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- Following widespread usage of antibiotics on humans and animals, waste from livestock and humans is generating antibiotic-resistance bacteria
- These bacteria are getting back into the environment through out waste

### 1.1 Antibiotic Resistance is:

- A complex problem that involves helping many actors see the big picture and not just their part of it

- Issues where an action affects (or is affected by) the environment surrounding the issue, either the natural environment or the competitive environment
- Problem whose solutions are not Obvious

## **1.2 Systems Thinking**

- Considers the whole rather than parts of the whole:
  - Events
  - Patterns
  - Underlying Structure

## **1.3 Cycle of Infection**

- Farm animals receive antibiotics often, developing resistant bacteria in their gut
- This can be transmitted through produce, waste, shared environments, etc.

## **1.4 Bacteria**

- Bacteria are single celled organisms that can grow in colonies
- Many different kinds of bacteria can grow together in similar environments

## **1.5 Explaining Resistance**

# **2 09.18.20**

## **2.1 Hurricanes**

### **2.1.1 How Hurricanes Form**

- Water evaporates over the ocean and forms clouds when it touches cold air
- A column of low pressure develops at the center with winds around the column

- Speed of the wind around it increases
- Categorized based on wind speed (1-5)
- Hurricane development requires warm water and low wind shear
  - Caribbean has warm water all year but also high wind shear which isn't conducive to hurricanes

#### **2.1.2 Climate Change & Hurricanes**

- Storm surge more dangerous (accounts for 90% of hurricane deaths)
- 40% increase with a 0.5 degree C inc in temperature
- Increasing of North Atlantic hurricane season
- Climate change is expected to shift the Bermuda high westward
  - Bermuda High is a pressure system over the Atlantic
  - Has the ability to move hurricanes on the Atlantic

#### **2.1.3 Hurricane Harvey Intensification**

- Went from a tropical depression to a Cat 4 Hurricane in 57 hours
- Soil in TX affected the amount of water maintained in the Earth
- Huge economic impacts

#### **2.1.4 General Impacts**

- Storm Surge
- Extreme Rainfall
- Potential Wind Speed

### **3 09.16.20**

#### **3.1 Heat Waves**

- Heat extremes doubled in frequency from 1980-1999 to 2000-2019
- Climate change affecting heat waves

- Shifting the frequency of hot and cold weather, heat waves are more frequent
- Exacerbating heat inducing droughts, dry land leads to even hotter temps
- Causes: Global warming ->
  - Large scale global circulation change
  - Atmospheric Blocking increase
  - Air mass temp increase
- Effects and Consequences
  - Decreased human productivity
  - Increased tropical disease and death
  - Environmental racism
  - Crop productivity decreases
  - Lower biodiversity
  - Decreased water availability
  - Increased fire risk

### **3.2 Wildfires**

- Climate change is increasing the size, intensity, and frequency of wildfires
- Wildfires create more climate change through the increase of carbon expulsion through wildfires
- Wildfires have global impacts due to smoke and temperature changes
- Wildfire season has gotten longer due to climate change

## **4 09.14.20**

### **4.1 Coriolis Effect**

- Deflection of an object's path due to the rotation of the Earth
- North and south poles have different deflections of wind patterns
- Little/no deflection at the equator

## **4.2 Air circulation**

- Hottest air at the equator, moves north or south, cools, then comes back into equator

### **4.2.1 Cells**

- Hadley cells: 0-30 degrees North and South
- Ferrell Cell: 30-60 degrees North
- Polar cells: North and South poles
- Northeast and Southeast trade winds (remember directions!)
- Westerlies: bring rain and precipitation

## **4.3 Surface Ocean Currents**

- Ocean currents also affect the distribution of climates
- Surface ocean currents generated by wind, Coriolis effect, heat, and continents
- Heat redistribution from the Tropics
  - Trade winds push warm surface waters west
  - Water reaches continents and flows north and south
  - water cools
  - Westerlies push cooler water east
  - Water reaches continents and flows to equator

## **4.4 El Nino (Southern Oscillation)**

- Recurring climate pattern involving changes in the temperature of waters in the central and eastern tropical Pacific Ocean.
- The ocean and atmosphere can interact to affect climate
  - Water in the eastern pacific warms up
  - Sea level pressure drops but rises in the W pacific
  - Trade winds weaken

- Upwelling in the Pacific is reduced
- Warmer waters - increased rainfall in Peru
- Cooler waters, drought in Australia/Indonesia
- Critical because of its ability to change atmospheric circulation, temps, and precipitation
- Significantly hurts fisheries and developing countries

#### 4.5 La Nina

- exacerbates normal conditions and leads to cooling in the Eastern Pacific

#### 4.6 Heat Waves

- Global warming has amplified the intensity, duration, and frequency of extreme heat and heat waves.

