AP Environmental Science

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Overview of Unit One - The Living World

Symbiosis

Symbiosis is the close and long-term interaction between two species in an ecosystem and there are multiple different types of interactions. **Mutualism** is the interaction between two species in which both species benefit for example gut bacteria and humans, the bacteria helps us process and digest foods such as milk and we provide them energy. The next relationship is **commensalism,** meaning one species benefits from the interaction while the other is neither harmed nor benefited. One example is cattle egrets and livestock; the cattle egrets will feast on the flies that swarm around the livestock but the livestock neither gain nor lose anything in the interaction. **Parasitism** is the last interaction. This is when one species benefits while the other is harmed. We see this relationship between us humans and mosquitoes.

Competition

Competition can occur within or between species in an ecosystem where there are limited resources. However, **resource partitioning** is when species use the available resources in different ways or at different times to reduce the competition.

Terrestrial Biomes

Biomes contain different characteristics, communities, or plants and animals, that adapt to their climate. Certain animals will thrive in one biome but could not possibly survive in another one.

The distribution of nonmineral terrestrial natural resources, such as water and lumber, varies due to the unique combination of **climate, geography, latitude and altitude, nutrient availability, and soil.** However, the distribution of nonmineral **marine** natural resources, such as fish, varies due to factors such as **salinity, depth, turbidity, nutrient availability, and temperature.**

There are 9 terrestrial biomes you should know: the **taiga, temperate rainforests, temperate seasonal forests, tropical rainforests, shrubland, temperate grassland, savanna, desert,** and lastly, the **tundra.** The taiga is described as being cold and fairly dry during the winter months but wet during the summer months. It is located in the northernmost part of the world and has clear distinct seasons. The temperate rainforests have a good amount of rainfall during some months but low rainfall during the summer. They have no clear location and they are on the smaller side of forests. The temperate seasonal forests typically have a significant amount of rainfall and varying temperatures. This is where you will also find the deciduous forest. The tropical rainforest is located around the equator and has a constant temperature with tremendous amounts of precipitation. Shrubland is a kind of desert that has a high temperature and low precipitation rate. They are typically found in and around the Middle East. The temperate grasslands, which are found in most parts of the United States and some parts of Russia, have huge variations in temperature plus modest to sporadic precipitation. The savannah is another form of desert that has very high precipitation rates in the winter versus very low during the summer. The temperature stays fairly constant. The desert is an area that has low precipitation however there are three types:

Terrestrial Biomes (continued)

Three Types:

- **temperate desert:** temperature varies
- **cold desert:** temperature varies, however, it gets very cold during the winter months
- **tropical desert:** temperature varies yet it stays relatively warm

The tundra is similar to the desert as it has low precipitations and varying temperatures.

Aquatic Biomes

There are two types of aquatic biomes: freshwaters (these are your streams, rivers, ponds, and lakes) and salt waters (oceans, coral reefs, marshland, and estuaries.)

For the open ocean and ocean floor, there are three main parts:

- **euphotic zone** (phytoplankton, low nutrient levels, high levels of dissolved oxygen, upwellings brings nutrients from below)
- **bathyal zone** (dimly it, zooplankton and smaller fish)
- **abyssal zone** (dark and cold, high levels of nutrients, little dissolved oxygen, deposit feeders, filter feeders)

Saltwater

The **coral reef** is another large part of ocean life. In a way, they are like the tropical rainforests of the ocean. They have a generous amount of wildlife that are unfortunately being destroyed worldwide due to factors such as coastal development, dredging, quarrying, destructive fishing practices and gear, boat anchors and groundings, and recreational misuse.

Then we have estuaries and marshlands. **Estuaries** are the areas where rivers meet the sea. **Marshlands** are coastal lands that are covered with water all or part of the year. Both are highly productive ecosystems as they have high nutrient levels plus saltwater is mixing with freshwater.

Freshwaters

Moving onto freshwaters, we have lakes. Lakes are **lentic** ecosystems, meaning the water is still. This is opposite to **lotic** ecosystems, habitats with running water. Lakes have four zones based on depth and distance from shore.

1. **littoral zone -** this area is near the shore where rooted plants grow so there's a high biodiversity
2. **limnetic zone -** open sunlight area away from the shore; main photosynthetic zone with some larger fish
3. **profundal zone -** located in deep water so too dark for photosynthesis, very low oxygen levels, some fish but very little
4. **benthic zone -** contains decomposers, detritus feeders, some fish, and is nourished primarily from dead matter

There are also different types of lakes. There are **oligotrophic lakes,** which have low levels of nutrients and low net primary productivity (NPP) with very clear water, and **eutrophic lakes,** which have high levels of nutrients and high NPP with murky water plus high turbidity. Additionally, there are three different aquatic life zones in freshwater: the **source zone** (shallow, cold, clear, fast, high amount of dissolved oxygen), the **transition zone** (wider, deeper, warmer streams, more turbid), and the **floodplain zone** (wide deep rivers, broad flat valleys).

Food Chains and Food Webs

A food web is a model of an interlocking pattern of food chains that depicts the flow of energy and nutrients through one or more food chains. A food chain, however, depicts the flow of energy and nutrients between a set of organisms, with each organism becoming the next source of food. A food web is simply a more complex and full model of a possible ecosystem that consists of multiple food chains.

Food Chain ex. sun → grass → caterpillar → frog → snake → eagle

There are **positive** and **negative feedback loops** that play a role in food webs. When one species is added or removed from a specific food web, the rest of the food web can be affected. Positive Feedback Loop Example → Chemicals signal platelet activation. These platelets then release more chemicals, forming a never-ending loop.

Negative Feedback Loop Example → Depending on one's amount of sleep, they can either lower or increase their tiredness. This is not a positive loop as there is not an endless cycle; when we get more sleep, you feel less tired and vice versa.

There are a variety of organisms that live in an ecosystem. On one side, we have **autotrophs,** organisms that produce their own food. On the opposite side of the spectrum, we have **heterotrophs,** organisms that must rely on other organisms as their food source. A **consumer** is an organism that is incapable of photosynthesis. There are multiple types of consumers but the most important ones are:

- The primary consumer aka herbivores
- The **secondary consumer** is a carnivore that eats primary consumers
- The **tertiary consumer** is the last consumer of an organism.

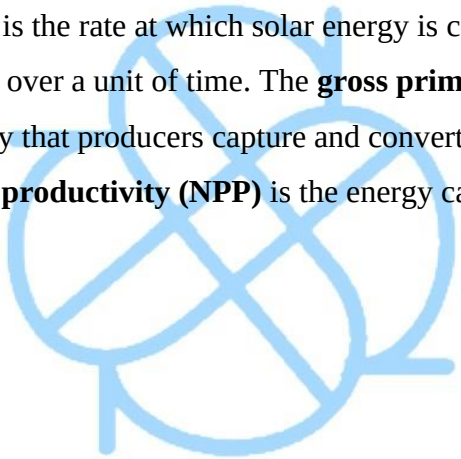
A **herbivore** eats only plants, also known as producers seeing as they can photosynthesize. A **carnivore** is the opposite as it only eats other consumers.

Food Chains and Food Webs (continued)

Energy is captured by producers and then moved through **trophic levels** (each of several hierarchical levels in an ecosystem that is based on organisms that share the same function in the food chain and the same nutritional relationship to the primary source of energy). However, energy is lost as it moves up the trophic levels, which is why carnivores need to eat so much more compared to primary producers. This is referred to as the **10% rule,** in which only 10% of the energy will be passed on to the next trophic level.

Primary Productivity

Primary productivity is the rate at which solar energy is converted into inorganic compounds via photosynthesis over a unit of time. The **gross primary productivity (GPP)** is the total amount of solar energy that producers capture and convert via photosynthesis over a unit of time. The **net primary productivity (NPP)** is the energy captured by producers minus the energy producers respire.

