Environment & Sustainability

Environment and Sustainability Lecture

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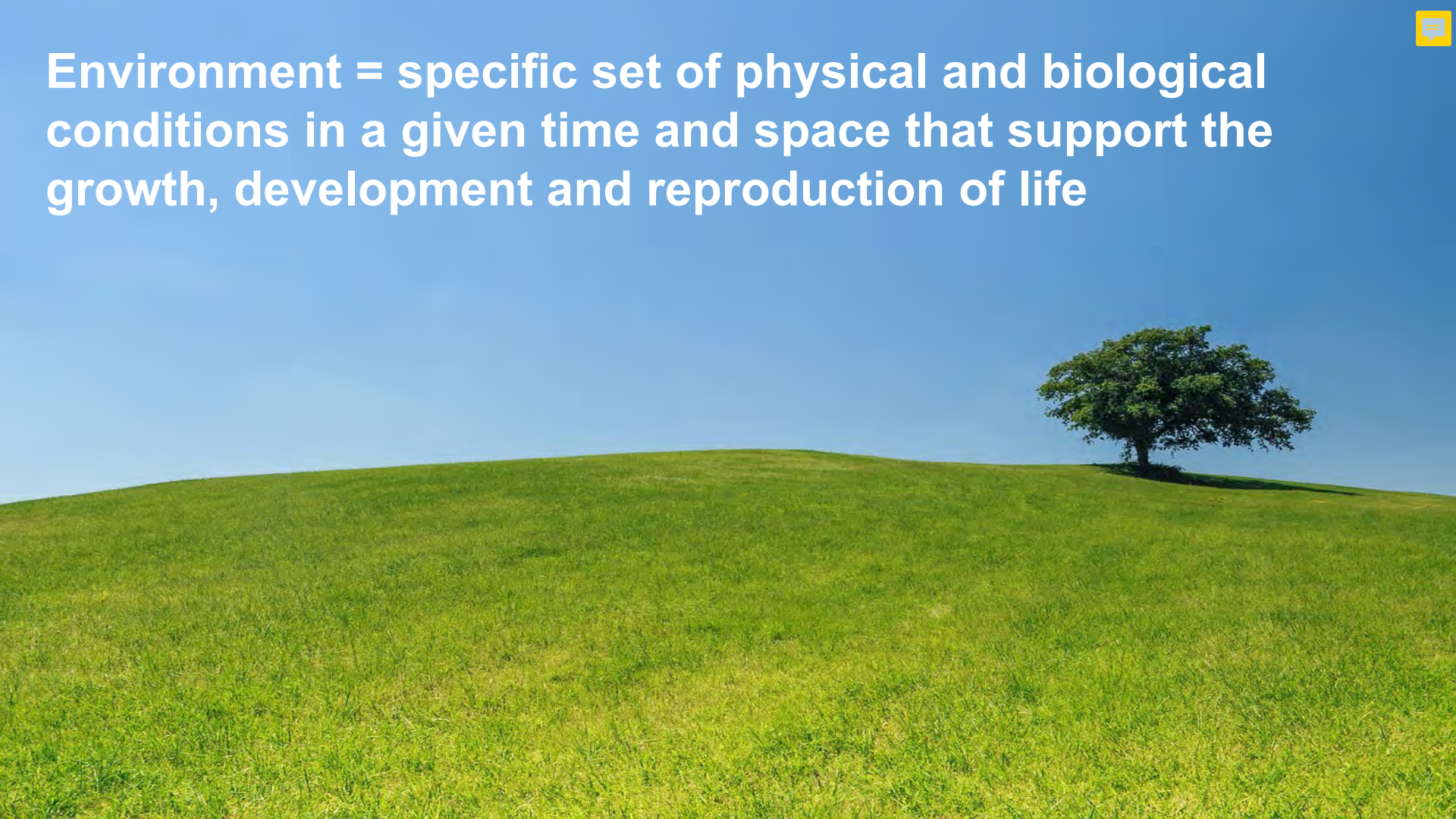
Environment and Sustainability Learning Objectives

1. Define environmental science and identify the disciplines that it draws from.
2. Describe environmental literacy and the environmental problems that this literacy helps us to solve.
3. Outline the United States' environmental history and understanding of Earth systems.
4. Recognize how our individual actions as a species impact our planet and identify the potential for living sustainably.

Objective 1: Define environmental science and identify the disciplines that it draws from.

Environment = specific set of physical and biological conditions in a given time and space that support the growth, development and reproduction of life



Physical Environment = incoming radiant energy of the sun, air, water, and soil minerals, all of which are required for life on Earth

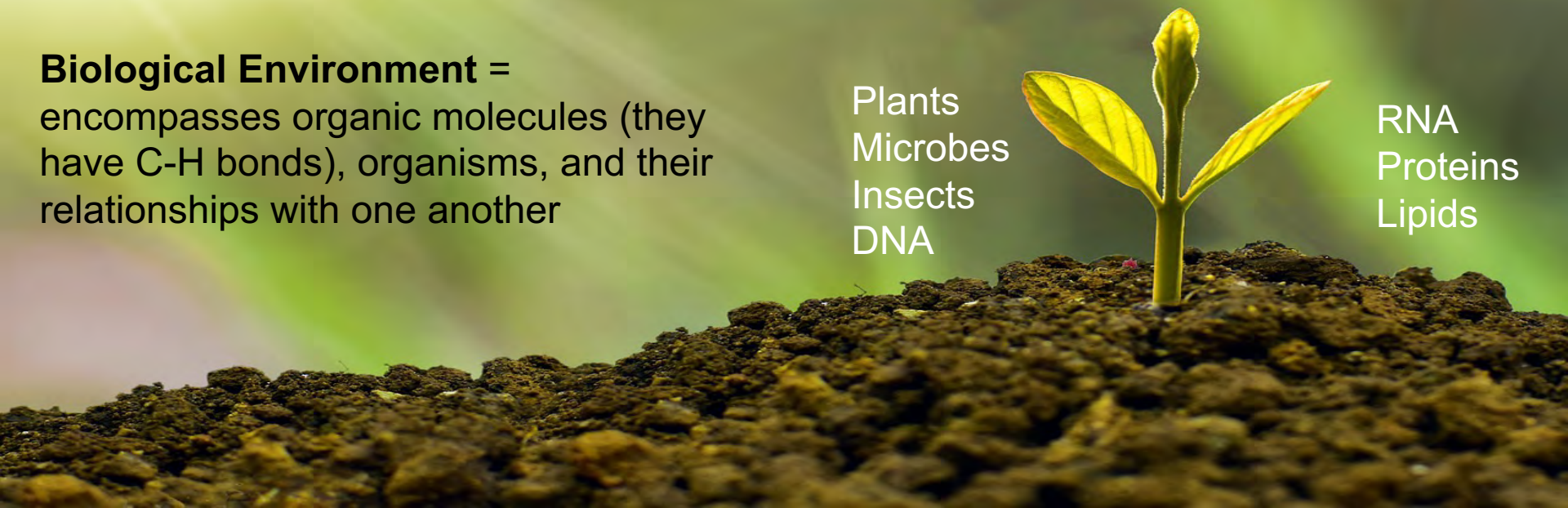
Nitrogen, N_2
Oxygen, O_2
Carbon dioxide, CO_2
Water, H_2O

Sunlight
Minerals

Biological Environment = encompasses organic molecules (they have C-H bonds), organisms, and their relationships with one another

Plants
Microbes
Insects
DNA

RNA
Proteins
Lipids



Environmental Science = the interdisciplinary study of humanity's relationship with other organisms and Earth

Environmental science relies on a combination of natural sciences, social sciences, and humanities in order to better understand the planet and to discover solutions to environmental problems.

