OUR ISLAND, EARTH

Introduction to Environmental Science

Our Earth is like an island in space.

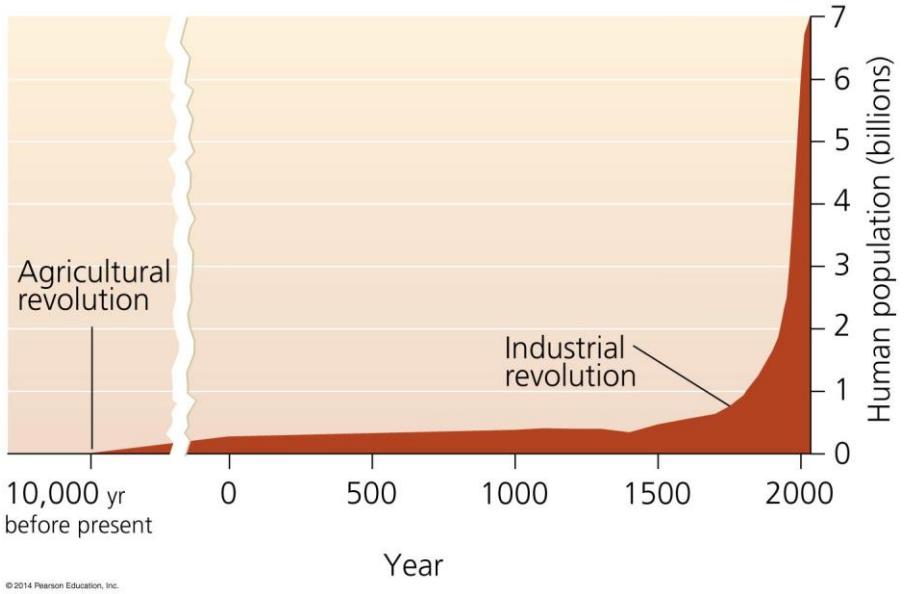
All of the conditions, resources, and processes necessary to support life are here on Earth.

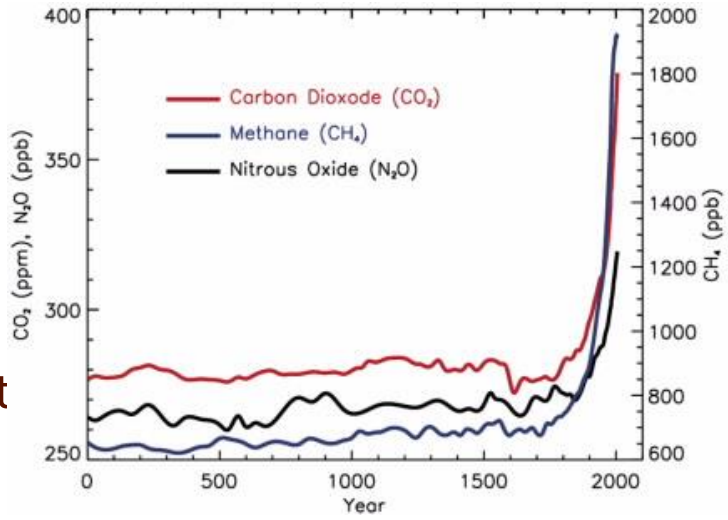
- Conditions: Abiotic conditions on Earth match the ***range of tolerance*** of humans for conditions such as O_2 concentration in the atmosphere, UV light exposure, temperature range, etc.
- Resources: Animals and plants for food, textiles and building materials. Mineral resources are the raw materials for manufacturing goods. Energy resources for doing work, heating and cooling our homes, and cooking our food. Water for drinking, cooking and washing.
  - ***Renewable resources:*** Natural resources that are replenished by natural processes on a time scale that is useful to humans.
  - ***Nonrenewable resources:*** Natural resources that are finite and never replenished by natural means or which are replenished so slowly compared to a human lifetime that once we consume them they are no longer available.
  - The difference between renewable and nonrenewable resources is the time it takes for natural processes to replenish the resource. It is not black and white, it is a continuum of resources.
- Processes: Natural processes on Earth not only provide us with natural resources, they also provide us with services that make life possible.
  - ***Ecosystem services:*** We are dependent on healthy, functioning ecosystems to purify the air and water, cycle nutrients, regulate climate, pollinate plants, and recycle our wastes.

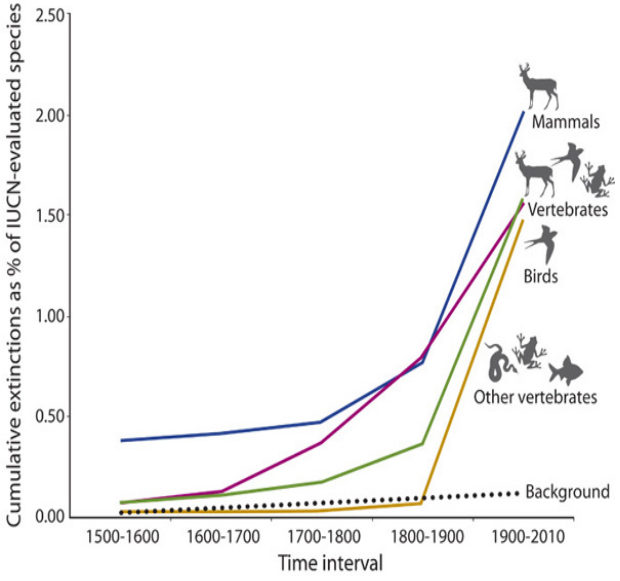
Our Earth is Like and Island in Space

Our growing consumption of resources provided by Earth, and the wastes this produces, threaten to push conditions beyond our range of tolerance and disrupt the ecosystem services we rely on.

