbines would offer much better capacity due to higher wind speed but they cost too much to build since they require long, water-resistant electricity transmission lines.

SOLAR

STEAM-POWERED* TURBINE* GENERATOR

ACTIVE SOLAR & PASSIVE SOLAR

Active solar power includes photovoltaic cells (PVCs) and steam-generating power plant. The two major problems are (1) they require a huge amount of land and (2) manufacturing of the PVC panels requires mining of rare earth metal. (Consider all the negative impacts on ecosystem from mining.) Passive solar uses the design on the building to reduce the use of energy to keep house warm in winter and cool in summer. Houses should face south (generally) to receive more sunlight in winter.

BIOMASS

BURNING VEGETATIONS (e.g. TREES)

Burning biomass is considered as renewable energy sources because the vegetations absorb CO₂ from photosynthesis and the same amount of carbon is being emitted during burning. Therefore, the net carbon emission is considered as zero. However, burning biomass poses **significant health risks** because the regions where biomass is used are likely **poor** and **indoor air pollution** from burning will be a leading factor of death.

FUEL CELL

HYDROGEN; POOR NET ENERGY RATIO

Fuel cell is still at an experimental stage because the net energy ratio is less than 1, meaning that there is a net energy loss to use such energy. Hydrogen is difficult to extract and it is not abundant (0.000055%) in the atmosphere. The advantage of fuel cell is that the only byproduct (or "waste") is water vapor. It is a GHG with a very short residence time in the atmosphere when compared to CO₂. The risk of fuel cell includes safety of the storage device due to explosion risk.

TIDAL/WAVE

TURBINE GENERATOR

SMALL PRODUCTION CAPACITY

Tidal/wave energy harnesses the constant motion of water in the ocean. It does not alter land use and only has a minimal impact on the shallow seafloor. The limitation of this energy source is that the scale of energy production is small. It won't be able to compete with wind or solar. It could be used to provide electricity in remote areas but not larger cities or suburbs.

GEOTHERMAL

STEAM-POWERED TURBINE GENERATOR

ONLY AVAILABLE IN SEISMIC ZONES

Geothermal power plants can be built at seismic zones where energy from magma can be used to heat water to produce steam. Because of its location, earthquake could pose significant risks to the structure of the power plant. In addition, geothermal energy could lead to water pollution that contaminates groundwater. The U.S. is currently the leading country in geothermal electricity generation.

ETHANOL

IT DEPENDS ON THE SOURCE CROP.

There are different crops used to extract ethanol. In the U.S. corn is used for ethanol extraction while Brazil uses sugarcane and switchgrass. Corn-based ethanol has a poor net energy ratio, slightly above 1, whereas sugarcane- and switchgrass-based ethanol has a net energy ratio 5-8. The problems of using corn as fuel source are (1) It requires the use of fertilizers and pesticides; (2) Corn is a significant food source; (3) There are not many vehicles that can utilize ethanol as fuel.

Topic: CLIMATE CHANGE

Key Facts: Climate change is caused by anthropogenic emission of CO₂. Temperature has been steadily increasing. The rising CO₂ concentration and temperature is causing various disasters.

ULTIMATE CAUSE OF CLIMATE CHANGE

CO₂ ↑
from fossil fuel burning

KEY TERMS

Notable GHGs Other than CO₂

CH₄

Source
agriculture, melting permafrost

N₂O

Source
fertilizers, cars, deforestation

CFC_s

Source
aerosol, refrigerants

PRIMARY IMPACT FROM CO₂ INCREASE

RISE IN GLOBAL AVERAGE TEMPERATURE

Because CO₂ is a GHG, it absorbs thermal radiation (infrared) and makes the climate warmer. With removal of trees, we are putting more CO₂ in the atmosphere.

ACIDIFICATION OF OCEAN

With more CO₂ in the atmosphere, it disrupts the balance between ocean and CO₂. More CO₂ will dissolve into the ocean, forming carbonic acid (H₂CO₃), making the ocean more acidic.

MELTING ICE EVERYWHERE

Ice sheets from Greenland and Antarctic have been melting at unprecedented rate in the previous decades. Ice extent at the Arctic continues to shrink over the years. It will affect the thermohaline circulation, which redistribute heat. **WITH LESS ICE ON SURFACE, MORE HEAT WILL BE ABSORBED BY LAND OR WATER, CAUSING FURTHER HEATING.**

EXTREME WEATHER EVENTS

These events include droughts, precipitations (rain or snow), tornadoes, hurricanes, and heat waves. According to IPCC, the U.S. will have more severe drought. India with stronger monsoon. The intensity of hurricane will increase (not the number of hurricanes).

SEA LEVEL RISING

Two causes of increasing ocean volume: (1) More ice melt (freshwater) from glaciers and ice sheets; (2) Expansion of sea water from warmer ocean. Rising sea level will jeopardize coastal ecosystems, countries, and cities that are near or below sea levels.

INCREASE IN METHANE (CH₄) EMISSION

Lots of CH₄ stored under permafrosts and at deep ocean due to decomposition. When melting permafrosts and warmer ocean, CH₄ is released into the atmosphere. **CH₄ is a GHG and it is 30x more powerful in absorbing heat compared to CO₂.**

CORAL REEF BLEACHING & DYING

Corals rely on microorganisms and algae to provide nutrients for them to grow. With the stress from warmer and more acidic ocean, the microbes are dying fast. It leads to the discoloration (bleaching) of corals, which will eventually lead to the death of corals.