### 5 09.11.20

- Northern latitudes experience greater seasonality in CO<sub>2</sub> concentrations
  - This is due to variation in photosynthetic activity by plants
- Greenhouse effect
  - Some incoming solar radiation is absorbed
  - Other amounts are reflected back into the atmosphere
  - Greenhouse gases capture and reradiate some heat over and over, warming the Earth
  - More gases, more heat
- Albedo: measure of the reflectivity of a surface
  - light surfaces have a higher albedo, darker surfaces have a lower albedo
  - surfaces with a low albedo release more heat into the atmosphere
- Positive Feedback Loops

- applied to albedo:
  - temps rise -> more ice melting -> more water warming -> temps rise
- Urban Heat Island Effect
  - cities will be inc their population, inc energy and temperature
  - cities in particular have higher temperatures
  - tree cover -> cooler temperatures
- Small changes in overall global temp can cause significant changes in weather creating more extreme storms and more record temps
  - roughly twice as many heat records
  - alterations in global jet streams
  - frost comes later and begins earlier
- General climate change impacts:
  - Health impacts
  - Crop productivity
  - Coastal erosion
  - Biodiversity
  - Water availability
  - Fire risk
- Weather events getting more extreme with
  - sea levels
  - wildfires
- Need both adaptation and mitigation
  - Adaptation: Responding to warming that has already happened
  - Mitigation: Preventing further warming by addressing climate change causes



## **6 09.09.20**

### **6.1 The Earth's Atmosphere**

- Climate change is a serious environmental problem impacting species, ecosystems, and the globe
- The atmosphere helps protect the Earth from the sun and keeps the temperature of the Earth cool
- Atmosphere has a significant impact on climate
- Earth's Atmosphere Composition
  - Nitrogen (78%)
  - Oxygen (21%)
  - Other - Greenhouse Gases (1%)

### **6.2 The Keeling Curve**

- Curve developed to track atmospheric CO2 levels in Earth's atmosphere since 1952

## **7 09.02.20**

### **7.1 Demographic Transition Model**

- Demographers use age structure diagrams to predict future growth potential of a population
  - Pyramid structures indicate fast growth
  - House-shaped structures have moderate growth
  - Diamond structures have low/negative growth
- Development leads to smaller families
- Demographic transitions happen country by country
- Industrialization might not lead to a demographic transition in all countries
  - May not be linked to quality of life
  - Religion/Cultural beliefs

- Social justice issue, improving the well-being of women and children key to dec. fertility

## 7.2 Social Justice: Education for Women

- Education of girls & economic opportunities for women are correlated with lower birth rates
- Education empowers women to take control over their own fertility through:
  - Birth control
  - Marrying later
  - Delaying childbirth for career opportunities
- Women earning more money is correlated to lower child mortality

## 7.3 Environmental Impact

- Slowing population growth is critical to sustainability and reducing our population impact
- Our impact on the population is a result of (1) our population size and (2) our consumption habits - both must be addressed
- Ecological footprint: the land area needed to provide the resources for, and assimilate the waste of, a person or population

## 7.4 Sustainability

- A dynamic process between the economy, society, and environment
- Sustainable: The process or the activity can be maintained without exhaustion or collapse
  - Intra & Inter-generational issue
  - Capacity of a system to accommodate changes:
    - \* rates of renewable resource use should not exceed regeneration rate
    - \* rates of non-renewable resource use should not exceed rate of renewable substitute dev

\* rates of pollution should not exceed assimilative capacity of the environment

- Sustainable development has three factors:
  - Social equity
  - Economic efficiency
  - Environmental responsibility

## 7.5 Worldviews

- Culture influences our beliefs through:
  - Knowledge
  - Beliefs
  - Values
  - Learned ways of life
- Worldviews are affected by:
  - Environmental Ethics

## 8 08.31.20

### 8.1 Human Populations

- 3 major sparks of growth
  - Agricultural Revolution
  - Industrial Revolution
  - Green Revolution
- With more food and technology, the population and need for more human labor increased
- The human population is rapidly increasing and the impact of humans is due to:
  - More humans overall
  - Greater growth / person

- To address population growth, we need to pursue a variety of approaches that address factors encouraging high birth rates
- Zero population growth: the absence of population growth, occurs when birth rates = death rates
  - Replacement fertility is reached

## 8.2 Population Ecology

- Analyze and categorize human populations using population ecology techniques
- Population Ecology: a branch of biology dealing with the number of individuals in a particular species in an area over time
- Ecologists study populations to understand what makes them survive and thrive
- Size, distribution, and growth rate is influenced by a variety of factors and are important to understanding population ecology

## 8.3 Monitoring Population Dynamics

- Population Dynamics: Changes over time in population size and composition
- Important metrics:
  - Minimum viable population - min number of individuals that would still allow population to persist or grow
  - Carrying Capacity (K) - the maximum population size that a particular environment can support indefinitely
- Population Density - the overall density a particular population can sustain

## 8.4 Exponential Growth & Populations

- Exponential growth occurs in populations when growth is unrestricted. This is, overall, unsustainable
- Growth which becomes progressively larger each breeding cycle
- Produces a J curve when plotted