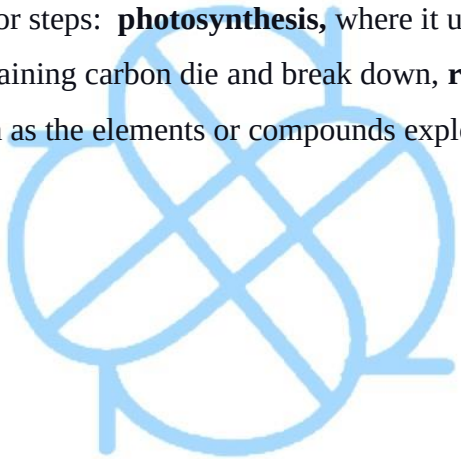


Photosynthesis and Respiration

Fortunately for us, we only need a basic understanding of photosynthesis and respiration for this class. Photosynthesis is simply the process by which producers use solar energy to convert carbon dioxide and water into glucose and oxygen. Respiration is the complete opposite as consumers convert glucose and oxygen into water and carbon dioxide in order to release that energy.

The Carbon Cycle

The carbon cycle is the movement of atoms and molecules containing carbon between sources and sinks (Fun Fact, the ocean is actually the largest sink). These reservoirs where carbon occurs in the cycle can be held there for a very long time or very little time, it all depends. The carbon cycle has four major steps: **photosynthesis,** where it usually starts, **decomposition,** when plants or organisms containing carbon die and break down, **respiration**, and lastly, **combustion,** when things such as the elements or compounds explode.



The Nitrogen Cycle

The nitrogen cycle is the movement of atoms and molecules that contain the element nitrogen between sources and sinks. The reservoirs that hold the nitrogen compounds hold them for relatively short periods of time and the atmosphere is the main reservoir of nitrogen as around 78% of the air on earth is nitrogen. There are 5 relative steps in the nitrogen cycle. First, there is **nitrogen fixation,** the phase when gaseous nitrogen (N2) is converted to ammonia (NH3 or

NH4+) via biological fixation due to bacteria such as cyanobacteria. Next, there's **nitrification,** where NH3 or NH4+ is converted into NO3- via bacteria**.** Then **assimilation** occurs, as organisms incorporate NO3- or ammonia formed versions, plants take it in by their roots and animals take it in via plants**. Denitrification** is the reduction of NO3- to gaseous N2 by anaerobic bacteria. This process only occurs when there is little to no oxygen such as deep in the soil near the wettable. Finally, there is **ammonification,** when organically bound nitrogen plants and animals are recycled after their deaths. Organisms that perform ecological decay services typically aid in this process.

The Phosphorus Cycle

The main thing to know about the phosphorus cycle is that its reservoir and sinks are sedimentary rock and that it has no gaseous form. It is also typically the limiting factor (something that limits population growth) in biological systems.

The Hydrologic Cycle

More commonly known as the water cycle, the hydrologic cycle is powered by the sun and is the movement of water through its various states. The oceans are the primary reservoir of water, with ice caps and groundwater acting as smaller reservoirs. There are multiple steps in the water cycle, the first one being **evaporation.** Here, the sun turns surface water into water vapor and it moves into the atmosphere. **Sublimation,** another step in the water cycle similar to evaporation but takes a bit longer. Sublimation also moves water vapor into the air, however, this process occurs when ice converts directly into water vapor and skips its liquid state. Next, **condensation** occurs, where the water vapor begins to cool in temperature and the particles draw closer together forming clouds and fog in the sky. **Precipitation** comes after condensation and is when the condensed water vapor, also known as clouds, pours down due to wind or temperature change. It may also begin to precipitate when the air can no longer hold any more water. **Transpiration** is when liquid water is turned into water vapor by plants as they use it for photosynthesis. **Runoff** is the process in which water runs over the surface of the earth displacing the topsoil and minerals with it. This can cause landslides and other disasters and can lead to damage to crops after the topsoil has been completely runoff. **Infiltration** is the last step in the water cycle and this is when the water that doesn’t get absorbed by the plants or turned

into runoff moves deep into the soil. This increases the level of groundwater and aids in the refilling of natural aquifers.

Biodiversity

Biodiversity is the variety in the earth's species. A species is a set of individuals who can mate and produce fertile offspring. Their offspring must be fertile or they are considered to not be the same species. There is **genetic biodiversity** which is the variety of genes in a population. The more genetically diverse the population is, the better it can survive and respond to stressors. A population bottleneck can lead to loss of genetic diversity. **Species biodiversity** is when there is both a number and a variety of species. There are two types of species, generalist, meaning it has a broad niche, and specialists, meaning there is a narrow niche. Specialist species tend to be the first species to be lost with the loss of habitat. A panda is an example of a specialist species as they have a particular diet. Raccoons are an example of a generalist species as there are native species that normally live in that specific ecosystem, plus invasive species that are introduced to the ecosystem. Alongside generalist and specialist, we have **indicator species,** species that allow us to monitor environmental quality plus **keystone species,** species that have a large effect on types and/or abundances of other species. Keynote species help maintain the survival of other species and without them, the food web may collapse. **Species richness** increases productivity and stability or sustainability.

Ecosystem Services

An ecosystem service is a positive benefit for humans, not for the ecosystem in general. **Provisioning services** are a type of benefit to people that can be extracted from nature. Some examples are food, water, lumber, gas, oils, plants, clothes. **Regulating services** are a benefit provided by an ecosystem that moderate a natural phenomena such as forest purifying the air we breathe. **Cultural services** are services that benefit the culture such as the woods helping someone write poetry. **Supporting services** sustain themselves with the consistency of underlying natural processes, such as photosynthesis, nutrient cycling, and the water cycle. Anthropogenic activities can disrupt ecosystems and ruin them.

Island Biogeography

Island biogeography is the study of ecological relationships and distribution of organisms on islands and of these organisms' community structure. Most island species have evolved to be specialists due to limited resources such as food and territory. However, specialist species survival can be threatened by the introduction of invasive species, typically those being generalist. An ecological tolerance is the range of conditions such as temperature, salinity, sunlight, and flow rate that an organism can endure before injury or death results. This can apply to both individuals and species. The **law of tolerance** states that for each abiotic factor, an organism has a range of tolerances within which it can survive.

Adaptations

Species migrate, or move, for a variety of reasons including natural disruptions. Some migrate for long or short periods of time. Biological evolution is how the Earth's life changes over time through changes in the genetic characteristics of populations. Natural selection is individuals with certain traits are more likely to survive and reproduce under a certain set of environmental conditions. There is a lot of evidence that supports this. Populations evolve by becoming genetically different, not individuals. Genetic variations are the first step in biological evolution, it occurs through mutations in reproductive cells. Mutations are random changes in DNA molecules. Natural selection acts on individuals. It is the second step in biological evolution. The adaptation may lead to differential reproduction. Genetic resistance is the ability of one or more members of a population to resist a chemical designed to kill it. We see this with pesticides as insects have adapted to be able to resist the lethal chemicals. Adaptive genetic traits must proceed change in the environment. A population's reproductive capacity is when a species that reproduces rapidly and in large numbers is better able to adapt to its environment.