A combination of many disciplines such as biology, geography, chemistry, physics, geology, economics, engineering, anthropology, agriculture, politics, ethics, literature, psychology, and many more are needed to work together.

Image from NASA Earth Observatory, Public Domain.

Environmental science is a **fundamental science** based on **empirical evidence.**

Fundamental science seeks to develop information and theories to explain, understand and predict natural phenomena.

Empirical evidence is based on data and information collected from observations and experimentation.

Environmental science is an **applied science.**

Applied science uses scientific knowledge to inform resulting actions, develop technologies and generate positive changes.

Fundamental science determined the best material to manufacture the wind turbine blade and optimum wind speed.
Applied science built and operated the wind turbine to create clean electricity from wind.

Image from Kenueone, Pixabay.

Objective 2: Describe environmental literacy and the environmental problems that this literacy helps us to solve.

Environmental Literacy = understating natural systems and environmental problems in order to make informed decisions involving sustainability and the environment

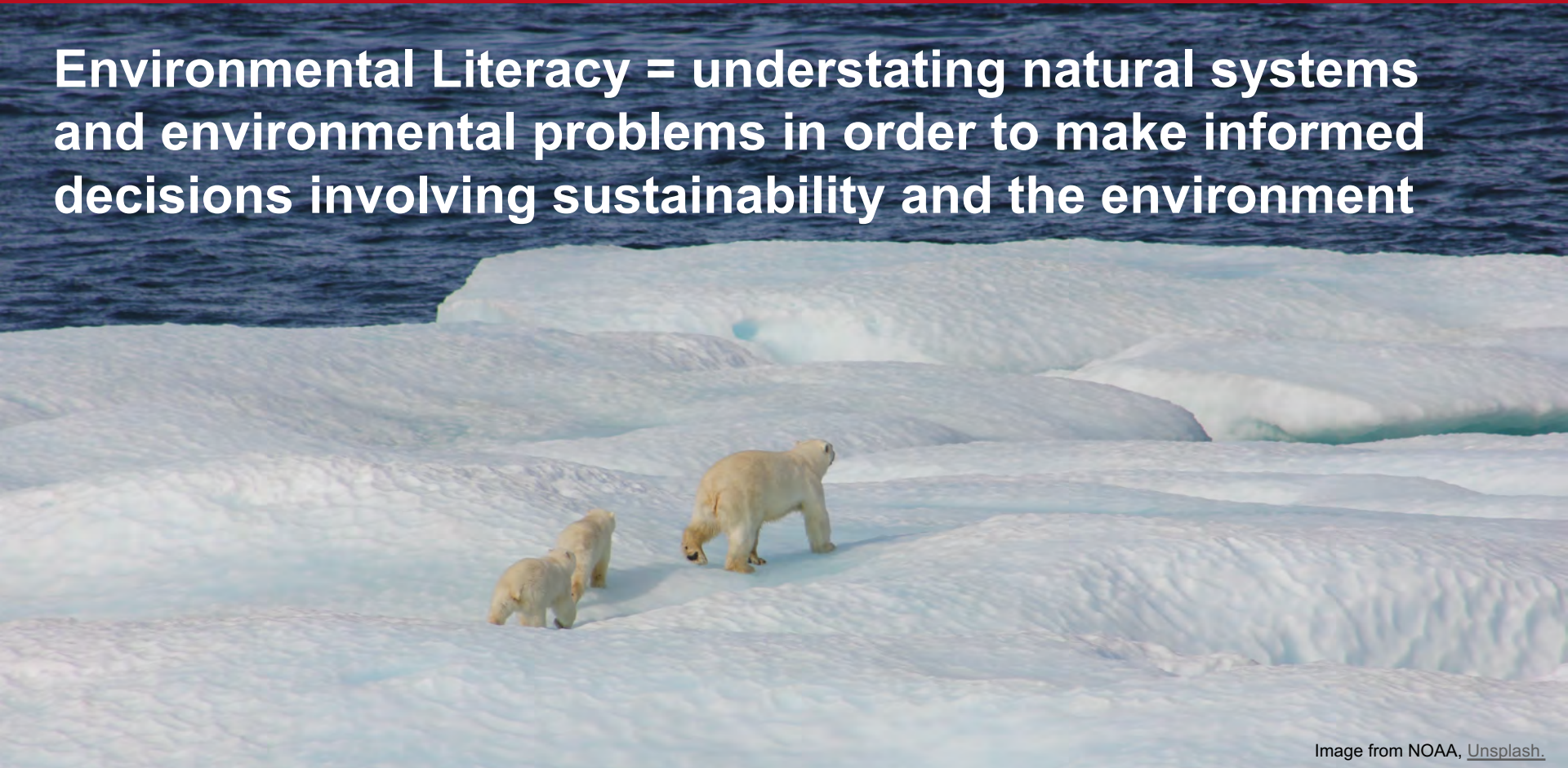


Image from NOAA, Unsplash.

Today's Environmental Challenges

- Energy production
- Climate change
- Food production
- Food waste
- Air pollution
- Water quality and quantity
- Ecosystem conservation and preservation
- Fossil fuel mining
- Hazardous waste
- Human population growth
- Loss of habitat and biodiversity
- Urbanization and transportation
- Environmental inequality and justice

Humans are an environmental force, and our activities impact Earth systems

Anthropogenic = caused by or related to human action

Most environmental issues are referred to as “wicked problems”