- Population growth has lead to infinitely more resource consumption and amplifies our impacts.
- Population increases driven by:
  - ***Agricultural revolution***, 10,000 year ago, created a shift from hunter gatherers to sedentary farming
  - ***Industrial revolution***, beginning in the lat 1700's, led to a shift from rural to urban populations and rapidly increasing dependence on fossil fuels.







Our Earth is Like and Island in Space

Much like the island scenario you were presented with:

- There is little hope of rescuers whisking us away to another land.
- and building a raft to move large numbers of people from our island to another land is still a long ways off.
  - We don't know of another planet that can support life as we know it.
- ***Environmental Science*** helps us to understand the challenges we face with regards to population growth, resource consumption, maintaining ecological processes, and managing our production of waste materials and their disposal.
  - Applies science (Biology, Geology, Chemistry, and Physics) to help humans be more efficient, less impactful and more sustainable in obtaining the goods and services we rely on from the environment, while maintaining conditions on our planet that are within our range of tolerance.
  - The goal is to reduce the ***ecological footprint*** of humans, while maintaining and improving our standard of living.

Science Applies Math to Understand and Solve Scientific Problems

- Manage very big and very small numbers (be able to use scientific notation)
- Convert between measurement units (be able to use the metric system)
- Calculate percent difference (percent increase, percent decrease)
- Calculate area and volume, densities and concentrations.
- Read and interpret graphs
  - Identify relationships between variables
  - Calculate rates by determining the slope of a graphed line
  - Use a line of best fit and its slope to interpolate / extrapolate values not present in the data set graphed.
- Apply formulas to solve for unknowns.
  - NPP = GPP - Respiration
  - $E = P \times T$
  - $N_t = N_o e^{rt}$

How many meters of rain fall on the island annually? (1 inch = 2.54 centimeters) Use dimensional analysis, and show your work, including units.

- (75 inches/1 year) x (2.54 cm /1 inch) x (1 meter / 100 cm) =
- (75 ~~inches~~/1 year) x (2.54 ~~cm~~ /1 ~~inch~~) x (1 meter / 100 ~~cm~~) = ??? Meters / year
- (75 x 2.54 x 1) / (1 x 1 x 100) = 190.5 / 100 = 19.05

1.905 meters / year

What is the area of the island in square kilometers (km^2)? (1 mile = 5280 feet, What is the total volume of rainfall (in m^3) that falls on this island each year? Use dimensional analysis, and show your work, including units. Express your answer in scientific notation.

$72\ mi^2 \times (5280\ ft / 1\ mi) \times (12\ in / 1\ ft) \times (2.54\ cm / 1\ in.) \times (1m / 100cm) \times 1km / 1000m) =$

Using dimensional analysis, we notice that the units don't cancel out in the set up above, squaring the conversion factors makes the unit cancel, and gives us the final units we need.

$72\ mi^2 \times (5280\ ft / 1\ mi)^2 \times (12\ in / 1\ ft)^2 \times (2.54\ cm / 1\ in.)^2 \times (1m / 100cm)^2 \times 1km / 1000m)^2 =$

$72\ \cancel{mi^2} \times (2.79 \times 10^7\ \cancel{ft^2}/1\ \cancel{mi^2}) \times (144\ \cancel{in^2}/1\ \cancel{ft^2}) \times (6.45\ \cancel{cm^2}/1\ \cancel{in^2}) \times (1\ \cancel{m^2}/10{,}000\cancel{cm^2}) \times (1\ km^2/1 \times 10^6\cancel{m^2}) = ?km^2$

$(72 \times 2.79 \times 10^7 \times 144 \times 6.45) / (10{,}000 \times 1 \times 10^6) = 1.87 \times 10^{12} / 1 \times 10^{10}) =$

$1.87 \times 10^2\ km^2$ or $187\ km^2$

Miles, feet, inches, centimeters, meters, kilometers are units of length or distance, not area (A=LxW). Length and width are distances, the units of Area must be (distance unit)^2 For example: mi^2 or km^2

What is the volume of rain that falls on the island annually in meter^3 /year (m^3/yr). Use dimensional analysis, and show your work, including units. Express your answer in scientific notation.

- V = L x W x H or V = Area x Height
- From the previous problems we know:
  - Area of the Island = 187 km^2
  - Height of Rainfall = 1.905 m / year

So V = (1.905 m/yr) x (187 km^2) =

Quick dimensional analysis shows units cancelation wont give us the desired units of m^3/yr, so we need a conversion factor.

So V = (1.905 m/yr) x (187 km^2) x $(1000m/km)^2$ =

V = (m/yr) x ($\cancel{km^2}$) x ($m^2/\cancel{km^2}$) = m^3/yr

V = 1.905 x 187 x 1000^2 =

356,000,000 m^3/yr or 3.56 x 10^8 m^3/yr

Imagine that the island population eventually grows to 320 people. What is the percent increase of the population? Show your set-up.

Initial population = 200 people

Final population =320 people

Increase in population = 320 – 200 = 120 people

% Change = [(Final – Initial) / Initial] x 100 =

(320 people – 200 people) / 200 people] x 100 =

(120 people /200 people) x 100 =

60% increase