There are three common myths about evolution through natural selection:

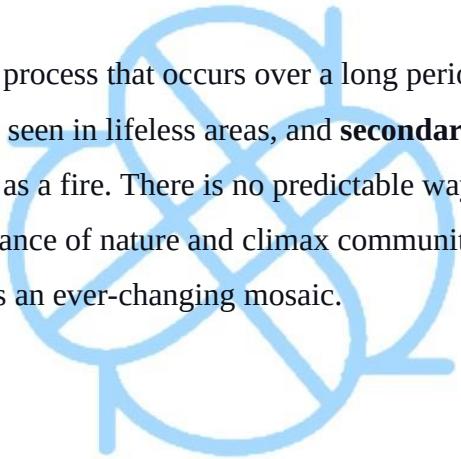
a. Fitness is a reproductive success, not strength, meaning your strength does not decide if you can reproduce or produce viable offspring
b. Organisms do not develop traits out of need or want
c. There is no grand plan of nature for perfect adaptation.

Adaptations (continued)

Species evolve in three ways: speciation, geographic isolation, and reproductive isolation. Speciation is where one species splits into two or more species. Geographic isolation is when the physical isolation of a population for a long period of time causes separation into multiple species. Reproductive isolation occurs when mutations, natural selection, and geographically isolated populations combine, leading to the inability to produce viable offspring when members of two different populations mate. This eventually leads to extinction; **extinction** is the process in which an entire species ceases to exist. An **endemic species** is when they're found only in one area and are particularly vulnerable to extinction. A **background extinction** is typically a low rate of extinction. **Mass extinction** is a significant rise above the background level.

Ecological Succession

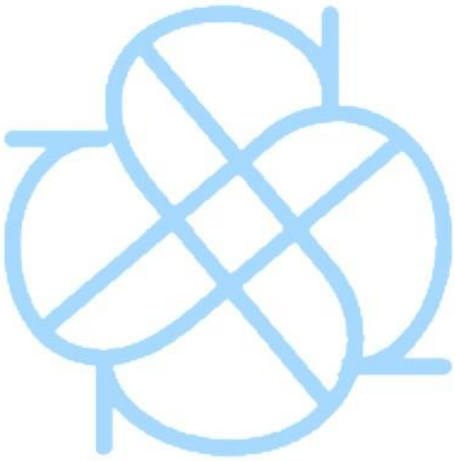
Ecological succession is a process that occurs over a long period. There are two types, **primary succession,** which is seen in lifeless areas, and **secondary succession,** which is seen in areas disturbed by events such as a fire. There is no predictable way but the traditional view on succession is that there is a balance of nature and climax communities. The current view, however, is the thought that it's an ever-changing mosaic.



Populations

Generalist species can adapt as they have a wide range of ecological tolerances. Specialist species are not as fortunate; due to their tight tolerance range, they do not adapt to change. In the changing world, generalist species will be able to thrive and survive compared to specialist species. **K selected species** typically live in stable environments, are larger, have less offspring,

and mature after many years. They also use a significant amount of energy for their offspring, in terms of caring and raising them, have long life spans, and have relatively high competition for resources. Some examples of K selected species are humans, elephants, and dolphins. **R selected species** are essentially the complete opposite of K selected species. They have a short life span, many offspring, mature early, and experience low competition. Examples are rats, weeds, and ants. **Biotic potential** is the maximum reproductive rate of a population in ideal conditions, a tool commonly referenced with the variable "r". Consider biotic potential having unlimited resources. Not all species fall into the k or r species group. Some change in different conditions at any time. When introduced to invasive species, the k selected species is typically negatively affected but the r selected species are not as affected.



Survivorship Curves

Survivorship curves are a-line graphs that display the relative survival rates of a group of individuals of the same age in a population. It shows the survival rate from birth to the maximum age reached by any individual of the population. They are broken into three types.

- **Type 1:** typically related to k selected species with a high survivorship
- **Type 2:** also related to k selected species but tend to have a more continual/linear progression, with their survivorship dropping as they get older
- **Type 3:** related to r selected species, have a low survivorship curve with most not making it.

Carrying capacity is when resources no longer support the population. It's typically denoted by the variable “k” and when the population overshoots the carrying capacity, it will rise slightly until it falls under the new carrying capacity. A new carrying capacity is made because when the population overshoots, it uses so many resources that they are severely depleted and it may get lower. The impact of the carrying capacity is typically a dieback, where a lot of individuals of the population die due to the lack of resources, creating a bottleneck effect. Population growth is limited to resource availability, with this case causing these resources to be finite and limited. There is no such thing as an infinite number of resources and there will always be a point in which a population will overshoot carrying capacity. There are abundant resources and limited resources that will affect the population size.

Age Structure Diagrams

An age structure diagram is a simple diagram that shows the age and gender of a population. It can be used to interpret growth rates and determine future shifts in the population. We can separate the ages depicted in the diagram into three categories: **pre-reproductive ages, reproductive ages, and post-reproductive ages.** You will also tend to see four types of age diagrams that begin **expanding rapidly, expanding slowly, stable, and declining.** In a population that is expanding rapidly, there are more children than adults. You can see this in countries such as Nigeria and Guatemala. Expanding slowly means there is almost a perfectly shaped triangle in which there are still more children compared to the other age groups but not too many. This trend can be seen in the United States and Australia. Stable population growth is seen when there is a fairly even amount of all ages depicted in the diagram; we see this pattern in Japan. Lastly, we have a declining age graph. Here, there is a greater elder population compared to adults, meaning not enough children are being born to support the population. We see this trend in China and Germany.

The age structure diagram is used by the government to show economists how the economy will be affected after people retire and if the working class will be able to support them.

These diagrams also show us how developed a country is as less developed countries have less access to birth control, meaning an expanding population. Developed countries, on the other hand, have healthcare and more access to birth control and education, meaning it will either be a stable or declining population (aka, fewer children are being born.) While this may seem fine temporarily, it will eventually lead to a declining population.

Human Population Dynamics

Total fertility rate (TFR) is defined as the number of children born to a woman during her lifetime. This can be affected by the age at which females have their first child, their education, and government acts and policies. Replacement level rate is the average number of children needed for a couple to replace themselves. In industrialized countries, that rate is around 2.1 but in developing countries, that number is around 2.5. The fraction takes into account infant mortality and young deaths. If a population has a TFR greater than 2.1, it's growing. Less than 2.1, it's declining. Greater than 4, the population is rapidly growing. The greatest factor in TFR is women's access to education. Education allows them to be better informed about their options and when making their decisions. Infant mortality also affects TFR as a low mortality rate means the population is growing.

Human Population Dynamics (continued)

The human growth curve is an exponential graph and we do have a carrying capacity. As the human population grows, so does the global total human ecological footprint. The **cultural carrying capacity** is the total number of people who could live in reasonable freedom and comfort indefinitely, without decreasing the ability of the earth to sustain future generations. Some factors that affect birth rates and fertility rates are having children as part of the labor force, cost of raising children, urbanization, educational/employment opportunities for women, availability of legal abortions, availability of birth control methods, and religious beliefs and traditions. Some factors that affect death rates are life expectancy, infant mortality rate, number of live births that year. Population growth can also be affected by density-independent (major storms, fires, heat waves, etc.) or density-dependent (access to clean water, food availability, disease, territory size) factors.

Population Formulas

Population change = (Births + Immigration) - (Deaths + Emigration)

Crude birth rate CBR = Total number of Live Births/ 1000/ Year

Crude death rate CDR = The Number of Deaths/ 1000/ Year

Doubling time of a population = 70/ Population Growth Rate %

Demographic Transition

Refers to the transition of high to lower birth and death rate as a country becomes more developed. There are four stages. The first is **stage one preindustrial** which is when population grows slowly because of high birth and death rate. The second stage is **stage two transitional** which is when the population grows rapidly due to high birth rate but low death rate due to

improved living conditions. The third stage is **stage three industrial** which is when the population growth slows as both birth and death rates drop because of improved food, and improved education for females. The last stage is **stage four post industrial** where population growth levels off and then declines as birth rates equal and then fall below death rates.