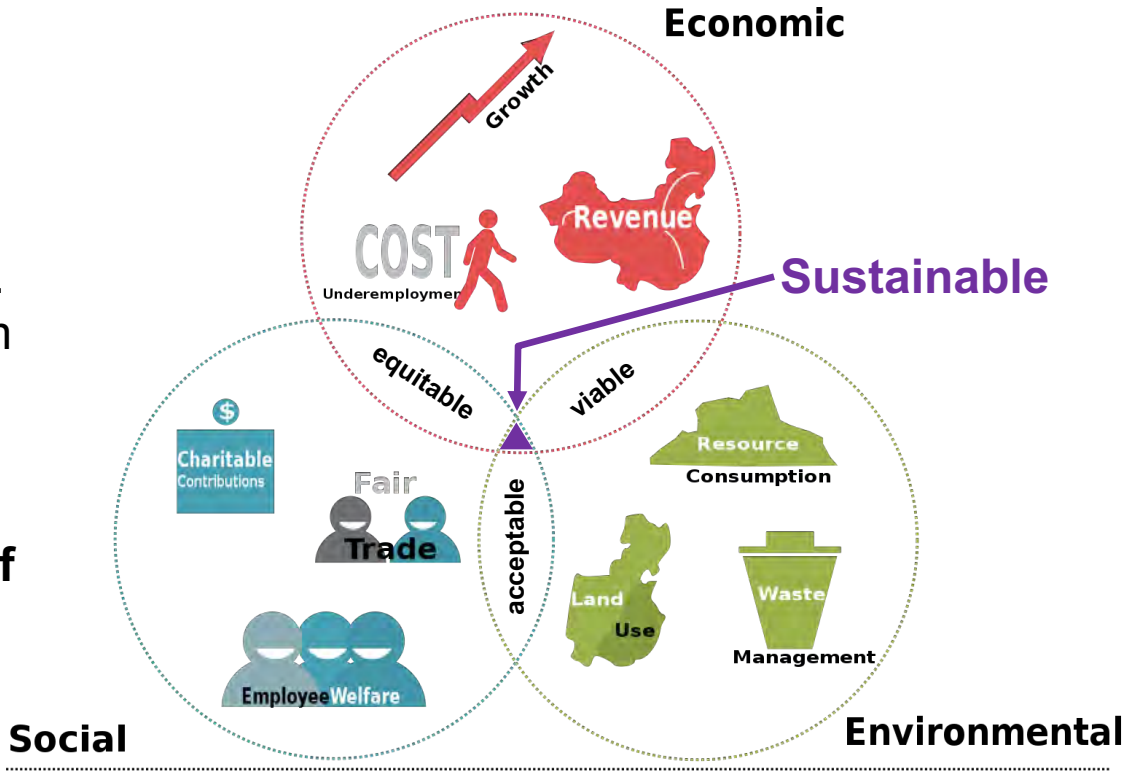
Wicked Problems = problems that are difficult or impossible to solve due to their scale and complexity (social, economic, environmental considerations)

Wicked problems are multifaceted

1. There are many causes. Each cause by itself is challenging to address.
2. There are many consequences. This makes finding one solution often impossible.
3. There are many possible actions to take. Each possible action comes with different associated trade-offs (pros versus cons).
4. The effects of wicked problems are felt differently by different groups. Groups and individuals will often differ in their opinions on how to solve these problems.

Robust, versatile and innovative solutions are needed to solve wicked problems. Solutions must not only consider the environment, but how they will impact society, and the economy. This is known as the triple bottom line.

Triple Bottom Line = considering the combination of environmental, social, and economic impacts of our choices and decisions



Social Traps = decisions that seem good in the short-term but lead to negative outcomes in the long-term

Choices that are made by individuals or groups can result in short-term benefits but later cause long-term consequences for society.

Image from C. Ortiz Rojas, NOAA. Public Domain.

Tragedy of the Commons

Shared natural resources are not owned by anyone but individuals who try to maximize benefit harm the resource for everyone.

Time Delay

The passage of time shifts a natural resource from positive to negative over time as it is not able to be regenerated at a fast enough rate.

Sliding Reinforcer

Solutions that are helpful at first backfire and become more harmful over time.

Objective 3: Outline the United States' environmental history and understanding of Earth systems.

Image from NPS, Public Domain.

Early inhabitants (pre-1500)

Early inhabitants of the Americans included many indigenous populations that were conscious of the nature that existed all around them and understood their place within the ecosystem. They were experts in hunting and gathering. They had a keen understanding of their natural resources and were stewards of the land.

Colonization and Westward Expansion (1600s - Late 1800s)

When Europeans first settled in what is now the United States, the vast land was seen as an unending supply of natural resources to exploit. Settlers moved west and began claiming land, planting crops, harvesting timber and hunting and trapping wildlife.

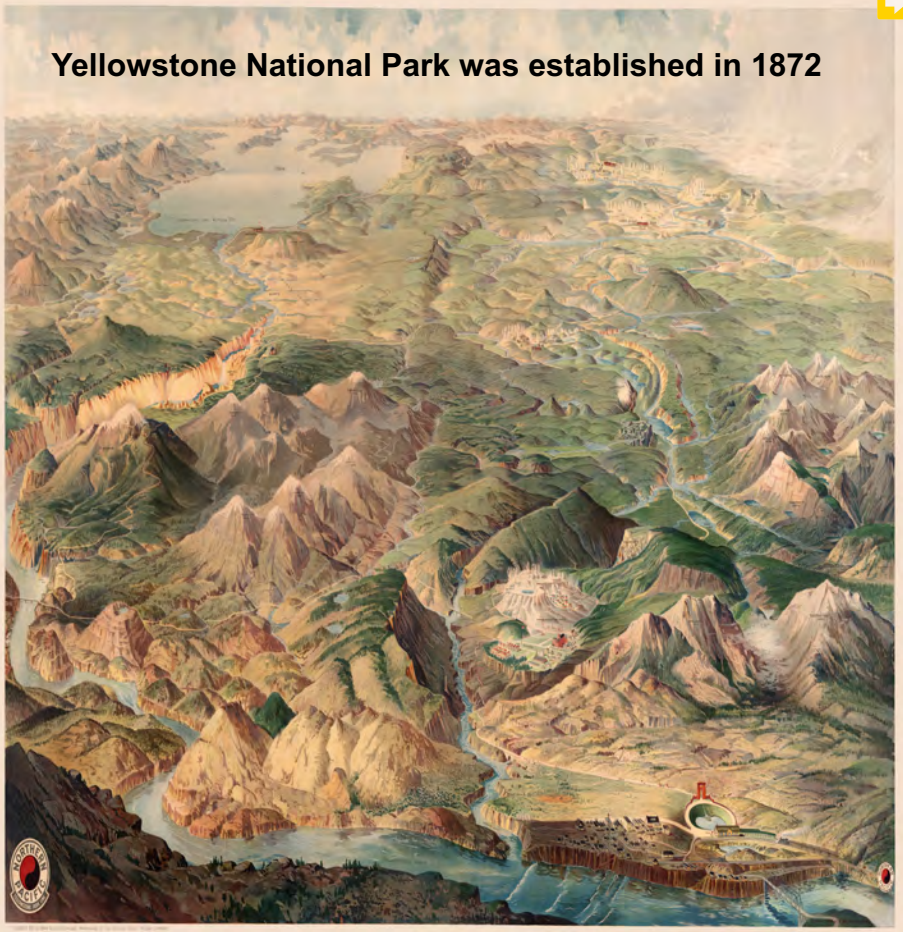
The ideas of “Manifest Destiny” forced indigenous communities out, slaughtered bison and other native species and damaged the environment.