DISRUPTING SEASONAL PATTERNS

Winter becomes shorter. Spring comes earlier. Summer gets longer. We notice the change of seasonal patterns by observing indicator species such as migratory birds and trees that lose their leaves for winter. This will cause major impact of the balance of food chain and species population.

INVASIVE SPECIES, VECTORS, DISEASES

Warmer temperature will put stresses on native, endemic species that have a narrow range of tolerance. More adaptive invasive species could threaten the population of native species. Population of vectors, such as mosquitoes and ticks, will increase exponentially (r-species). This will help diseases like Lyme disease, malaria, West Nile Virus.

WILDFIRE: FREQUENCY AND INTENSITY

With more drought and higher temperature, more forest trees and species are expected to be removed from wildfires. In the U.S. there are more intense wildfires in California, Colorado, Washington State in the past yrs.

THERE IS A BUILD-IN DELAY ON EVENTS.

It is important to understand that there is a build-in delay on climate change and also sea level rise. It may take years to see the full impact of increasing CO₂ concentration and temperature.

MONTREAL PROTOCOL (1987)

Int'l agreement that phased out the production of CFCs and HCFCs. Both will cause the depletion of ozone.

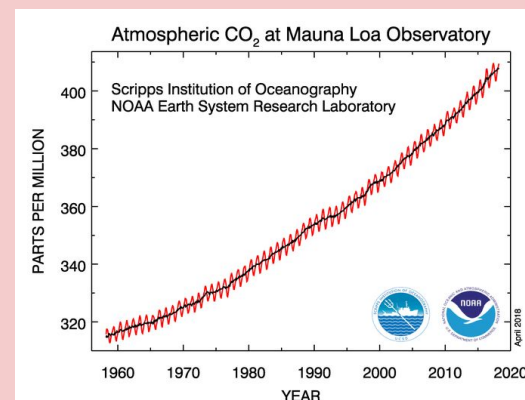
KYOTO PROTOCOL (1997)

Int'l agreement that aimed to cut down GHGs/carbon emission. Nations set target for GHGs reduction such as: CO₂, CH₄, N₂O, SF₆, HFCs and PFCs. Major countries who did not sign the agreement: **U.S.A.** and **Canada** (withdrawn in 2006)

PARIS CLIMATE ACCORD (2016)

The Accord aims to respond to the global climate change threat by keeping a global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. Despite President Trump's opinion against the Accord, the earliest withdrawal date is Nov 2020.

KEELING CURVE



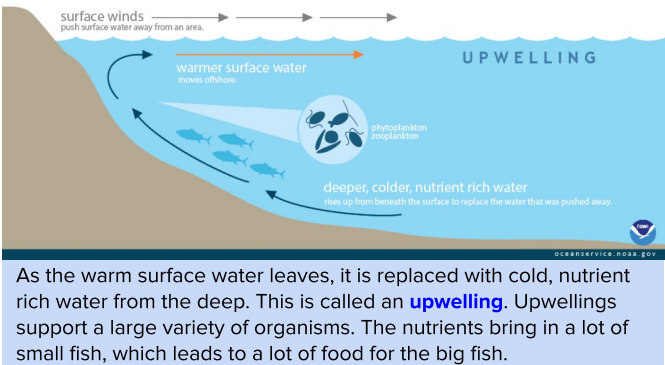
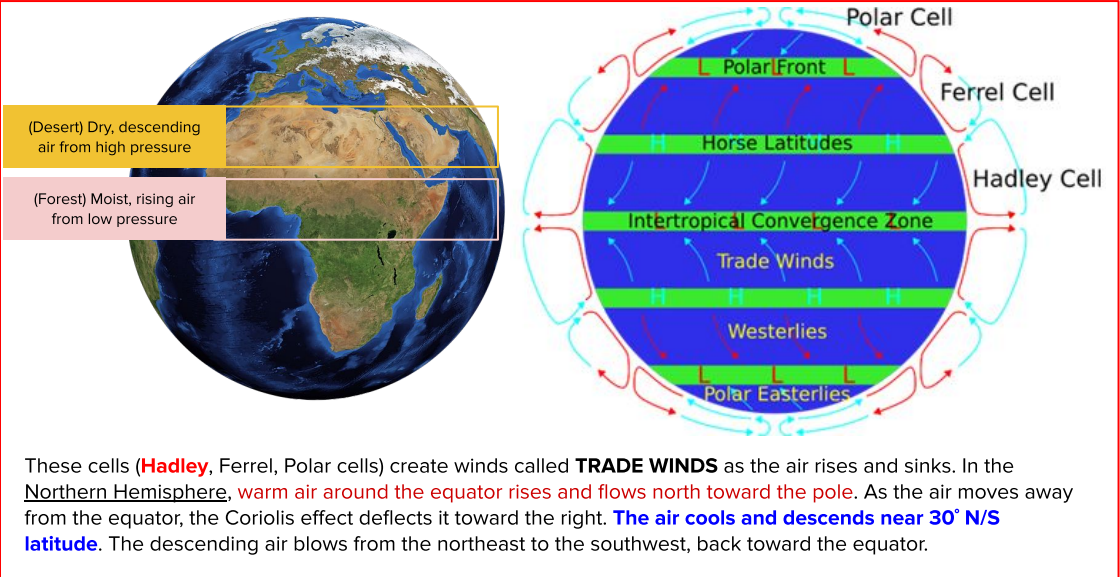
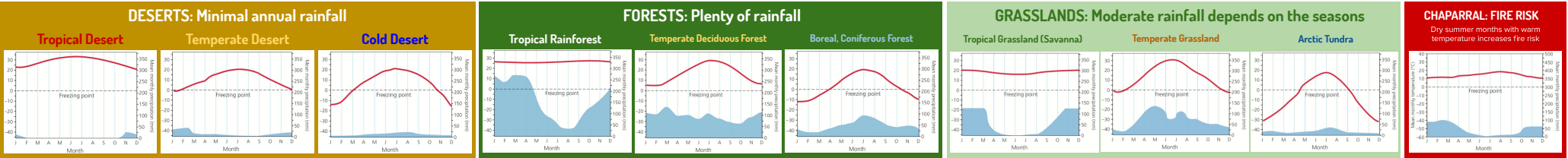
2019/04 CO₂ READING: 413 ppm