Plate Tectonics

Geology is the study of the dynamic processes taking place on earth's surface and in earth's interior. There are three major concentric zones of the earth. The core, mantle and crust. The earth crust is broken into tectonic plates that float on the asthenosphere. There are three types of plate boundaries: convergent (creates mountains, island arcs, earthquakes, and volcanoes), divergent (can result in sea floor spreading, rift valleys, volcanoes, and earthquakes), and transform (can result in earthquakes). Divergent means that they spread away from each other, convergent means one is moving under and transform is when the slide against one another.

Soil formation and erosion

Physical weathering : is the mechanical breakdown of rocks and minerals. It can have abiotic causes (water, wind, temp) or biotic causes (plants, burrowing animals). It eventually leads to an increase in surface area for example the grand canyon. The weathering can also be **chemical** in which releases essential nutrients from rocks. There is also **anthropogenic chemical weathering** in which the chemical weathering is caused by humans. **Acid rain** has many effects as it can cause human health issues such as asthma and bronchitis. It can also cause impaired visibility and acidification in the soil. Soil develops in two ways **from above** (deposition of organic material from dead organisms and their waste) or **from below** (physical breakdown of rocks and primary materials provide raw material. Soil does have **horizons** where "o horizon" is the organi decomposed organic material that is mostly pronounced in forest. The "a horizon" is the topsoil that has the most biological activity. The "e horizon" does not always exist but is where metals and nutrients are leached or eluviated from above, it is in some acidic soils. The " b horizon" is the subsoil where all the minerals and nutrients accumulate. The "c horizon" is the least weathered and most similar to the parent material. The " r horizon" is your bedrock. There are different soil profiles by biomes.

Soil Composition and Properties

The physical properties such as size and weight for sand is much larger while clay is the smallest and silt is in the middle. These are the three types of soil you need to know. There is a soil texture chart that will be used on your exams. The concentration of sand, clay, and silt in the soil determines the soil profile. The permeability or ability for water to infiltrate is higher for sand, the lowest for clay and medium for silt. Clay is the most impermeable. **CEC** is the chemical property of soil and it stands for cation exchange capacity which is the soils nutrient holding capacity. The base saturation is the proportion of bases to acids in percentage for and in soil our bases that are essential for nutrition is calcium, potassium, magnesium, and sodium. Our acids that are detrimental are aluminum and hydrogen.

Earth's Atmosphere

The two most innermost layers of the atmosphere is the **troposphere** which supports life and the **stratosphere** that contains the protective ozone layer. The troposphere is the first layer, the stratosphere is next, after that is the mesosphere and finally is the thermosphere. The troposphere is 75 to 80% of earth's mass and is mostly nitrogen. The rising and falling air currents and greenhouse gasses play a major role in weather and climate. The stratosphere is similar but it has less water and contains the ozone layer that protects us from the sun.

Global wind patterns

There are four properties to determine air circulation patterns the first being air density. When it's less dense, warmer air rises. Water vapor capacity is another and its when warm air has a higher water vapor capacity. Another is adiabatic heating/ cooling which is all about how air changes as it rises and falls. Latent heat release is the last one in which the release of energy as heat when water vapor condenses into precipitation (in clouds). The coriolis effect is when a moving object veers to the right in the northern hemisphere and towards the left in the southern hemisphere.

Watersheds

Area is the volume of water that can be generated from rainfall. Length can be measured in multiple ways but it does tell us the length of the mainstream waterslow. The slope will affect the

momentum of runoff and it affects the velocity of overland flow, watershed erosion potential, and local wind systems. Vegetation affects watersheds also as it adds more organic material to the soil. It can prevent erosion, cover the surface of the water and buffer water from runoff (**riparian zone**). The divides are just the peaks and ridgelines of the watershed. There are agricultural and urban watersheds that can change the natural watershed. Mountainous watersheds have a steep gradient and high runoff leading to downstream areas being vulnerable to flooding. Forest watersheds have less runoff and desert watersheds hold in most water; it just doesn't get a lot of water due to the low precipitation rate. Coastal watershed has a high rainfall amount, no channel control, flooding and a high water table. There are wetland watersheds but they are fairly similar to coastal watersheds except for the fact that there isn't any saltwater intrusion.

Solar Radiation and Earth Seasons

Some factors that affect solar energy are the rotation, Revolution, tilt of the axis and lastly the atmospheric conditions. The tilt of our axis causes seasons. Summer is the period of greatest solar radiation and occurs in the northern hemisphere when the earth is tilted down. The distance of the sun has nothing to do with the season's and we see this as in the winter we are closer to the sun but we do not get more sunlight.

Earth's Geography and Climate

Things that determine climate patterns are global air circulation, ocean currents, and the angle of the sun's ray or the tilt. Heat and precipitation are distributed unevenly due to the sphere shape of the earth. Topographic features such as mountain ranges and the proximity to water also affects the climate. We see this with the **rain shadow effect.**

El Nino and La Nina

A **gyre** is a large-scale circulation of water that moves clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. An upwelling is the upward movement of ocean water, it mixes the water, bringing cool and nutrient-rich water from the bottom of the ocean to the surface. It supports large populations of phytoplankton, zooplankton, fish, and fish

eating seabirds. Upwellings occur when; far from shore: surface currents move apart and draw water up from deeper layers, along the Steep western coast of some continents: winds blowing along the coast push surface water away from land and draw water up. Essentially El Nino occurs every few years in the Pacific Ocean. Normal Shore upwellings are affected by changes in weather patterns leading to Pavilion prevailing tropical Trade Winds going east to west which weaken or reverse Direction. Western Pacific warmer waters move towards South America and suppress the normal upwelling of cold nutrient-rich water. The possible effects of El Nino is an decrease in nutrients which reduces primary productivity and causes a decline in fish populations. It can also alter the weather of at least two-thirds of the globe especially in the Pacific and Indian oceans. La Nina cools some coastal surface waters and brings back upwellings. During a la nina you'll see more atlantic hurricanes, colder winters in Canada and Northeastern U.S. There will be warmer / drier winters in a Southeastern and southwestern United States, and more wildfires. There will be wetter winters in the Pacific Northwest and torrential rains in Southeast Asia. This will lower wheat yields and Argentina also.

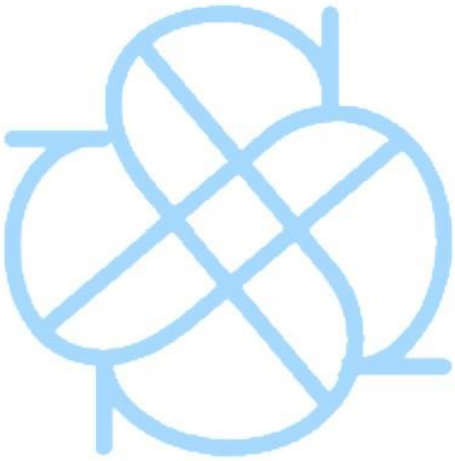
Tragedy of the Commons

The tragedy of the commons is when you have a common resource that everyone can use and it essentially becomes overused such as grass becoming overgrazed. It leads to the destruction of that resource and no one benefits from it anymore.

Clear Cutting

Ir primarily affects the forest and is defined as land dominated by trees and other woody vegetation that is sometimes used for commercial lodging. Most commercial timber organizations are privately owned (73%) and the government spends a lot of money in subsidizing the actual cost of timber to make it affordable and so that the environmental cost is not included in the actual price of the timber. There are benefits to clear-cutting such as it is the easiest, usually most economical approach to obtaining Timber and often stands are replanted. Secondary succession can also take place leading to a replacement of the trees that was

previously cut down. It however has adverse effects such as the reduction in biodiversity, increase and wind erosion, loss of soil nutrients, stream sedimentation, let's lies, increased water temperatures. Tree plantations are clear-cut and quickly replanted with single fast-growing species, this leads to a reduction in the biodiversity of the natural habitat. These trees will never mature into diverse ecosystems, and will lead to nutrient depletion from the soil. Selective cutting is the removal of single trees or small amounts of trees. Young seedlings grow next to establish old growth trees leading to optimum growth amount to shade tolerant species. This creates less erosion, and a loss of biodiversity. However many drawbacks are the same as clear cutting. The forest does provide services such as absorbing polluted and storing carbon dioxide. The cutting and burning of trees releases carbon dioxide and contributes to climate change.