Resource Management and Preservation (Late 1800s – Early 1900)

At the end of the 19th century, individuals began seeing the negative effects that expansion had on the environment and natural resources and the need for preservation became evident.

Lands began to be set aside to create national parks, environmentally focused governmental agencies and groups were formed. Early naturalists and writers helped influence these decisions.

Image by Henry Wellge, Public Domain



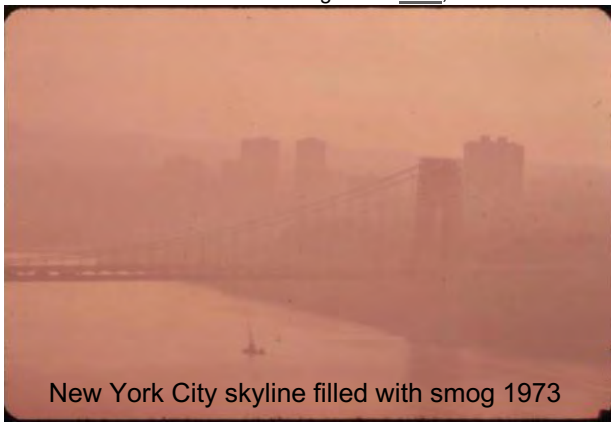
Pollution Concerns (1960s – 1980s)

In the 1960's and 1970's the United States began to see the effects of decades of unchecked pollution and exploitation of our natural resources. There was an increase in the manufacturing, use and discharge of toxic chemicals into our nation's waters and air. In addition, we saw an increase in environmental disasters like oil spills, and river fires. This caused the U.S. public to demand legislation to protect our environment, wildlife, water and air.

In the early 1970s, landmark laws were passed by the U.S. Congress, **Clean Water Act**, **Clean Air Act** and **Endangered Species Act**. The **U.S. Environmental Protection Agency (EPA)** was created in 1970.

Image from USPS, Public Domain.

Image from EPA, Public Domain.



New York City skyline filled with smog 1973

Environmental Movements and NGOs (1970s – 1980s)

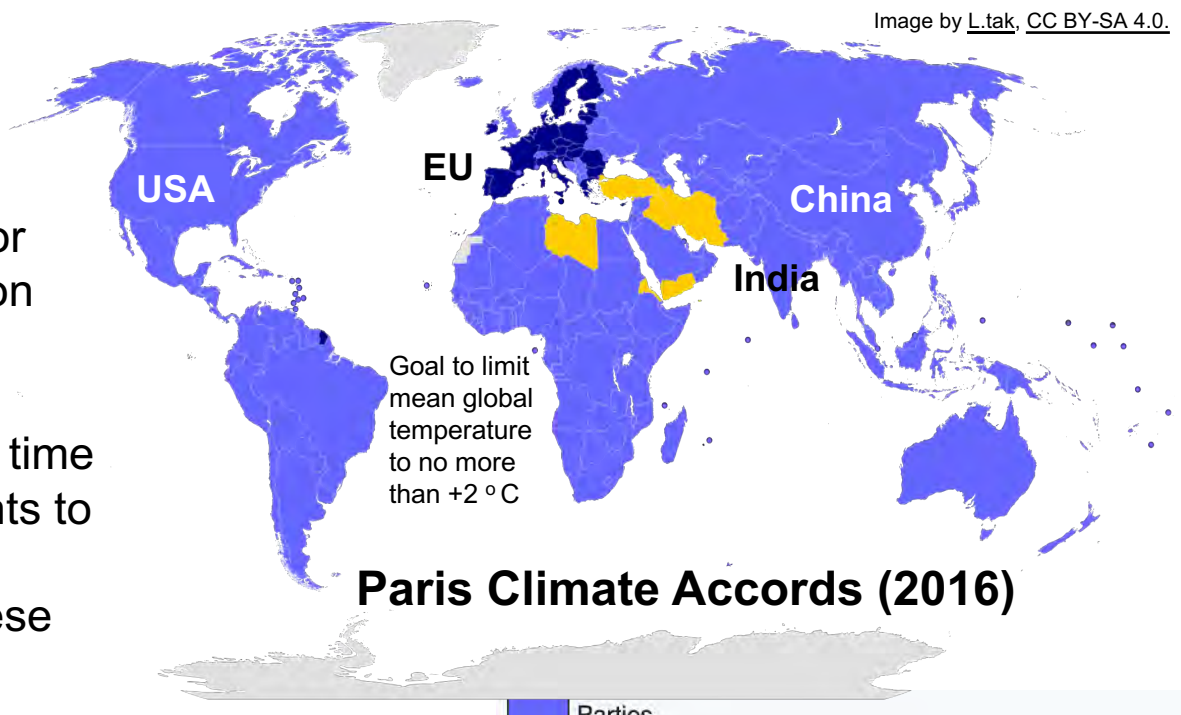
As the public began to recognize the gravity of environmental problems, a modern environmental movement was born. In the 1970's and 1980's, a variety of environmental non-governmental agencies (NGOs) were formed. NGOs operate on local, national, and international scales to represent a wide variety of environmental issues.

Environmental NGOs Examples
• Greenpeace
• Environmental Defense Fund
• Global Footprint Network
• International Union for Conservation of Nature
• World Wildlife Fund
• Wetlands International

International Efforts (1980s - Today)

To ultimately improve our planet for the future, international cooperation and coordination is essential.

Conventions have been held over time to develop international agreements to work towards international environmental improvements. These include agreements such as the **Montreal Protocol (1987)**, **Kyoto Protocol (1997)** and the **Paris Agreement (2016)**.



USA, China, EU, India account for 70% of all greenhouse gas emissions

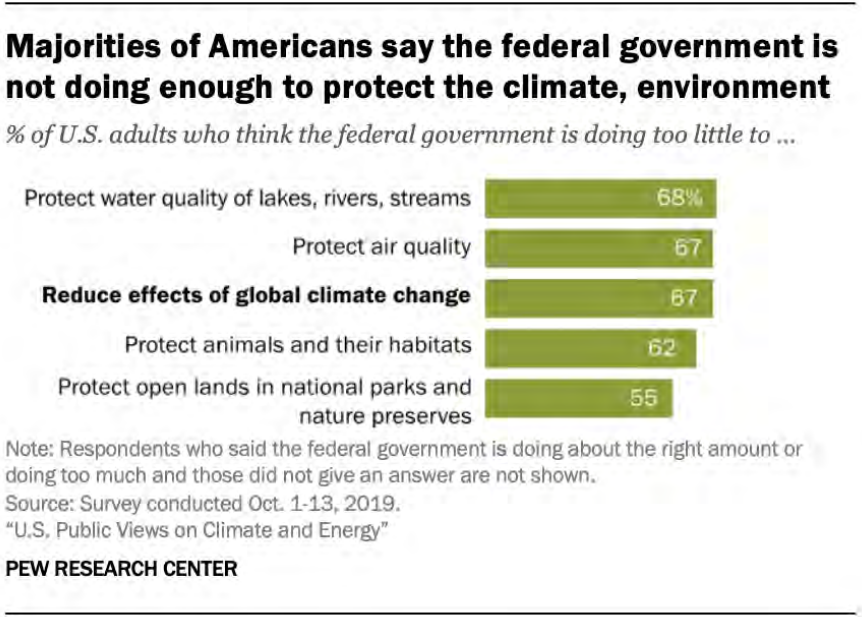
What stage are we at *today*?