SECONDARY IMPACT FROM CO₂ INCREASE

WEATHER PATTERNS

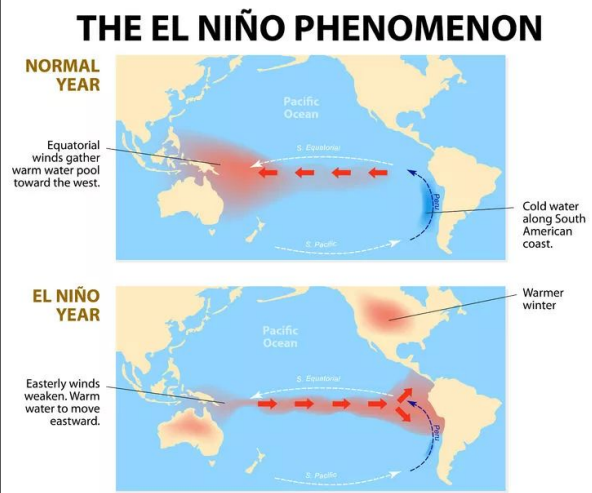
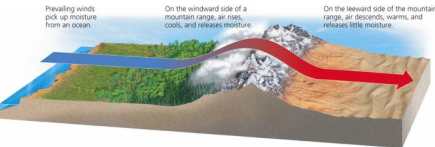
CLIMATE: Climate is a pattern of weather conditions at a specific region. Climate data is produced by averaging at least 30 years of weather data, such as temperature and precipitation. We can also study ancient climate by studying ice core and tree rings. Ice core samples reveal ancient GHG levels and temperature, usually done by studying element isotopes, such as oxygen.

THERMOHALINE CIRCULATION: A global ocean circulation that transports heat across all the major oceans. The warm water descends near Greenland as water evaporates near Greenland, resulting in denser saltwater. The melting of Greenland ice sheet would dilute the saltwater, reducing the rate of sinking. This will slow the entire circulation, creating areas in Indian Ocean and Pacific Ocean (near Japan) to accumulate heat. This would breed powerful storms and monsoon that could jeopardize human lives in the affected regions.



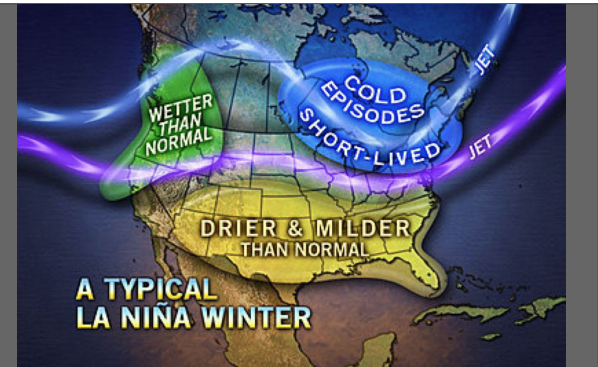
Upwelling causing significant temperature difference by the coast. This feature can be seen near the San Francisco Bay area where the wind often pushes the surface water offshore, causing upwelling. This is why Alcatraz was built at San Francisco because the water would be too cold for prisoners to escape.

Rain Shadow Effect: Windward side of the mountain acts as barrier, forcing the moisture to condense. The windward side will have more precipitation. As the air passes through the mountain range without the moisture, the leeward side of the mountain is dry, possibly having a desert climate. Example: Arizona, Nevada, Chile

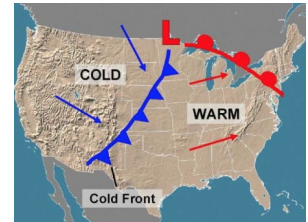
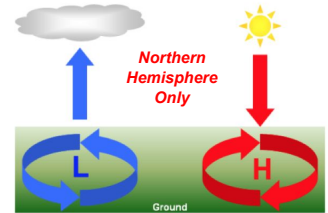


Normally, the winds flow from East to West, and push the warm sun heated surface water from East Pacific over to West Pacific near the equator. Every few years the trade winds in the tropics weaken or sometimes reverse direction. When this happens it is called an El Niño pattern.

IMPACT OF EL NINO
During an El Niño pattern, the winds weaken or reverse, so warm water is pushed towards the South & North American western coasts (instead of away) and causes the surface water to heat up there. Since wind isn't pushing the warm water away, El Niño suppresses upwellings, resulting in less food for predators AND fisherman too. In terms of weather pattern, due to higher sea surface temperature, the evaporation rate of water increases, leading to more rainfall in the U.S. (west coast & Midwest).