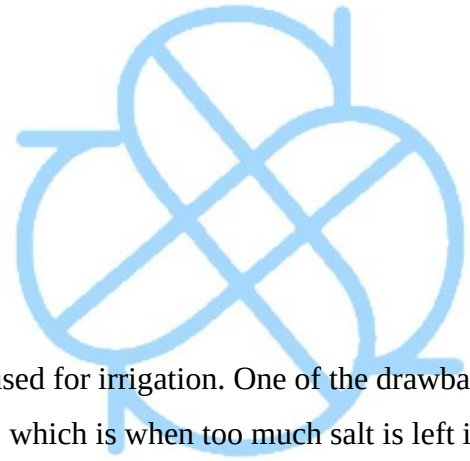


The Green Revolution

Industrialized agriculture is the mechanisms and standardization applied to food production. The green revolution does not mean everything was made more sustainably but it was instead just more optimized for food production. Monocropping are large plantings of a single species or variety that is very efficient and productive. However there is a huge loss of biodiversity and more soil erosion. Genetically modified organisms are genetically modified food. Artificial selection was the traditional com technique that we used since the beginning or time. Some benefits are an increase in quality and quantity, but there are concerns as there is little evidence to tell us if eating them are safe and there is a spike in food allergies due to it. Some effects on biodiversity is the unintentional breeding of gmo plants and organic plants that lead to a loss of biodiversity when they reproduce.

Agricultural Practices

Plow and till is when you turn the soil upside down which leads to the death of weeds and insects. It does overall lead to soil degradation with irrigation and overproduction. Slash and burn is another method in which you cut everything down and then burn it. The ash provides nutrients but it can not be maintained in the long run as copious amounts of CO2 are released and an endless positive feedback loop that leads to desertification. We do add fertilizers and organic fertilizers are used to help the soil while synthetic are primarily used to feed the plant. Without them we wouldn't be able to feed the world. The main drawback is the use of fossil fuel and the probability of soil runoff into waterways that cause an algae bloom.



Irrigation Methods

Most of our freshwater is used for irrigation. One of the drawbacks of irrigation is waterlogging and salinization, which is when too much salt is left in the soil. Furrow irrigation is when you build trenches and fill them with water. It's low in effort and cheap to do but can lead to waterlogging. Flood irrigation is when you flood the field and its around 80% effective however can lead to waterlogging and salinization in the soil. Spray irrigation is typically how people water their lawn and it is more efficient but does cost more. Drip irrigation is when a slow dripping hose is used and is the best method. However it's extremely expensive and labor taxing. The largest aquifer is the ogallala aquifer. The water inside it however is being used up and lost.

Pest Control Methods

Pesticides are used in the United states the most and a lot of the pesticide ends up in our watersheds. There are broad scale pesticide, herbicides, and fungicides. There are plenty of environmental effects such as bioaccumulation which is when the chemicals begin moving its

way up the food chain. For example the DDT case. Natural selection resistance is also another drawback and it's when more pests begin to become resistant to the pesticides. It can pollute groundwater which can lead to health issues for humans. Pesticides drift is when the pesticide runs off into a different location such as into watersheds, and lakes or other sources of water.

Meat Production Methods

It takes about 20x more land to produce the same amount of calories in meat compared to plants. It also takes 10x more water. High density animal farming is one method to grow meat and is used for beef, dairy and poultry. You'll find that antibiotics and nutrient supplements are supplied to keep them healthy as they are packed into small spaces. The drawbacks are antibiotic resistance and diseases such as mad cow disease. There are ethical concerns as they are in tight spaces. And there are environmental drawbacks as the nutritional aspects of it can be affected on whether or not their free range or not. The manure these animals produce can also runoff into water sources and cause eutrophication. The grazing that they do can also cause issues such as overgrazing which lead to soil depletion and erosion, and also a loss of biodiversity. Around 50% of the United States rangelands are in poor condition due to overgrazing. Acts have been put into place to help save the environment and land from overgrazing.

Impacts of Overfishing

There is a rapidly growing farmed fish production in the world as in asia and africa, fish is their primary source of meat. This is a prime example of tragedy of the commons. Around 90% of the fish population has collapsed due to overfishing and overexploitation. We are now at a point where most of our fisheries are at the limit of sustainability. There are multiple methods of

catching fish such as long line, trawling, and others. The issue with these methods is the by catch in which other types of fish are caught and killed and then left in the ocean. There are some devices being created to reduce this problem such as TED which is used to help turtles.

Effects of Mining

Some mining techniques are surface, subsurface, tailings and then slay. For surface mining we have strip mining and it's typically used for ores that aren't as deep. Tailings are unwanted waste materials. Strip mining is the primary method for getting coal and you typically start at one length and work your way down. Open pit mining is another method and is typically used for metals such as copper and gold. Mountaintop removal is when you use explosives to get materials. Subsurface mining is very expensive as it's typically used for depths deeper than 100m. It's used when the ore is too low for an open pit mine but there are plenty of environmental effects. Soil erosion and nutrient loss are some of them, loss of biodiversity and pollution are others. It is harmful for humans, for example black lung. There are mining laws that are still in effect today but there are few provisions put in place for environmental concerns.

Impacts of Urbanization

Suburbs is an area surrounding the metro area and is not densely populated. Nowadays more people in the United States live in urban areas and not rural. Saltwater intrusion is a major concern as it pollutes freshwater due to groundwater development and urban sprawl. Some causes of urban sprawl are living cost and communication difficulties. It is much more expensive to live in a suburb than an urban area and because of this the socioeconomic status of the area degrades and leads to urban blight. Gentrification is the opposite and it's when more expensive buildings into an area of urban blight force people to move out.

Ecological Footprints

The ecological footprint measures how fast we consume resources and acquire waste. It's a measure of area in hectares and is used to see the amount of land someone would need to support themselves. On earth there is about 11.3 billion hectares biologically productive. When you exceed your ecological footprint there is an ecological deficiency. Most developed countries are ecological deficient and now we would need 3 earths to not exceed the planet's ecological footprint. Developing countries have a smaller footprint because developed countries eat more meat, use more fossil fuels, and require more CO2 fixation.

Introduction to Sustainability

Sustainability is the idea that human uses of resources do not deplete the future generations' needs and requirements for those resources. Currently we are having many extinctions and a rising extinction rate which leads to the balance of our ecosystem degrading. It's difficult to remain sustainable with food production as there are so many people and so many methods being used to feed them. The average temperature and CO2 concentration are also rising. The human population is still increasing but the growth rate is decreasing. The maximum sustained yield is the maximum amount of resources that can be used without compromising the futures ability of that resource.

Methods to Reduce Urban Runoff

Because in urban areas there is no natural ground layer that absorbs the water and slows down the runoff. Because of this in urban areas 50% of runoff will be evaporated and only 5% will be able to deeply infiltrate compared to in a natural area in which 10% will lead to run off. The runoff concentrates and gathers speed as it moves through sewers and it can completely wipe out a wet habitat and it carries pollutants such as oil, waste, heavy metals, pesticides, and road salts.

Some things that are being done is mitigation which is permeable pavement. More trees are being planted in efforts to slow down runoff.