## 8.5 Monitoring Population Growth

- Population growth rate - the rate at which a population of a species grows over time
- Growth factors - factors which assist in the growth of a population
- Resistance factors - factors which inhibit the growth of a population
- Limiting factors: resources needed for survival but that may be in short supply

## 8.6 Logistic Growth

- Occurs when a population nears carrying capacity ( $k$ )
  - Maximum sustainable population size
  - Determined by limiting factors

## 8.7 Density-dependent/ Density-independent Factors

- Density dependent factors increase as populations grow, typically biotic
  - Disease
  - Competition
  - Predation
- Density independent factors affect population growth regardless of population size
  - Storm
  - Fire/Flood
  - Avalanche

## 8.8 Regulation

- Tendency for populations to decrease in size when above a certain level, and increase in size below that level
- Populations can only be regulated by density-dependent factors
- Top down Regulation

- Predation
- Disease
- Bottom up Regulation
  - Nutrients
  - Water
  - Sunlight

## 9 08.28.20

### 9.1 What is Science?

- Science: a body of knowledge that allows us to understand the world around us
- Science is based on empirical evidence
- Science allows us to test our ideas and evaluate the evidence
- Scientific knowledge, including facts, theories, and laws, is subject to change
- Scientific claims change as new evidence is made available

### 9.2 White-Nose Syndrome Case Study

#### 9.2.1 About WNS

- White-Nose Syndrome
  - 2007-2016, 6+ million bats dead as a result of White Nose Syndrome
  - The reason for the deaths was White-Nose Syndrome
- Chytridiomycosis
  - Infectious, fungal disease affecting amphibians
  - Helped understand white-nose syndrome with bats

### 9.2.2 Science with WNS

- Scientific Method: the procedure used to empirically test a hypothesis
  1. Observations generate questions
  2. Choose a question to investigate
  3. Consult literature
  4. Develop a hypothesis and make a testable prediction
  5. Design and carry out a study
  6. Analyze data
  7. Draw a conclusion
- Inferences: Conclusions drawn based on observations
- Hypothesis: An inference that proposes possible explanation that includes previous knowledge/observation
- Testing a Hypothesis: Hypotheses can be tested through an observational or experimental study
- Scientific Studies: A fair test with results that could support or falsify the research prediction
  - Experimental Studies: Conditions are manipulated intentionally
    - \* Test Group: the group in an experimental study such that it differs from the control in only one way
    - \* Control Group: the group in an experimental study to which the test group's results are compared
  - Observational Studies: Gather real-world data without any intentional variable manipulation
- Theory: A hypothesis that survives repeated testing by significant research can become a theory
- Correlation v Causation
  - Correlation: two things occurring together but not necessarily having a cause-effect relationship
  - Cause-Effect Relationship: the association of a two variables that identifies one variable occurring as a result of the other
  - Observational studies can derive correlation but not causation

- Experimental studies can derive causational relationships
- Policy: a formalized plan that addresses a desired outcome or goal
  - policies need to be flexible, adapt to new findings, address the environmental problem, fit social need and be economically viable in order to work effectively.

### 9.3 Summary

- Scientific knowledge, through reliable and durable, is never absolute or certain
- This knowledge, including facts, theories, and laws, is subject to change
- Physical evidence, systematically collected and logically analyzed, helps scientists understand environmental issues and guide policy decisions

## 10 08.25.20

### 10.1 Applied v Empirical Science

- Applied Science = research whose findings are used to solve practical problems
- Empirical science: A scientific approach that investigates the natural world through case studies

### 10.2 Social Traps

- Occurs when a large amount of people are using a shared resource
- Seem good in the short term but are actually bad in the long term
- 3 Types:
  - Tragedy of the Commons: When resources are shared, individuals try to maximize personal benefit which hurts the resource itself
  - Time delay: Collective decisions that are good today but gone tomorrow
  - Sliding reinforcer: related to the evolution of natural organisms and GMOs



### 10.3 Beginning with Data Interpretation

- Variables represent factors that can be manipulated, controlled, or merely measured for research
- Variation = how much a variable changes
- Independent var is controlled to see effects in the Dependent var
- Graphs explore relationships with data and report this data

### 10.4 Observational v Experimental Studies

- Observational studies can observe a correlation but are unable to derive a causational reln.
- Experimental studies have a control var (required) and are able to derive causational relns.

## 11 08.24.20

### 11.1 Definitions

- Ecology: the branch of science dealing with the relationships of living things to one another & the environment
- Environmental Science: The study of all aspects of the environment, including physical, chemical, and biological factors, particularly with respect to how these aspects affect humans, and vice versa
- Environmental Ethics: Personal philosophy that influences how a person interacts with their natural environment and thus influences how one responds to environmental problems

### 11.2 Ecology != Environmentalism

- Distinguish between environmentalism & ecology

Environmentalism	Ecology
Activism to protect the environment	Scientific study of living and non-living things