La Niña is the EXACT opposite of El Niño. The Pacific experiences unusually cool surface water temperatures along the California coast as the trade winds speed up, which makes for larger than usual upwellings along the coasts of California and South America. Hurricane activity in the Pacific declines these years. Because of La Niña, Texas, California, Arizona, and New Mexico experience a **"Megadrought"** between 2009 and 2012.



COLD FRONT: Thunderstorm due to rigorous convection, heavy rainfall, sudden drop of temperature after the passing of a cold front.
WARM FRONT: Light rain/drizzle; cloudy sky

Topic: GEOLOGY/MINING

Key Facts: Mining involves the exploration and extraction of nonrenewable materials. Mining activities can pollute air and water and requires use of fossil fuel.

Subduction: A denser tectonic plate is submerged underneath another less-dense tectonic plate. Earth earthquakes can occur.

Hot spot: Hot magma intrudes through the crust, forming volcanic islands. Example: Hawaii & Yellowstone volcano.

Igneous rock: Rocks formed by lava (on earth's surface) or magma (below earth's surface).

Sedimentary rock: Rocks formed by weathering and/or erosion (by wind, water, and/or acid) of igneous or metamorphic rocks.

Metamorphic rock: Rocks formed by heat and pressure below the earth's surface. Usually found near convergent plate boundary.

Richter Scale: A logarithmic scale that describes the magnitude of an earthquake event. Ex. M 8.0 is 10x stronger than M 7.0 and 100x stronger than M 6.0. In terms of **energy released** in an earthquake event, each integer difference 30x. M 8.0 earthquake releases 30x more energy than M 7.0 and 900x more energy than M 6.0. Earthquake with a M 6.0 or higher is considered as an major earthquake.

Focus: Location of an earthquake event. Shallow earthquake is <70 km from the surface; deep earthquake is >300 km below surface.

Epicenter: The surface perpendicular above the focus.

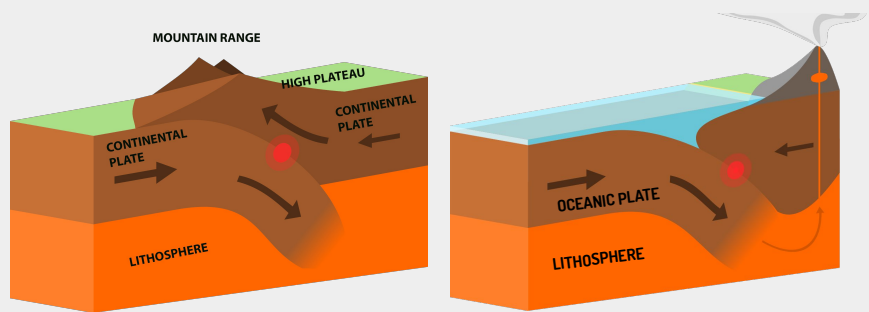
Tsunami: Gigantic ocean waves caused by the displacement of water. Recent events: 2011 Tohoku (Japan), 2004 Sumatra (Indonesia)

Spoils: Waste soil and rock removed during surface mining. **Gangue:** undesired, waste materials in an ore.

Tailings: Leftover, useless materials from mining; usually mixed with waste water.

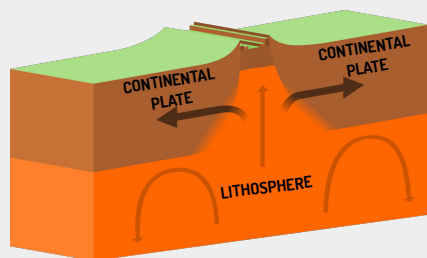
Mining Dilemma: Low-grade ores are widely available, but it requires great amount of energy to extract and refine. High-grade ores are limited and difficult to locate.

CONVERGENT PLATE BOUNDARY (DESTRUCTIVE)



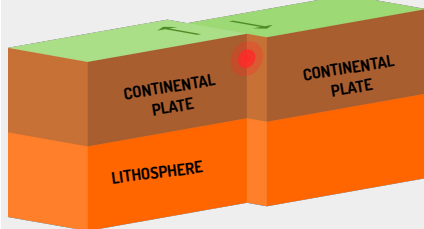
Two tectonic plates moving **toward** each other, often creating catastrophic earthquakes. (Recent: 2011 Japan Tohoku M 9.0 earthquake) Two possible features can form at this type of boundary. **Mountain range** (left picture): The less-dense continental plate is being pushup. Example: The **Himalayas** formed by the collision and pushing of Indian and Eurasian plates. **Trench** (right): The denser oceanic plate is subducted and pushes the continental plate down. The melting of both plates will lead to formation of volcanoes and volcanic eruption. Example: **Mariana Trench** (near the Philippines.)

DIVERGENT PLATE BOUNDARY



Two tectonic plates moving away from each other. New surface is formed. Mild earthquake may occur. Example: Mid Atlantic Ridge.

TRANSFORM FAULT



Two tectonic plates moving in opposite direction, parallel from each other. Major earthquake can occur if the plates fail to move. Example: San Andreas Fault.

KEY TERMS

MINING METHODS

Open-pit mining: Cheapest and safest mining method. It devastates large area of land by removing trees and natural habitats.

Strip mining: More eco-friendly but costly because smaller areas of land are being mined.

Contour mining: More eco-friendly but costly. Mining is done along the same height of a mountain.

Mountaintop removal: Devastating to natural habitat and ecosystem, especially when mountains have great biodiversity due to the diversity of climate and ecosystems. Example: West Virginia

THE GENERAL MINING LAW OF 1872

Outdated mining law to let mining company to buy land at a cheap price to develop the West. It becomes a loophole to acquire valuable land cheap.