Integrated Pest Management

It's the idea that we take sustainability, economics, practicality, and integration to control pests while minimizing the disruption to the environment. One method is crop rotation and intercropping with the idea being to prevent weeds from growing by rotating crops with different effects on the soil until you can grow weed sensitive crops. One method is to use pest resistant plants but that can lead to resistance in the pest that you're targeting. Another is creating a habitat for predators of pests to have the natural predators protect the plants by eating the other pests. It's important to understand the IPM is not organic as there are some chemical aspects of it.

Sustainable Agriculture

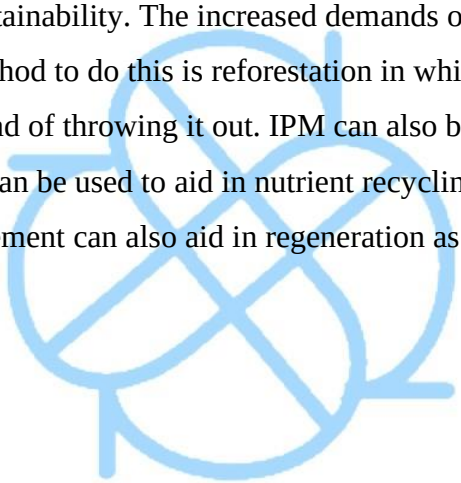
The goal of sustainable agriculture is to feed the world without ruining the environment. One of the methods to do this is contour plowing in which you use the contours of the land to slow soil erosion. Another method is windbreaker in which you plant a row of trees to prevent soil erosion from the wind and to protect the crops on the ground. You could also plant perennial crops that will continue to produce year after year. Terracing is when there is a series of wide steps on a slope that helps prevent erosion. No-till agriculture is also a good method as you're not tilling the area and there's less oxidation and reduction of CO_2, however there is an increase of herbicide used. To improve soil fertility many will rotate their crop and the idea is that you use plants that will prepare tjs soil for the next crop and allows for the nutrients to be recycled. Rotational grazing is somewhat of a similar idea as you rotate where you allow your livestock to graze to prevent overgrazing in one location. You could also have a free ranged farm instead of CAFOS as it is more ethical, the manure can be recycled, fewer fossil fuels are used, and there are fewer antibiotics being used. Some negatives of a free range farm is the rise in cost and land.

Aquaculture

It's the breeding, rearing, and harvesting of fish, shellfish, plants, algae, and other organisms in types of water environments. One method is fish farming where man made tanks are built and some fish we use it for are salmon. Mariculture is another method and it's when you use the open ocean as an enclosure and we harvest flounder and shellfish. Some benefits of mariculture is there isn't as much habitat destruction, it's efficient and uses less fuels. Some drawbacks are the fish manure will feed the contamination in an area and the spread of disease and parasites due to high fish density. There is also the worry of fish escaping and invasive species outcompeting native species or breeding with native species.

Sustainable Forestry

Forests are key to global sustainability. The increased demands on the forest need to be sustainably managed. One method to do this is reforestation in which we reforest an area. Another is reusing wood instead of throwing it out. IPM can also be used to prevent the spread of disease and fire management can be used to aid in nutrient recycling as nutrients can be used in the dead biomass. Fire management can also aid in regeneration as the openings provide for early succession species to arrive.



Unit 6, 7, 8

Energy in physics is the capacity for doing work. Humans can not create energy as energy is neither created nor destroyed. Energy exists in potential, kinetic, thermal,electrical, chemical, and nuclear. We can break the bond in chemical energy by using thermal energy. In this example it takes energy to convert energy. There are 2 types of nuclear energy fusion and fission, we use fission (the splitting of molecules) to create nuclear energy. For electrical energy we use a generator to convert energy. Electricity is defined as the movement of electrons and there are two types of currents, DC direct current and AC alternating current (bounces back and forth from positive and negative in the generator). Nonrenewable energy: We evaluate energy resources by accessing the supplies, environmental impact, and how useful it is. We do this to get as close to a 1;1 ratio as possible. The 2nd law of thermodynamics states that the state of entropy of the entire universe, as an isolated system, will always increase over time. The second law also states that the changes in the entropy in the universe can never be negative.

Net energy is expressed as a net energy ratio (ex; conventional oil; high net energy ratio compared to the nuclear power fuel cycle which has a low net energy. *Note: conventional oil is currently abundant, has a high net energy yield and is inexpensive. However, it causes air pollution and releases greenhouse gases. Heavy oils from oil sand and oil shale exist in potential large supplies but have low net energy yields and higher environmental impacts compared to conventional oil (aka light oil)* some vocab *petroleum/ crude oil= conventional/ light oil. Fossil fuels; crude oil and natural gas. Oil extraction is simply another type of distillation. Petrochemicals are products of oil distillation. Oil is simply a bunch of hydrocarbons.*

Unit 6, 7, 8 (continued)

More developed countries have resources with the middle east having the most light oil. Venezuela and Canada have pockets of light oil however they do have pockets of heavy oil which is just oil sand/ tar sand.

Advantage of conventional oil	Disadvantages of conventional oil
Ample supply of 42-93 years	Need to find substitutes within 50 years
Low cost	Large government subsidies
High net energy yield	Environmental cost not included in market cost
Easily transported between nations	Artificially low price encourages waste and discourages search for alternatives
Low land use	Releases pollutes air when produced and burned
Technology is well developed	Releases CO2 when burned
Efficient distribution system	Can cause water pollution

Oil sand/tar sand contains Bitumen which is the main ingredient of asphalt. Oil shale is a rock that is mined just like coal. We use high amounts of heat to essentially melt the rock and then we catch it in containers under it. We then throw out the rest of the rock. The ratio for it is about 2.5: 1 and there's a potential for us to carry on with the obscene amount of oil use if we use it however it takes plenty of energy to use. It also releases carbon into the air as it is a carbon compound. Shale gas is similar to oil shale but instead, it's gas. But we can't use the same method as we did for the oil shale so we use a method called Fracking which is when you drill a hole, stick a pipe into it, and then pump it full of water, sand, and chemicals that help expand the water. Because it's pumped at such a high pressure the gas will flow out through the drill and we can contain it.

Unit 6, 7, 8 (continued)

Advantages of heavy oils	Disadvantages of heavy oils
Moderate cost (oil sand)	High cost (oil shale) Low net energy yield

	Environmental cost not included with price
Large potential supplies (oil sand) especially in Canada	Large amounts of water needed
Easily transported between countries	Severe land disruption
Efficient distribution system in place	Severe weather pollution
Technology well advanced (oil sand)	Air pollution and CO2 emissions when burned

Most natural gases are Methane (CH4) however ethane, propane, butane, and pentane are also included.

Advantages of nuclear energy	Disadvantages of nuclear energy
Large fuel supply	Cannot complete economically without large subsidies
Low environmental impact	Low net energy yields
Moderate land distribution	No widely acceptable solution for long time waste storage

Unit 6, 7, 8 (continued)

There are two different types. Control rods control the rate of the reaction by absorbing the neutrons. The two types of decay are beta and alpha decay. Alpha decay is when the atom randomly becomes a new element. In beta decay is when the neutrons turn into a proton. All power plants are cooled and have a containment shell around the core to not prevent radioactive material from leaking out. We store the spent fuel rods in water-filled pools or dry casks. However, when the dry cask or water-filled pools become full they need to be stored somewhere else such as underground. Nuclear power plants do pollute water as they release boiling hot back

into the water which results in thermal pollution. Nuclear power is the slowest growing energy source and it's going to grow even slower as there is a history of poor management and it's extremely expensive.