Our environmental history is complex and full of milestones that have brought us to where we are today.

Our nation's view of the natural world has greatly changed over time and will likely continue to change.

- Anthropocentric View (1800s)
- Biocentric View
- Ecocentric View (Today)

Pew Research Center



USA today has Ecocentric View of Earth

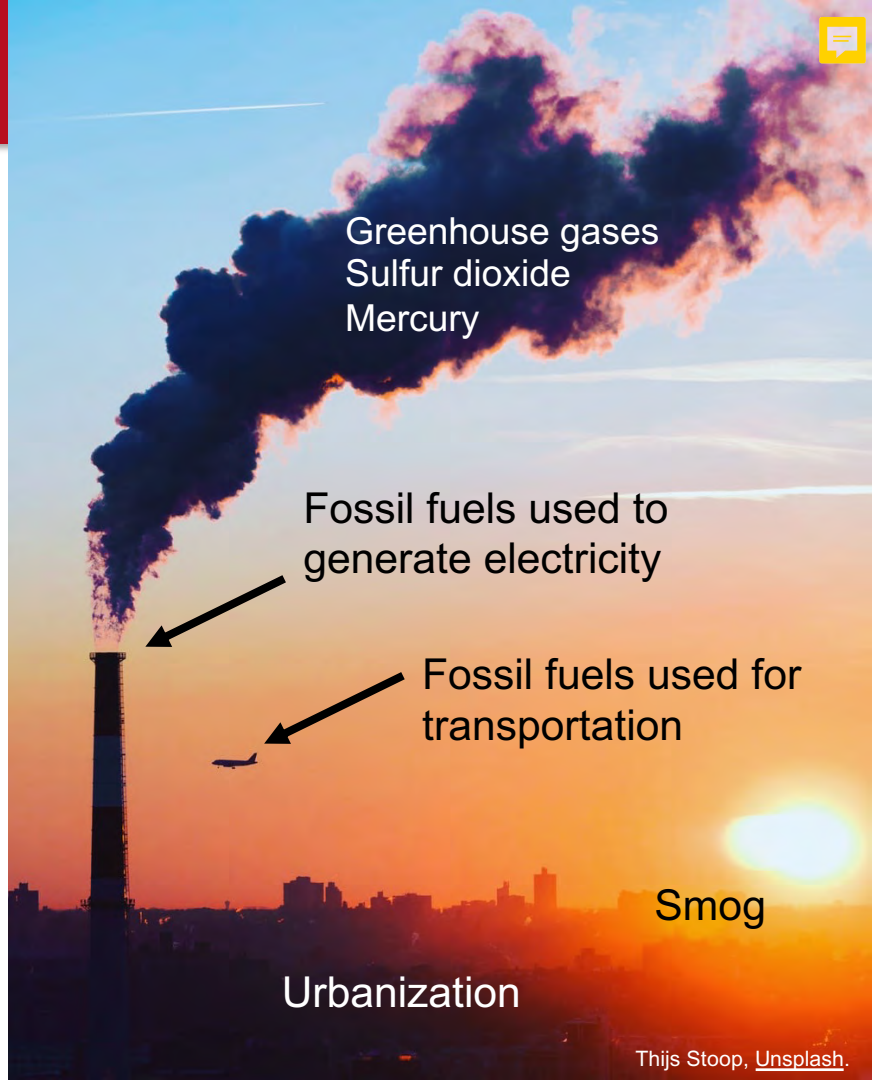
Objective 4: Recognize how our individual actions as a species affect our planet and identify the potential for living sustainably.

How have humans impacted our planet?

Humans influence the biological and physical environment in many ways. Negative impacts include:

- Deforestation
- Pollution
- Overpopulation
- Burning of fossil fuels

We impact the environment every day both in terms of our **individual choices and actions** and our **collective choices and actions**.