SURFACE MINING CONTROL AND RECLAMATION ACT (SMCRA)

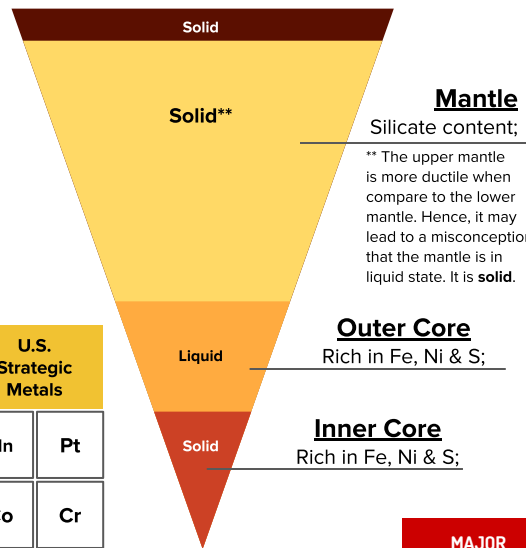
This was passed in 1977 due to mining occurring without the disregard of the environment. This program paid for the cleaning of abandoned mines to help the environment. SMCRA requires that companies obtains permits, gives government authority to regulate and inspect mining sites, and prohibits mining on certain lands such as national parks.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA)

CERCLA (1980), also known as **Superfund**, established prohibitions and requirements concerning closed and abandoned hazardous waste sites; provided for liability of persons responsible for releases of hazardous waste at these sites; and established a trust fund to provide for cleanup when no responsible party could be identified. It has two response actions: **Short-term removals** (urgent) and **Long-term remedial response actions** (not immediately life threatening).

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

RCRA (1976) is created by the EPA to (1) manage and regulate solid waste; (2) manage and regulate hazardous waste; and (3) protect groundwater from underground storage tanks (such as nuclear waste storage facilities). It also aims to reduce over amount of solid and hazardous waste.



SEISMIC WAVES

P (primary) Wave: Longitudinal wave -- the particles' vibration is parallel to the movement of the wave. It can penetrate through solid and liquid.

S (secondary) Wave: transverse wave -- the particles' vibration is perpendicular to the movement of the wave. It can only penetrate through solid (crust and mantle).

Surface wave: rotational wave. This is the wave that we can feel during an earthquake event.

The difference in P and S waves allows geologists to understand the physical properties (solid vs. liquid) of inner earth layers.

MAJOR VOLCANIC ERUPTION

Mount Pinatubo (1991): Violent eruption in the Philippines that ejected great amount of volcanic ash and aerosols that led to a 0.5°C decrease in global mean temperature. Aerosols were trapped in the stratosphere.

Topic: **FOOD/AGRO**

Key Facts: The current industrial agricultural practice is unsustainable in terms of energy use, water use, land use, and chemical use.

Organic fertilizer: Made from compost and/or cow manure. Nutrients can slowly release to soil for plant absorption.

Inorganic fertilizer: Made from chemicals that can easily dissolve in water. Nutrients not absorbed by plants can pollutant water.

1st Green revolution: Industrialization of farming practice by utilizing heavy machineries. Increases the use of fossil fuel.

2nd Green revolution: Innovation of genetic engineering that can modify crops to be resistant to drought, flooding, diseases, etc.

Traditional subsistence farming: Small scale farming in rural areas that aims to provide crops for farming to be self-sufficient

Traditional intensive farming: Moderate scale farming that aims to provide crops for farmers to sell for small profit.

Soil erosion: Loss of topsoil and nutrients by exposure of soil to sunlight/water/wind. Decreased crop production or crop failure.

No-till farming: Conservation farming practice that reduces the disruption of top soil. Covered by dead organic matter to protect soil.

Soil salinization: Accumulation of minerals/salts from excessive irrigation.

Feedlot: A.k.a. Concentrated animal feeding operation (CAFO); Unsustainable practice of livestock farming. It requires intensive use of fossil fuel, water, and, sometimes, hormones and antibiotics. It leads to major water pollution problem from surface runoff.

Aquaculture: As global fish stock collapses, more fish are farmed from cages in the water to provide sufficient supply for global market. It causes water pollution problems as feeds, feces, pollutants, and diseases easily spread in the water.

KEY TERMS

FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

Focused on providing federal control of pesticide distribution, sale, and use. EPA was given authority to study the consequences of pesticides usage and require users to register pesticides purchases.

MACRONUTRIENTS -- LARGE QUANTITY

Carbohydrates, proteins, and fats

MICRONUTRIENTS -- SMALL QUANTITY

Vitamin A (blindness)	Vitamin C (Scurvy)
Vitamin D (Rickets)	Calcium (bone loss)
Iron (anemia)	Iodine (goiter)

Notable Inorganic Fertilizers



Nitrates



Phosphates



Sulfates

COMMERCIAL FISHING METHODS

Bottom trawling: Fishing boat dragging large fishing nets near the bottom of the ocean floor. It results in large fish catch and also **bycatch**. It severely destroys the habitats of the ocean floor, including corals.

Longlining: A single long line with hooks that may result in large number of bycatch. The line and hooks can get stuck by rocks or corals, becoming harmful trash.

Purse seine: Fishing boat captures a small area of fish by circulating the fish with nets and then pulling all the fish out of water. Relatively smaller amount of bycatch.

