

APES Chapter 17-19 Supplemental Notes

Human Health, Air Pollution & Climate Change

- *ERT-2.G. Explain how natural disruptions, both short and long-term, impact an ecosystem.*
 - Earth's climate has changed over geological time for many reasons.
 - Sea level has varied significantly as a result of changes in the amount of glacial ice on Earth over geological time.
 - Major environmental change or upheaval commonly results in large swathes of habitat changes.

- *ERT-4.D. Describe the structure and composition of the Earth's atmosphere.*
 - The atmosphere is made up of major gases, each with its own relative abundance.
 - The layers of the atmosphere are based on temperature gradients and include the troposphere, stratosphere, mesosphere, thermosphere, and exosphere.

- *STB-2.A. Identify the sources and effects of air pollutants.*
 - Coal combustion releases air pollutants including carbon dioxide, sulfur dioxide, toxic metals, and particulates.
 - The combustion of fossil fuels releases nitrogen oxides into the atmosphere. They lead to the production of ozone, formation of photochemical smog, and convert to nitric acid in the atmosphere, causing acid rain. Other pollutants produced by fossil fuel combustion include carbon monoxide, hydrocarbons, and particulate matter.
 - Air quality can be affected through the release of sulfur dioxide during the burning of fossil fuels, mainly diesel fuels.
 - Through the Clean Air Act, the Environmental Protection Agency (EPA) regulated the use of lead, particularly in fuels, which dramatically decreased the amount of lead in the atmosphere.
 - Air pollutants can be primary or secondary pollutants.

- *STB-2.B. Explain the causes and effects of photochemical smog and methods to reduce it.*
 - Photochemical smog is formed when nitrogen oxides and volatile organic hydrocarbons react with heat and sunlight to produce a variety of pollutants.
 - Many environmental factors affect the formation of photochemical smog.
 - Nitrogen oxide is produced early in the day. Ozone concentrations peak in the afternoon and are higher in the summer because ozone is produced by chemical reactions between oxygen and sunlight.
 - Volatile Organic Compounds (VOCs), such as formaldehyde and gasoline, evaporate or sublime at room temperature. Trees are a natural source of VOCs.
 - Photochemical smog often forms in urban areas because of the large number of motor vehicles there.
 - Photochemical smog can be reduced through the reduction of nitrogen oxide and VOCs.
 - Photochemical smog can harm human health in several ways, including causing respiratory problems and eye irritation.

- *STB-2.C. Describe thermal inversion and its relationship with pollution.*
 - During a thermal inversion, the normal temperature gradient in the atmosphere is altered as the air temperature at the Earth's surface is cooler than the air at higher altitudes.
 - Thermal inversion traps pollution close to the ground, especially smog and particulates.

- *STB-2.D. Describe natural sources of CO₂ and particulates.*
 - Carbon dioxide appears naturally in the atmosphere from sources such as respiration, decomposition, and volcanic eruptions.
 - There are a variety of natural sources of particulate matter.

- *STB-2.E. Identify indoor air pollutants.*
 - Carbon monoxide is an indoor air pollutant that is classified as an asphyxiant.
 - Indoor air pollutants that are classified as particulates include asbestos, dust, and smoke.
 - Indoor air pollutants can come from natural sources, human-made sources, and combustion.
 - Common natural source indoor air pollutants include radon, mold, and dust.
 - Common human-made indoor air pollutants include insulation, Volatile Organic Compounds (VOCs) from furniture, paneling and carpets; formaldehyde from building materials, furniture, upholstery, and carpeting; and lead from paints.
 - Common combustion air pollutants include carbon monoxide, nitrogen oxides, sulfur dioxide, particulates, and tobacco smoke.
 - Radon-222 is a naturally occurring radioactive gas that is produced by the decay of uranium found in some rocks and soils.

- *STB-2.F. Describe the effects of indoor air pollutants.*
 - Radon gas can infiltrate homes as it moves up through the soil and enters homes via the basement or cracks in the walls or foundation. It is also dissolved in groundwater that enters homes through a well.
 - Exposure to radon gas can lead to radon induced lung cancer, which is the second leading cause of lung cancer in America.