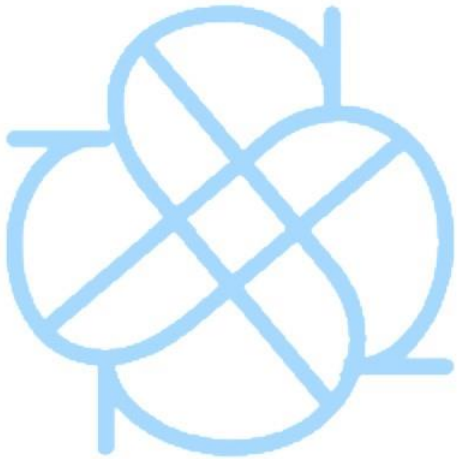
There are 2 different types of active solar heating; one using photovoltaic cells and the other using solar panels. Passive solar heating has one type and it's when you use the sun to heat anything. You could do this with your house by installing super windows and having high insulation (around 3 panes of glass), and you must have a floor that can radiate the heat back off it and absorb some of it (no carpet). Solar reflectors are similar to solar panels however instead they reflect the sun's rays to produce massive amounts of heat. One way to use them is to get rid of toxic waste. You can also use a solar reflector for cooking. This reduces indoor air pollution.

Advantages of solar energy	Disadvantages of solar energy
Free energy	Needs access to sun 60% of the time
No co2 emissions	Blocked by sun
Quick emissions	Heat storage
Very low air/ water pollution	High initial cost
Low land distribution	Eyesore
Moderate cost	maintenance

Geothermal Energy

Photovoltaic (PV) cells are also known as solar cells. These cells produce electrical energy directly. It takes the photons from the light and takes the electrons from it. It doesn’t produce mass amounts of electricity however a benefit is that it doesn’t need to be put in direct sunlight. Because it takes the photons instead of the direct heat coming from the sun. Our biggest plant is in Tuscan, Arizona because there are fewer weather changes and doesn’t reduce the life span of the plant as fast. They are also a lot easier to install compared to solar panels and when added together they can power your entire house. They are also expandable and can be uninstalled in case you move. The most common element in these s=cells is Boron enriched silicon (because

it's a semiconductor and we have plenty of it) and the other element is Boron. The only issue is that it has to be a direct current. When, however, when it's inside it becomes a photoreceptor because there is no direct sunlight.



Hydroelectric Energy

If you see the word hydropower or hydroelectricity, the college board is talking about dams. Every river will flood in due time and because of this, it will create very fertile land due to the nutrient-rich sediment being carried by the river. However, because of the dam, the soil will lose its richness. Building dams also causes habitat fragmentation. Scour is what happens when the water (that exits the dam) hits the catchment (the bottom of the dam where the water will be caught) and pressure washes the rock. This means that no aquatic plants will be able to survive in the catchment. The temperature will also change however it won’t be called thermal pollution. The flow rate will go back to normal within a mile (keep in mind it goes crazy fast so it will need time to slow down) and the temperature will return to normal (warm at the top, cool in the

middle, and cold at the bottom) in about a mile. Dams potentially increase the chance of earthquakes due to the high amount of pressure.

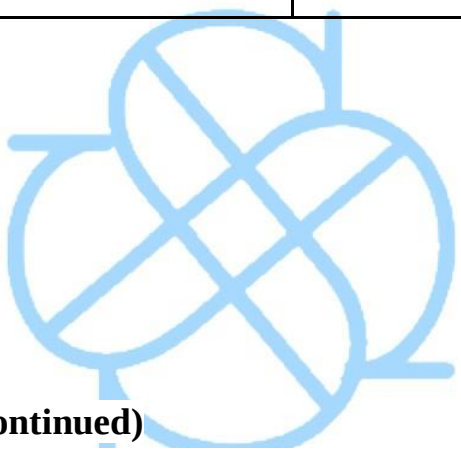
advantages	disadvantages
Moderate to high net energy	High construction cost
High efficiency (90-95%)	High environmental impact from flooding land to form a reservoir
Large untapped potential (you just need a river and the U.S has plenty)	Environmental cost not included in the market price
Low-cost electricity	High CO2 emissions from rapid biomass decay in shallow tropical reservoirs
Long life span (the bigger the longer it will work)	Danger of collapse
Reservoir is useful for fishing and recreation	Decreases flow of natural fertilizer (silt) to land below dam
No CO2 emissions during operation	Uproots people
Can provide flood control below dam	
Provides irrigation water	

Hydroelectric Energy (continued)

Biomass can be both a solid, gas, and liquid. Keep in mind when typically discussing biomass we are describing trees (btw charcoal is from trees). The main issue with this is the fact that in creating biomass farms we are creating monocultures of trees that deplete biodiversity. Remember the ways we cut trees! Clear cutting, selectively cutting, and Shelterwood logging. Ethanol is also known as biomass and is a renewable fuel that can be made from multiple plant materials such as sugar or in the US case corn. It is an alcohol that is used as a blending agent with gasoline because it can cut down on monoxide that is released from cars.

Advantages of biomass	Disadvantages of biomass
Large potential supply in some areas	Nonrenewable if harvested sustainably

Moderate cost	Moderate to high environmental impact
No net CO_2 increase if harvested	Environmental cost not included in market price
Plantation can be located on land not needed for crops	Increases CO_2 emissions if harvested and burned unsustainably
Can make use of agricultural timber, and urban waste	Low photosynthetic efficiency
	Soil erosion, water pollution, and loss of wildlife habitats
	Often burned and is inefficient and polluting to the surrounding environment



Hydroelectric Energy (continued)

Biodiesel is a liquid fuel produced from renewable resources (new and used vegetable oils and animal fats) is a cleaner-burning replacement for petroleum-based diesel fuel. It's non-toxic and biodegradable and is produced by combining alcohol with vegetable oil, animal fat, or recycled cooking grease.

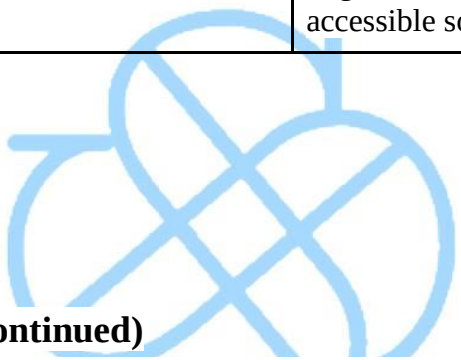
Advantages of biodiesel	Disadvantages of biodiesel
Reduced CO emission	Increased NOx emissions and smog
Reduced CO_2 emissions by 78%	Higher cost than regular diesel
High net energy yield compared to palm oil crops	Environmental cost not included in market price
Moderate net energy yield for rapeseed crops	May compete with growing food on cropland and raise food prices

Reduced hydrocarbon emissions	Loss and degradation of biodiversity
Better gas mileage	Can make engines hard to start in cold weather
Potentially renewable	Low net energy yield

Hydroelectric Energy (continued)

Advantages of ethanol	Disadvantages of ethanol
High octane	Lower driving range
Some reduction in CO2	Low net energy yield
High net energy yield	Much higher cost
Reduced CO2 emissions	Higher CO2 emissions (corn)
Can be sold as E85 or pure ethanol	May compete with growing food and raise prices
Potentially renewable	corrosive
	Can make engines hard to start in cold weather

Advantages of geothermal energy	Disadvantages of geothermal energy
Very high efficiency	Scarcity of suitable sites (can deplete the aquifers)
Modern net energy at accessible sites	Can be depleted if used to rapidly
Lower CO2 emissions than fossil fuels	Environmental cost not included in market price
Low cost at favorable sites	CO2 emissions
Low land use and disturbance	Moderate to high local air pollution
Moderate environmental impact	Noise and odor
	High cost excluding concentrated and accessible sources



Hydroelectric Energy (continued)

Fuel cells- are used by forming a combustion reaction with Hydrogen and Oxygen. It has the promise for powering cars however to use it it needs to be pressurized and cool to be contained in a tank. It's extremely flammable and has a high chance of exploding. Plus hydrogen gas is also not plentiful on earth. 43% of all the energy could be saved by improving energy efficiency. The best energy-efficient methods we have are wind and hydroelectric which is 93% efficient. We still use very inefficient devices such as the incandescent light bulb (5-10%), motor vehicles (20%), nuclear power plants (33-37%), and lastly, the coal-fired power plant (38-48%). There are multiple techniques to save energy.