Gillnetting: Stationary net with hooks that would capture the fish. Because the net is often invisible by fish, the hooked fish at the net may attract other fish to swim to the net, increasing fishery yield

SUMMARY OF PESTICIDES

First-generation pesticides: Highly toxic compounds such as arsenic, mercury, and lead that cannot be broken down because they are elements.

Second-generation pesticides: Synthetic organic compounds such as DDT. It is harmful because (1) It is a broad spectrum pesticide, meaning that it is toxic to a wide range of pests; (2) It is persistent, i.e. does not breakdown in long time; (3) It is fat-soluble, i.e. it can bioaccumulate and biomagnify.

Monsanto, GMOs & glyphosate: Monsanto developed and modified soybean seeds that can resist the application of glyphosate (key ingredient in Roundup®). It dominates the soybean market. Frequent, repeated usage of glyphosate (or any pesticides) will lead to chemical and genetic resistance, causing the rise of superweed. Glyphosate is proven to be carcinogenic and Monsanto is ordered to pay millions of compensations to the victims.

Rachel Carson: A biologist who wrote the book Silent Spring to raise public awareness on the uncontrolled use of pesticide that led to the death of fish and birds.

Chemical treadmill: Farmers who have been using pesticides to treat pests is forced to use more pesticides or more powerful pesticides in order to suppress pest problems. It's a financial problem too.

INTEGRATED PEST MANAGEMENT (IPM)

Physical Control: Highly toxic compounds such as arsenic, mercury, and lead that cannot be broken down because they are elements.

Biological Control: Synthetic organic compounds such as DDT. It is harmful because (1) It is a broad spectrum pesticide, meaning that it is toxic to a wide range of pests; (2) It is persistent, i.e. does not breakdown in long time; (3) It is fat-soluble, i.e. it can bioaccumulate and biomagnify.

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A NATION DEPENDENT ON CORN

The United States is known for corn farming in the High Plains. The area is suitable for corn farming because of the climate and the abundance of groundwater from the **Ogallala Aquifer**, which results in drastic depletion of the Aquifer. Corn farmers are subsidized by the government. This allows corns to be sold at a price below cost. This is the reason that corn is used to make animal feeds for livestock, which allows the meat price to be cheap. Fast food restaurants can sell meat products cheap for this reason. In addition, corn is used for the extraction of ethanol, despite the energy yield ratio is barely over 1.

WATER IRRIGATION METHODS

Drip irrigation: Directly deliver water to plant roots and/or soil surface to reduce evaporation. It can reduce water usage by 80% and increase crop yields.

Drought-tolerant crops: This kind of crop can reduce the consumption of water.

Irrigation scheduling: Integrating water sensors and weather forecast to determine the amount of and times to irrigate can reduce overconsumption of water.

Windbreaks: Planting 1 to 2 stands of trees around a farm can reduce evaporation rate and soil erosion by wind.

Conservation tillage or no-till farming: Using minimal to no-till practice can increase soil's ability to retain moisture. Cover crops can reduce exposure to sunlight and wind and, thus, reducing loss of water from evaporation.

CASE STUDY: HONEY BEES

Honey bee population is collapsing worldwide. This phenomenon is known as **Colony Collapse Disorder (CCD)**. There are a few reasons that lead to CCD.

Pesticide/Neonicotinoid: It is a known pesticide that will attack honey bees' neurological system, causing honey bees to lose their ability to navigate back to their beehives. It has already been banned in the European Union. The US, however, still allows the use of neonicotinoid.

Parasite/Varroa Mite: This mite spreads globally due to the global pollination operation. Honey bees are shipped to different continents to pollinate crops. Varroa mite can live inside the bee's body and eventually kill the bees. Use of chemicals to eradicate the mites is not an ideal option because it may lead to chemical resistance by the mite. **Co-evolution** would be a better strategy to let bees to fight off the mites.

GMOs: The change of genetics in crops is affecting the chemistry of honey bees' diet.

Invasive species/Zombie fly: Zombie fly is a natural predator of fire ants. It is introduced as the biological control of the fire ants in the US. It is known that the fly can attack honey bees as it does to fire ants. It highlights the challenge of biological control on invasive species.

Topic: **ECOLOGY**

Key Facts: The survival of the fittest, not the strongest.

KEY TERMS

Native species: Species that have established stable population dynamics in the habitat.

Nonnative species: Migrated species in new habitats. May not survive if they fail to adapt or become invasive with no predator.

Invasive species: Exist without the presence of natural predator. Population size explodes and invade native species' niche.

Indicator species: Capable of revealing important information about the environment, such as air/water quality. e.g. birds, fish

Foundation species: Help establish living habitat for other species. e.g. elephants, corals

Keystone species: Exist in small quantity but have significant impact on the health of an ecosystem, primarily population control.

Endemic species: Specialist species that are found in a unique habitat. Small population. Extremely sensitive to habitat changes.

Generalist: Adapt to wide range of living conditions. High tolerance on temperature, moisture, pH, etc. Likely to be invasive species.

Specialist: Adapt to specific living condition. Unable to survive when conditions are changed. Likely to be threatened/endangered.

Endangered species: High chance of species extinction if no actions are done to protect the species.

Threatened species: Shows a sign of population decline. Could become endangered if no protective actions are done.

K-species: Few offsprings, low reproductive rate, late reproduction, parental care, larger body size, die late.. Logistic population growth.

r-species: High reproductive rate, lots of offsprings, smaller body size, early reproduction, die early. Exponential population growth.