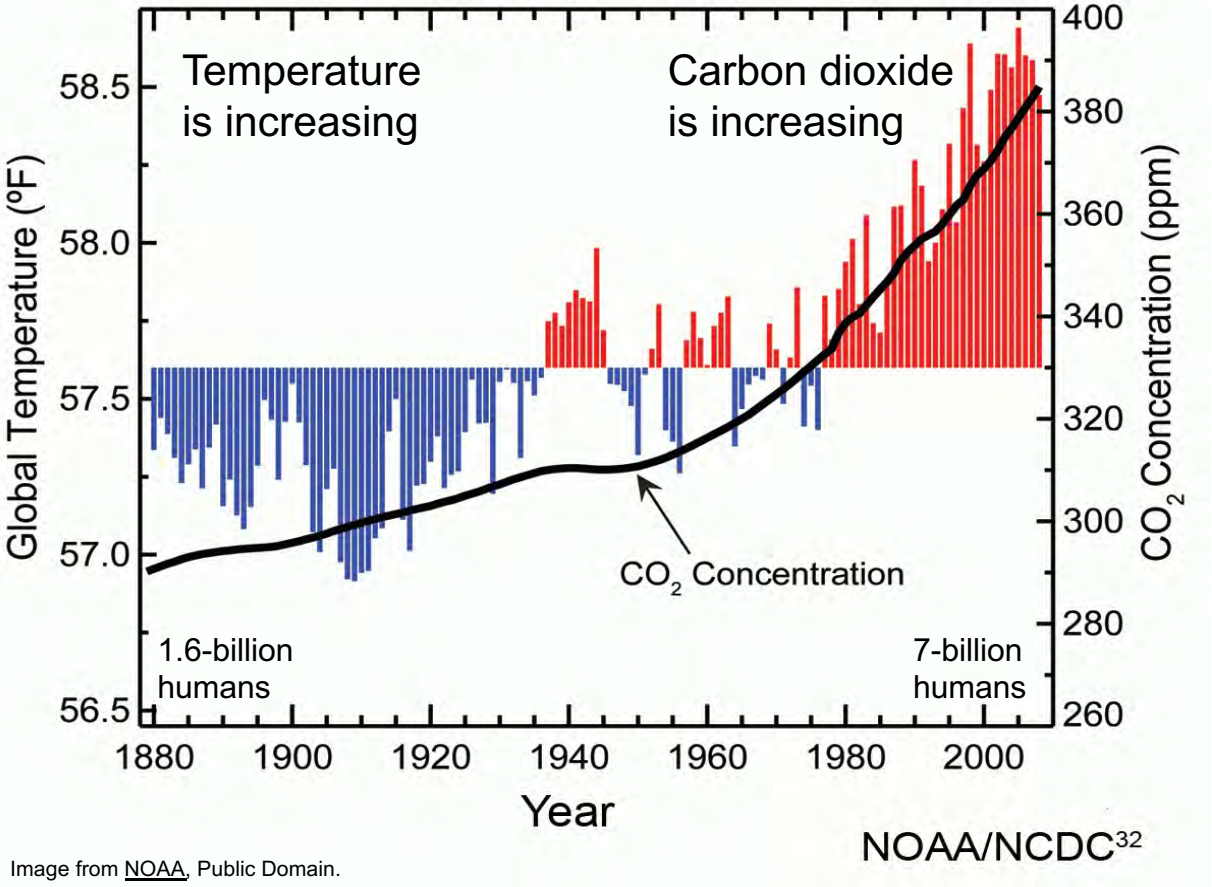


Image from NOAA, Public Domain.

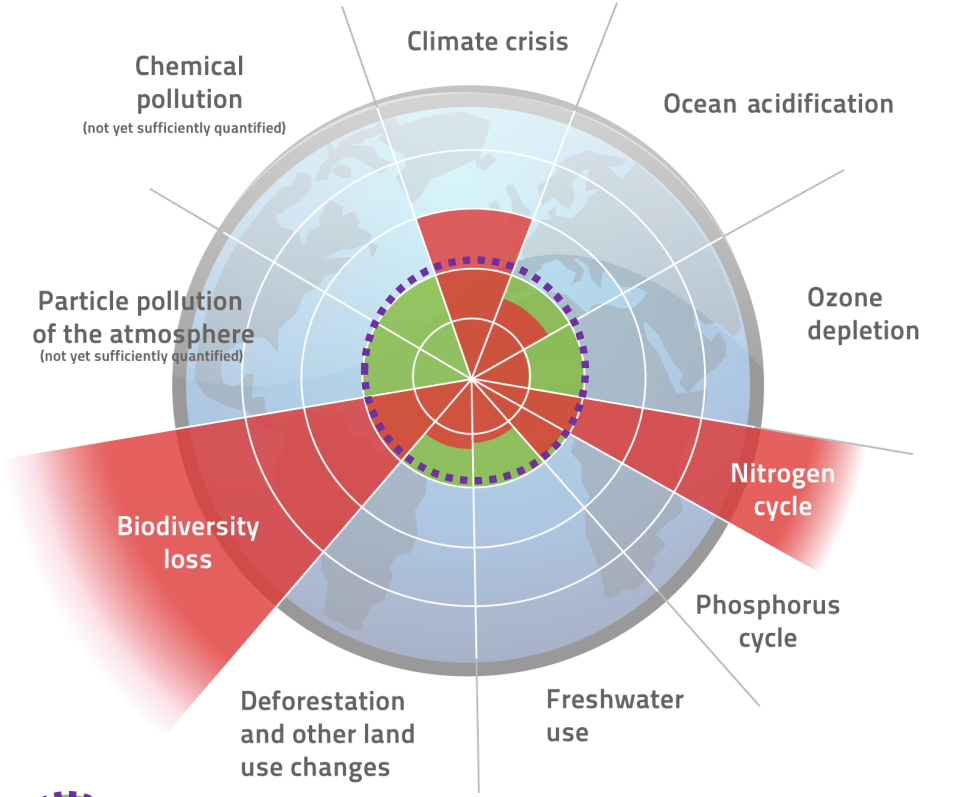
There are many ways that researchers can measure and track the impact that humans have had on the Earth.

Global atmospheric CO_2 levels have increased over the past 150 years. In 2021, the concentration is approximately 410 ppm.

The annual increase of atmospheric CO_2 over the past 60 years is 100 times faster than caused by natural processes.

Planetary Boundaries

after Johan Rockström, Stockholm Resilience Centre et al. 2009



Planetary Boundaries Framework = idea that Earth's processes contain environmental boundaries in which levels of human impact can be measured to keep us within safe operating zones

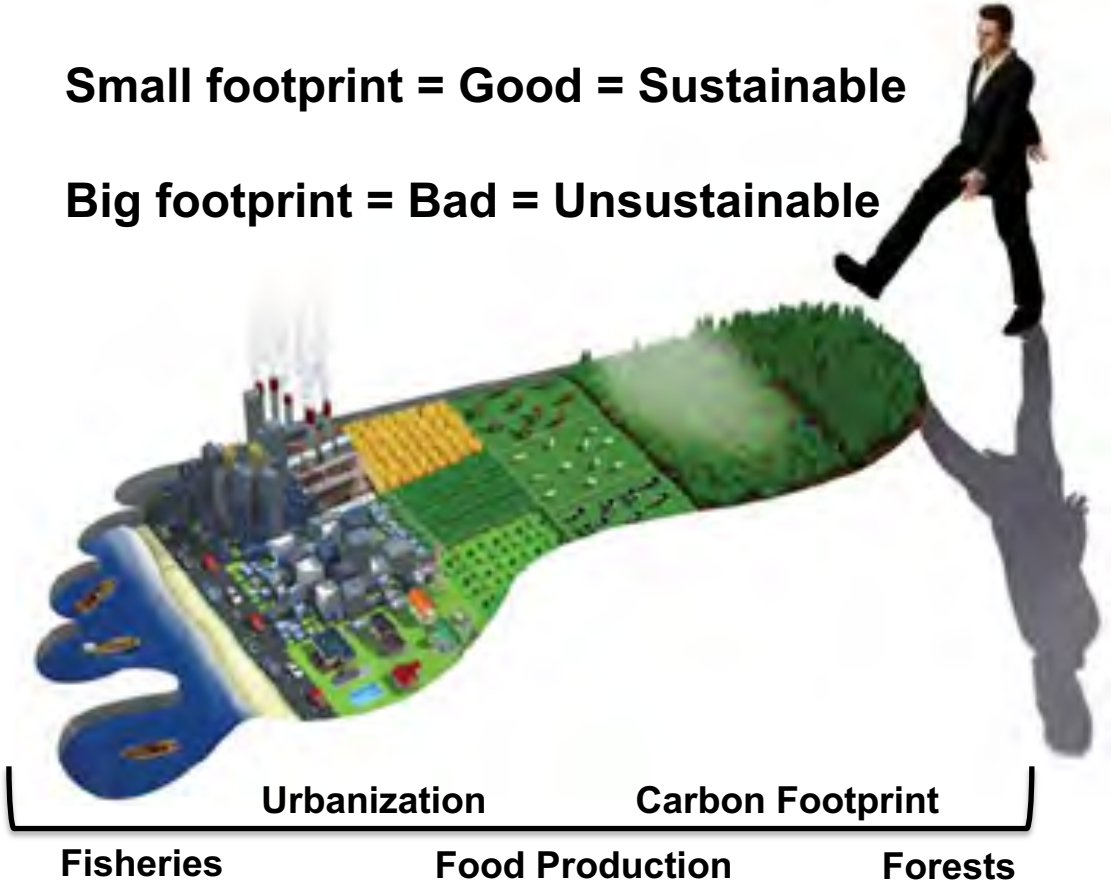
As of 2009, three boundaries, climate crisis, biodiversity loss and nitrogen cycle, have already been crossed and aren't sustainable. Ocean acidification, freshwater use and deforestation are also a concern for us.