- *STB-2.G. Explain how air pollutants can be reduced at the source.*
 - Methods to reduce air pollutants include regulatory practices, conservation practices, and alternative fuels.
 - A vapor recovery nozzle is an air pollution control device on a gasoline pump that prevents fumes from escaping into the atmosphere when fueling a motor vehicle.
 - A catalytic converter is an air pollution control device for internal combustion engines that converts pollutants (CO, NO_x, and hydrocarbons) in exhaust into less harmful molecules (CO₂, N₂, O₂, and H₂O).
 - Wet and dry scrubbers are air pollution control devices that remove particulates and/or gases from industrial exhaust streams.
 - Methods to reduce air pollution from coal burning power plants include scrubbers and electrostatic precipitators.

- *STB-2.H. Describe acid deposition.*
 - Acid rain and deposition is due to nitrogen oxides and sulfur oxides from anthropogenic and natural sources in the atmosphere.
 - Nitric oxides that cause acid deposition come from motor vehicles and coal-burning power plants. Sulfur dioxides that cause acid deposition come from coal-burning power plants.

- *STB-2.I. Describe the effects of acid deposition on the environment.*
 - Acid deposition mainly affects communities that are downwind from coal-burning power plants.
 - Acid rain and deposition can lead to the acidification of soils and bodies of water and corrosion of human-made structures.
 - Regional differences in soils and bedrock affect the impact that acid deposition has on the region—such as limestone bedrock’s ability to neutralize the effect of acid rain on lakes and ponds.

- *STB-3.B. Describe the impacts of human activities on aquatic ecosystems.*
 - When elemental sources of mercury enter aquatic environments, bacteria in the water convert it to highly toxic methylmercury.

- *STB-3.H. Describe the effect of persistent organic pollutants (POPs) on ecosystems.*
 - Persistent organic pollutants (POPs) do not easily break down in the environment because they are synthetic, carbon-based molecules (such as DDT and PCBs).
 - Persistent organic pollutants (POPs) can be toxic to organisms because they are soluble in fat, which allows them to accumulate in organisms’ fatty tissues.
 - Persistent organic pollutants (POPs) can travel over long distances via wind and water before being redeposited.

- *STB-3.I. Describe bioaccumulation and biomagnification.*
 - Bioaccumulation is the selective absorption and concentration of elements or compounds by cells in a living organism, most commonly fat-soluble compounds.
 - Biomagnification is the increase in concentration of substances per unit of body tissue that occurs in successively higher trophic levels of a food chain or in a food web.

- *STB-3.J. Describe the effects of bioaccumulation and biomagnification.*
 - Humans also experience harmful effects from biomagnification, including issues with the reproductive, nervous, and circulatory systems.
 - DDT, mercury, and PCBs are substances that bioaccumulate and have significant environmental impacts.

- *EIN-3.A. Define lethal dose 50% (LD50).*
 - Lethal dose 50% (LD50) is the dose of a chemical that is lethal to 50% of the population of a particular species.

- *EIN-3.B. Evaluate dose response curves.*
 - A dose response curve describes the effect on an organism or mortality rate in a population based on the dose of a particular toxin or drug.

- *EIN-3.C. Identify sources of human health issues that are linked to pollution.*
 - It can be difficult to establish a cause and effect between pollutants and human health issues because humans experience exposure to a variety of chemicals and pollutants.
 - Dysentery is caused by untreated sewage in streams and rivers.
 - Mesothelioma is a type of cancer caused mainly by exposure to asbestos.
 - Respiratory problems and overall lung function can be impacted by elevated levels of tropospheric ozone.

- *EIN-3.D. Explain human pathogens and their cycling through the environment.*
 - Pathogens adapt to take advantage of new opportunities to infect and spread through human populations.
 - Specific pathogens can occur in many environments regardless of the appearance of sanitary conditions.
 - As equatorial-type climate zones spread north and south in to what are currently subtropical and temperate climate zones, pathogens, infectious diseases, and any associated vectors are spreading into these areas where the disease has not previously been known to occur.
 - Poverty-stricken, low-income areas often lack sanitary waste disposal and have contaminated drinking water supplies, leading to havens and opportunities for the spread of infectious diseases.
 - Plague is a disease carried by organisms infected with the plague bacteria. It is transferred to humans via the bite of an infected organism or through contact with contaminated fluids or tissues.
 - Tuberculosis is a bacterial infection that typically attacks the lungs. It is spread by breathing in the bacteria from the bodily fluids of an infected person.
 - Malaria is a parasitic disease caused by bites from infected mosquitoes. It is most often found in sub-Saharan Africa.
 - West Nile virus is transmitted to humans via bites from infected mosquitoes.
 - Severe acute respiratory syndrome (SARS) is a form of pneumonia. It is transferred by inhaling or touching infected fluids.
 - Middle East Respiratory Syndrome (MERS) is a viral respiratory illness that is transferred from animals to humans.
 - Zika is a virus caused by bites from infected mosquitoes. It can be transmitted through sexual contact.
 - Cholera is a bacterial disease that is contracted from infected water.