- Cogeneration (combined heat and power CHP) - using leftover heat to produce energy.
- When it comes to architecture and urban settings we can do a lot to conserve energy. If they have flat roofs we can create living green roofs (the greenery around the Aflac house). These green roofs in the summertime provide shade and in the wintertime it provides insulation.
- At home, we can do the following: insulating and plug any leaks (also and basements needs at least 18 inches of insulation), use energy-efficient windows such as blinds, reduces other heating and cooling losses (75 in the summer 68 in

the winter) by buying higher efficiency equipment, heat water more efficiently (water heater blanket) and use low flow showerheads, if you have small appliances, only plug them in when you need it.

- Grey smog is called industrial smog - coal produces sulfuric acid H2SO4 - you can use steel and wood as an insulation to keep mice away-
  Urban fog is typically brown or red

Pollution

Air pollution - ***The Asian brown cloud is a brown/reddish smog that is an urban smog.***

The **troposphere** contains 75-80% of the earth's mass and is the closest to the earth's surface. Nitrogen is the most abundant gas with 78% and oxygen is 2nd with 21%. The troposphere also has rising and falling air currents that alter weather and climate. The **stratosphere** is very similar to the troposphere however there is much less water (due to condensation) and has the ozone (O3) layer. The ozone layer is at the bottom of the stratosphere and protects us from the sun's rays. Pollutants mix in the air to form industrial smog and photochemical smog (only happens during the day as it requires the light and heat energy from the sun to happen). Industrial is caused by the burning of coal and photochemical smog is caused by motor vehicles, industrial, and power plant emissions. Photochemical smog can also be called tropospheric ozone. **Pollution**- any in excess that causes you harm. Some **natural sources** are dust blown by the wind, pollutants from wildfires and volcanoes, and lastly volatile organisms released by plants (by-products of decomposition it produces VOCs and NOx which causes industrial smog). Pollutants are particular and will fall over time due to gravity. Some **human sources** are stationary sources (power plants and whatnot) and mobile sources (vehicles).

There are **primary pollutants** and **secondary pollutants**. Primary pollutants are for example when you burn wood and it releases carbon dioxide. Carbon dioxide is a primary pollutant. Now if the carbon dioxide mixed with water and turned into H2CO3 (carbonic acid) that's a secondary pollutant.
Ozone is formed by O2 + O + Light which turns into O3 and then the sun will break it down and turn it into O3 again. It's a continuous cycle that is being interfered with because we are adding different components into the atmosphere, such as methanol bromine. These components tear apart the O3 molecule before it can go through its cycle. In developed countries, there are laws in place to have clean air and clean water. For example, the clean air and water act. Companies decided that it would be cheaper to outsource (create goods in developing countries and then pay for the shipping to bring it over). This has sadly ruined their air and water quality.

Pollution (continued)

There are three major outdoor air pollutants:

-**Carbon monoxide** (CO) the source is the combustion of anything organic (anthropogenic). Some human health effects are that it's poisonous.

-**Carbon dioxide** (CO2) sources are the combustion of anything organic (anthropogenic) carbon dioxide has been on earth longer than us because vegetation requires carbon dioxide for photosynthesis. Some human health effects are the need to get rid of the carbon dioxide in our lungs. Environmental effects are the increase in temperature and the strengthening of hurricanes due to rising temperatures in the water. There will be plenty of flooding and countries such as Finland and Norway will be covered.

- **Nitrogen oxide** (NO) the sources (anthropogenic) of the combustion of anything that releases gas such as cars and whatnot. Some environmental causes are the decomposition of organisms and we see this in the rocky mountains with their red fog. It will later come back down as acidic rain. *note that natural rainfall is around 5.8-5.6* Some effects are that its respiratory irritants and an environmental impact is that the acid rain will decompose the xylem in the plants.

-**Sulfur dioxide i**s sourced from the burning of coal (anthropogenic) and volcanic eruptions/ thermal vents in the ocean (natural source. Some effects are that it's a respiratory irritant and that it also causes acid rain (sulfuric acid). It's unique however since the smog it creates (industrial/ grey) cools the planet down because it blocks the sun's rays.

Particles are suspended particulate matter and the smaller it is the longer it will stay in the air and vice versa. Some natural causes are dessert and anthropogenic causes are overflowing. It's a respiratory irritant and can suffocate livestock and people. Another effect is water pollution and it can also harm aquatic organisms due to the covering of potential eggs.
Ozone (O3)(go back to see the formula and how the balance works) anthropogenic sources will be smog and some impacts are that it's a respiratory irritant. An environmental impact is that it reduces the efficiency of photosynthesis.
Volatile organic compounds (VOCs) natural sources are hydrocarbons and terpenes and some anthropogenic sources are the evaporation of paint and gas. It's a respiratory irritant and is flammable. An environmental impact is none because mostly anthropogenic causes hurt the environment. *formaldehyde is one for example*

Pollution (continued)
Acid Deposition- caused mainly by coal-burning power plants and motor vehicles emissions and in some regions threatens human health, aquatic life and ecosystems, forest, and human-built structures. One of the ways we fight this is by liming the yard because it's made out of limestone and consists mostly of calcium which buffers out the acid rain. If you however live near the ocean and you can use seashells because they are made out of calcium carbonate.
Acid rain formation- burning coal which releases sulfur which turns into sulfuric acid through the sulfur reacting with the water. For nitric acid, it's slightly more complex however if conditions are right and there is heat and sunlight the nitrogen will react with the water and turn into nitric acid.

- There are some **local** and **regional problems** (btw do you know that our weather comes from the west) this is why it's a local and regional problem. It is however not a worldwide problem.
- Some buffers such as potash will react with the acid rain and this will create saltwater (chemistry!)
- Keep in mind that everywhere that is getting affected by acid rain is a forest (tropical, boreal, etc..) this is because the acid will burn the xylem in the plants which will eventually lead to the plant dying. (in our stomach we have hydrochloric acid) and (our appendix is a vestigial organ, similar to how cows have four stomachs, and now it sits in our body doing nothing. If it bursts, all of the stomach acid would be released and you'd die)
- Acid rain has several harmful effects such as creating or intensifying human respiratory disorders, ruining aquatic ecosystems (may mutate any eggs in there

such as frogs), and the release of toxic metals which can lead to heavy metal poisonings.
    - There are some prevention approaches: using phosphate fertilizer and water which will eventually cause eutrophication, however, it will buffer your organisms from acid rain.

Indoor Air Pollution

- You are more likely to suffer from indoor pollution than outdoor pollution and this is because the air is being recycled and it's not fresh. This works the same way with cars as it is much more polluted than the outdoors. The health risk is magnified for people that spend around 70-98% of their time inside.
- Tobacco, formaldehyde, radioactive radon 222 gas, are indoor pollutants that are carcinogenic and can kill. Very small particles such as dust are not a carcinogen, however are still respiratory irritants.
- Here are some other indoor pollutants
    - Pesticide residue
    - Lead particles (paint/paint)
    - Living organisms and their excrements
    - Airborne spores of molds and mildews
- Sick buildings are when at least half of the occupants are sick in the building, however are fine when they leave the building.