Rockström, et al., *Nature*, 2009.

Ecological Footprint = measurement of the land required to produce the resources we need and absorb the waste we produce as an individual or as a community

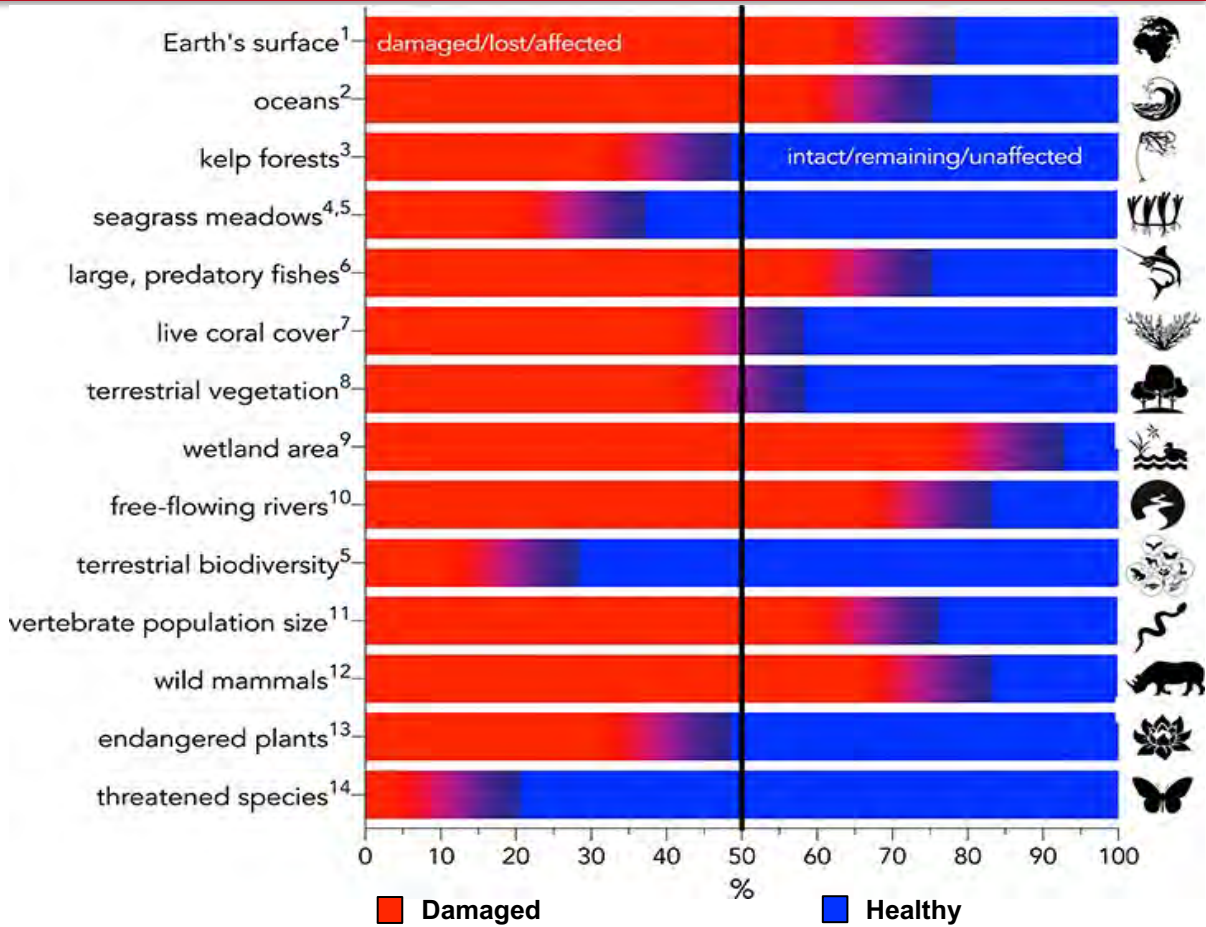
Ecological Footprint measures sustainability, how much and how fast we consume natural resources and generate waste.

https://www.footprintcalculator.org/



While more research is required to understand humanity's impact on Earth, this is what we do know:

- Geographic locations are impacted differently and to varying degrees
- Human populations and the populations of other species are impacted differently and to varying degrees
- Global human demand and consumption is currently greater than Earth's regeneration rate

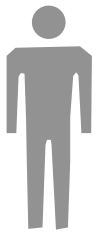


Carrying Capacity = population size that an area can support indefinitely

USA population
330,000,000

Total Area = 9,250,000 km^2

Ecological footprint of 1 person living in USA



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Area required to provide resources and absorb waste

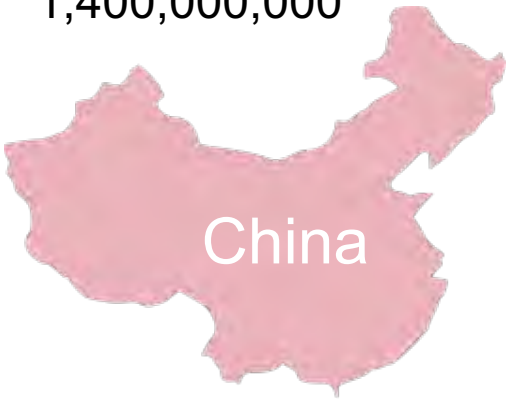
1 person living in USA uses 0.1 km^2 to provide their natural resources and assimilate their waste

= 100,000 m^2 = 0.1 km^2

USA's Ecological Footprint = 330,000,000 people x 0.1 km^2 = 33,000,000 km^2

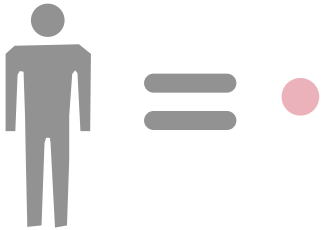
Let's look at China and see how it compares to the USA