Carrying capacity (K): The maximum population allowed by the available resources at the habitat. It may vary due to condition changes.

Intrinsic rate of increase: The maximum rate of population increase under ideal conditions: plenty of food and mating partners.

Biotic potential: The maximum population size under ideal conditions with the maximum rate of population increase.

Overshoot: Overpopulation of a species when it exceeds the carrying capacity of the habitat.

Reproductive time lag: The time between overshoot and population collapse after population exceeds carrying capacity.

ENDANGERED SPECIES ACT of 1973 (ESA)

ESA helps protect the ecosystems of endangered plants and wildlife. The classification of species (endangered or threatened) allows gov't to develop plans for species protection. It makes trading and capturing of those species illegal. It has authority to seize land from federal gov't to protect endangered/threatened species.

THE CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA (CITES)

It targets the trading of endangered species worldwide. However, CITES unintentionally creates black market that makes the problem worse. Also, the primary problem of species extinction is habitat destruction, not trading. CITES also involves politics and corruptions b/t gov'ts.

CONVENTION OF BIO. DIVERSITY (CBD)

An int'l treaty that aims to preserve biodiversity worldwide. It sets too many goals and the treaty is ineffective in executing the agendas. The US is not part of the treaty.

MAXIMUM SUSTAINED YIELD (MSY)

An ineffective model that allows fishing industry to capture the amount of fish near the maximum population. However, there is no way to tell if the population is indeed at its maximum during fishing season, causing the overfishing problem.

OPTIMUM SUSTAINED YIELD (OSY)

More effective model that allows fisheries to capture fish near, but below, the maximum population. It avoids the overfishing problem and allows young fish to have larger existing population to breed for offsprings.

INDIVIDUAL TRANSFER RIGHTS (ITRs)

A quota system that aims to restrain the no. of fish catch by fisheries. The quota can be traded among fishing companies/individuals. A problem with this system is that smaller fisheries would be pushed out by larger fisheries, leading to either monopoly or oligopoly. Small fisheries that are bought out may risk to fish illegally.

INTERSPECIES INTERACTIONS

Predation; Mutualism; Commensalism; Parasitism

PREDATION & PROTECTION STRATEGIES

Mimicry, chemical warfare, stalking

MASS EXTINCTIONS

Mass extinction occurs when the extinction rate exceeds the natural background extinction rate. There were five (5) mass extinctions in the past, most driven by climate change due to unexpected events such as meteor strike.

Sixth Mass Extinction: Current extinction rate is at least 100-1000x greater than background extinction rate. This mass extinction is driven by human beings due to climate change.

PRIMARY & SECONDARY SUCCESSION

Primary succession: It occurs when there is no existing soil in the environment. The rocks take long time to become soil through weathering and erosion. Time: 500-1000+ years.

Secondary succession: It occurs with existing soil. It often occurs after major environmental catastrophes such as hurricanes, wildfires, or human-caused events such as mining and deforestation. Time: 100-500 years.

NATURAL SELECTION OVERVIEW

There are three important processes in natural selection:

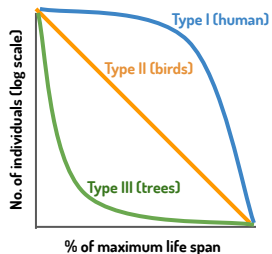
Genetic Mutation: Expected, unplanned genetic changes in the individual.

Adaptation: The genetic mutation may allow the individual to gain advantages on gathering food, finding mates, and producing offsprings.

Differential Reproduction: Individuals will have to compete with other peers for mates. Successful reproduction will allow the genetic traits to pass to their offsprings.

Note: There is no grand scheme of natural selection. Species that fit into the habitat will survive, vice versa.

SURVIVORSHIP TYPES



TYPE I: Most individuals can survive through the early stage and mature. Late deaths.

TYPE II: Some individuals cannot survive through early and developmental stages.

TYPE III: Most individuals may not survive through early and developmental stages. Early deaths.

FOREST PARTS

Emergent layer: Few tree crowns that surpasses the canopy layer. **Canopy:** Majority of tree grown. **Understory:** Below canopy

PROBLEM W/ SMALL POPULATIONS

Founder Effect: Limited individuals in a new colony. The number of healthy offspring could be limited due to the lack of genetic diversity.

Genetic Drift: With small population, the chance of unique genetic traits could be driven out of the gene pool due to limited mates.

Demographic bottleneck: Occurs after catastrophes (natural or human made). Low population size that may not reach the minimum viable population size could go extinct.

Inbreeding: High risk of genetic diseases when close relatives are mating to produce offspring. Healthy offsprings will be limited.

EVOLUTION OF SPECIES

A single species may evolve to different species through the following processes in order. Two distinctive species occurs when their offsprings are sterile.

Geographic isolation: Population of a species are separated into different geographical areas and they no longer interact with each other.

Reproductive isolation: The isolated population of a species mate exclusively among themselves without the interference of other population. Over time, the genetic traits will be significantly different from other species populations; hence becoming a new species.

Topic: HUMAN HEALTH

Key Facts: Some diseases can be prevented by making better decisions to avoid risk factors such as drug use, alcohol abuse, unsafe sex, overeating, smoking, and exposure to harmful chemicals. Genetics can play a huge role on human health too.

KEY TERMS

Pathogens: viruses, bacteria, fungi, protozoa, parasitic worms

Patient Zero: The first patient who is known to contract a certain disease. All individual contacted Patient Zero must be diagnosed.