- *STB-4.A. Explain the importance of stratospheric ozone to life on Earth.*
 - The stratospheric ozone layer is important to the evolution of life on Earth and the continued health and survival of life on Earth.
 - Stratospheric ozone depletion is caused by anthropogenic factors, such as chlorofluorocarbons (CFCs), and natural factors, such as the melting of ice crystals in the atmosphere at the beginning of the Antarctic spring.
 - A decrease in stratospheric ozone increases the UV rays that reach the Earth's surface. Exposure to UV rays can lead to skin cancer and cataracts in humans.

- *STB-4.B. Describe chemicals used to substitute for chlorofluorocarbons (CFCs).*
 - Ozone depletion can be mitigated by replacing ozone-depleting chemicals with substitutes that do not deplete the ozone layer. Hydrofluorocarbons (HFCs) are one such replacement, but some are strong greenhouse gases.

- *STB-4.C. Identify the greenhouse gases.*
 - The principal greenhouse gases are carbon dioxide, methane, water vapor, nitrous oxide, and chlorofluorocarbons (CFCs).
 - While water vapor is a greenhouse gas, it doesn't contribute significantly to global climate change because it has a short residence time in the atmosphere.

- *STB-4.D. Identify the sources and potency of the greenhouse gases.*
 - Carbon dioxide, which has a global warming potential (GWP) of 1, is used as a reference point for the comparison of different greenhouse gases and their impacts on global climate change. Chlorofluorocarbons (CFCs) have the highest GWP, followed by nitrous oxide, then methane.

- *STB-4.E. Identify the threats to human health and the environment posed by an increase in greenhouse gases.*
 - Global climate change, caused by excess greenhouse gases in the atmosphere, can lead to a variety of environmental problems including rising sea levels resulting from melting ice sheets and ocean water expansion, and disease vectors spreading from the tropics toward the poles. These problems can lead to changes in population dynamics and population movements in response.

- *STB-4.F. Explain how changes in climate, both short- and long term, impact ecosystems.*
 - The Earth has undergone climate change throughout geologic time, with major shifts in global temperatures causing periods of warming and cooling as recorded with CO₂ data and ice cores.
 - Effects of climate change include rising temperatures, melting permafrost and sea ice, rising sea levels, and displacement of coastal populations.
 - Marine ecosystems are affected by changes in sea level, some positively, such as in newly created habitats on now-flooded continental shelves, and some negatively, such as deeper communities that may no longer be in the photic zone of seawater.
 - Winds generated by atmospheric circulation help transport heat throughout the Earth. Climate change may change circulation patterns, as temperature changes may impact Hadley cells and the jet stream.
 - Oceanic currents, or the ocean conveyor belt, carry heat throughout the world. When these currents change, it can have a big impact on global climate, especially in coastal regions.
 - Climate change can affect soil through changes in temperature and rainfall, which can impact soil's viability and potentially increase erosion.
 - Earth's polar regions are showing faster response times to global climate change because ice and snow in these regions reflect the most energy back out to space, leading to a positive feedback loop.
 - As the Earth warms, this ice and snow melts, meaning less solar energy is radiated back into space and instead is absorbed by the Earth's surface. This in turn causes more warming of the polar regions.
 - Global climate change response time in the Arctic is due to positive feedback loops involving melting sea ice and thawing tundra, and the subsequent release of greenhouse gases like methane.
 - One consequence of the loss of ice and snow in polar regions is the effect on species that depend on the ice for habitat and food.

- *STB-4.G. Explain the causes and effects of ocean warming.*
 - Ocean warming is caused by the increase in greenhouse gases in the atmosphere.
 - Ocean warming can affect marine species in a variety of ways, including loss of habitat, and metabolic and reproductive changes
 - Anthropogenic activities that contribute to ocean acidification are those that lead to increased CO₂ concentrations in the atmosphere: burning of fossil fuels, vehicle emissions, and deforestation

- *EIN-4.C. Explain how human activities affect biodiversity and strategies to combat the problem.*
 - Global climate change can cause habitat loss via changes in temperature, precipitation, and sea level rise.