China population
1,400,000,000



Total Area = 9,250,000 km^2

Ecological footprint of 1 person living in China



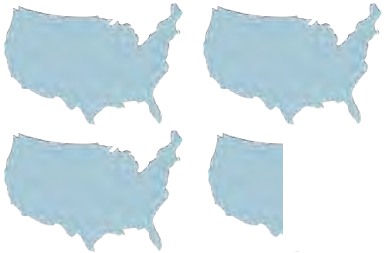
1 person living in China uses 0.01 km^2 to provide their natural resources and assimilate their waste

= 10,000 m^2 = 0.01 km^2

China's Ecological Footprint = 1,400,000,000 people x 0.01 km^2 = 14,000,000 km^2

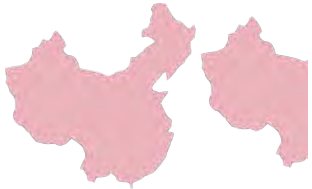
The USA and China both consume more resources than what they have within their borders = unsustainable development

The USA's 330-million people have a total ecological footprint of 33,000,000 km^2, which is about 3.5-times larger than the United States itself



If all 8-billion humans lived like a person living in the USA, we'd need 6 planets

China's 1.4-billion people have a total ecological footprint of 14,000,000 km^2, which is about 1.5-times larger than China itself



If all 8-billion humans lived like a person living in China, we'd need 1.5 planets

Image from NASA, Public Domain.

Image from NASA, Public Domain.

8-billion humans live on Earth today

We only have 1 planet

Have we already passed Earth's carrying capacity?

What will life on Earth look like for future generations?

What does a sustainable system look like?

Renewable Energy

Energy cannot be recycled; ecosystems need constant sources of energy. New inputs are needed in order to sustain life.

Recycling Matter

Matter can be recycled and reused; it is important that we not use it faster than it can be recycled.

Population Control

If populations get too large, they can cause damage to the environment. Keeping a population in check can help preserve resources for all.

Local Biodiversity

Greater biodiversity aids in each of these functions providing more energy, more matter, and better population control.

What does a sustainable system look like?

The best examples of sustainable systems are provided within nature itself.

By studying and understanding natural systems, we can engineer our own sustainable systems, methods and techniques to produce clean energy, use matter sustainably, maintain a healthy human populations, minimize the production of waste, and rely on local resources to preserve biodiversity.

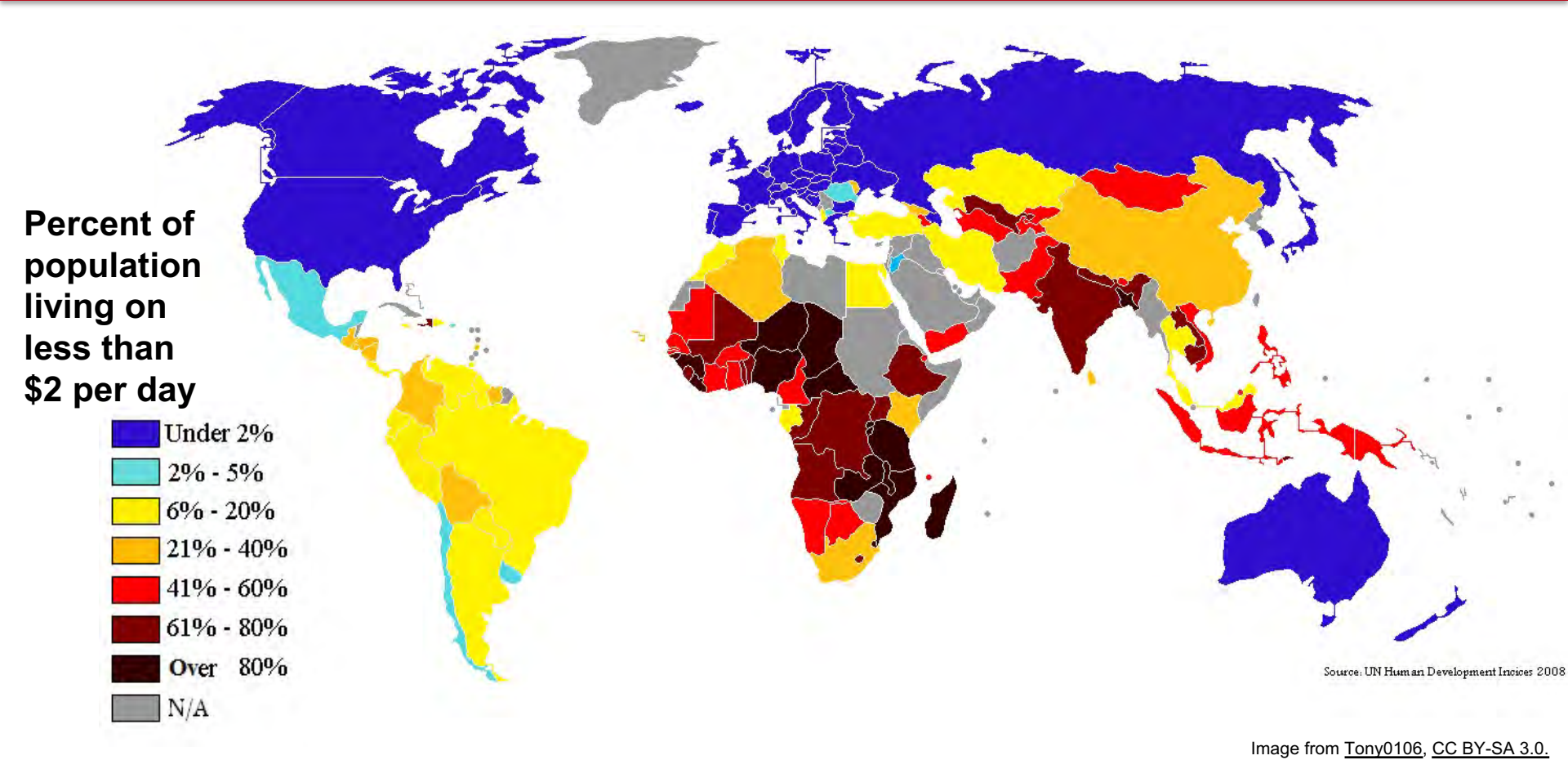
Chewy, Unsplash.

Obstacles to Sustainable Systems

The two major obstacles to sustainable development are:

1. **Unsustainable development**: trade-off between short-term gain and long-term costs

2. **Wealth inequality**: 20% of world's population controls 80% of Earth's resources



Environmental Worldviews

A person's worldview will determine their **environmental ethics,** their decisions, actions, interactions with the environment and views on environmental issues.

Anthropocentric Worldview = human lives and needs are most important

Biocentric Worldview = all life (biotic factors) has an intrinsic value and should be protected

Ecocentric Worldview = the entire ecosystem is most important including all biotic factors (living organisms) and abiotic factors (water, air, minerals, energy)

While our beliefs and views of the environment are important, its our **actions** that are most important to sustainable development.

What will sustainability look like in the future?