Emergent disease: Diseases that are new or have existed previously with a rapid increasing trend in incidence and/or area.

Epidemic: Disease that is affecting a localized region.

Pandemic: Disease that is affecting global regions.

Vaccines: Dead or weakened virus or bacteria that can allow human body to create immunity from some diseases

TRANSMISSIBLE DISEASES

SEVERE ACUTE RESPIRATORY SYNDROME (SARS)

SARS is a viral respiratory illness that was first reported in 2003. It spread rapid in Asian countries, killing hundreds of people in China, Hong Kong, and some in Canada. Global travel makes the spread easier.

INFLUENZA (FLU)

Major seasonal viral disease that can be transmitted for air and exchange of body fluid. The virus changes every year. Flu can be prevent by vaccines. It could potentially become pandemic as in Spanish Flu in 1918.

TUBERCULOSIS (TB)

TB is a bacterial disease. It affects lungs and possibly other parts of the body. It can spread through air through coughs, sneezes. AIDS patients can die from TB easily.

EBOLA

There is no known cure or vaccine to Ebola. It has extremely high death rate and it can be transmitted easily by close contact. Countries affected: Guinea, Liberia, Sierra Leone, Congo (all in Africa).

HEPATITIS-B

Hepatitis-B can be transmitted through sex, needles, and birth from mother. There is no cure for this disease. Newborn babies can be vaccinated to prevent contraction of Hepatitis-B.

HIV/AIDS

HIV can be transmitted through sex, shared needles, and birth. Infants with HIV have short lifespan (< 40 yrs). HIV has long incubation time and eventually attack and destroy the patient's immune system, causing AIDS.

OTHER DISEASES

MOSQUITO-RELATED DISEASES

These diseases include malaria, dengue fever, West Nile virus, Zika virus. Mosquitoes are known vectors to spread these diseases. Eliminate standing water to suppress mosquito population.

ASTHMA

Asthma is known to affect infants, children, and elders in areas where pollution is a major environmental problem. It does not transmit to other people.

OBESITY-RELATED DISEASES

Diabetes, cardiovascular diseases, and certain types of cancers, including colon cancer, breast cancer. The U.S. and Mexico are the top two obese countries in the world. These diseases put heavy burden to the medical system.

DEADLIEST DISEASES IN THE USA

1. Heart Disease
2. Cancer
3. Unintentional injuries
4. Chronic lower respiratory diseases
5. Stroke
6. Alzheimer disease
7. Diabetes
8. Flu & Pneumonia
9. Kidney disease
10. Suicide

Topic: WILDFIRES

Key Facts: Most wildfires are caused by humans. Climate change will increase the occurrence of large scale wildfire because of drought.

KEY TERMS

Prescribed fire: Controlled burn to remove excess fuel on forest floor and control pest population near the trees.

Surface fire: Only the leave litter and some dead plants are burned. Small scale and easy to put out.

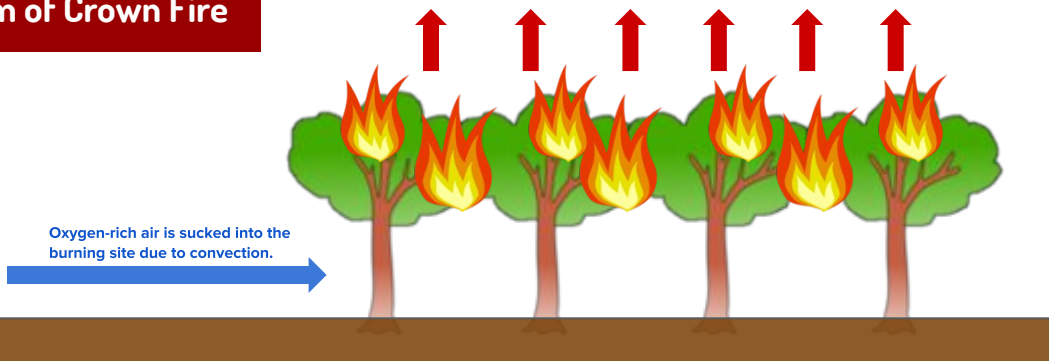
Ground fire: More extensive than surface fire. Harder to put out because the moisture level is low, often during drought.

Crown fire: Tree crowns in the canopy layer is burnt. Due to convection of air, it can spread very quickly.

Leave litter: It is a fuel for wildfire. It needs to be eliminated by prescribed fire during late winter or early spring season.

Mechanism of Crown Fire

Oxygen-poor air rises, creating an updraft of air that drives the convection of air at the scene.



OUR UNDERSTANDING OF WILDFIRE

EARLY STAGE: Before the full understanding of wildfire, it was thought that any wildfire is bad for the environment. It led to a period of wildfire suppression. This resulted in more intense wildfire that puzzled scientists.

DISCOVERY: It was later discovered that fire is essential for some tree species. They rely on fire to eliminate weeds and pests that could harm the trees' survival. Some tree species have developed adaptations for occasional fires. Some seeds can only germinate after moderate burn near the ground.

Wildfire can be difficult to control and put out when there are too many leave litters remained on the forest floor. This is why we established prescribed fire to reduce fuel for wildfire.



Most of the large scale wildfire are caused by humans. With climate change, more areas suffer from drought, increasing the chance of intense wildfire.

Slogan: **"ONLY YOU CAN PREVENT WILDFIRE."**