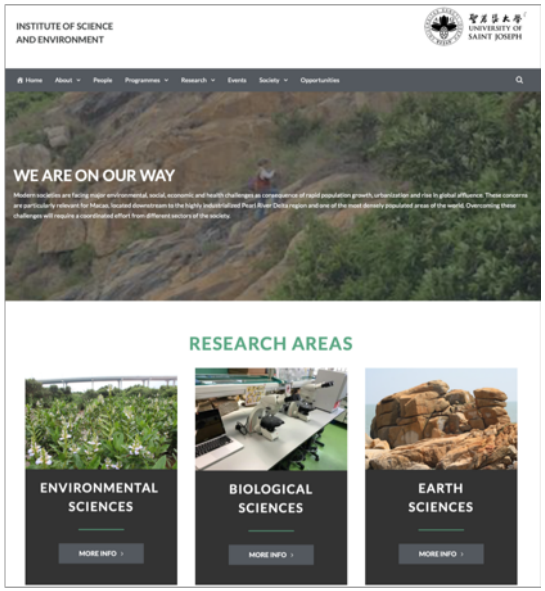
Institute of Science and Environment

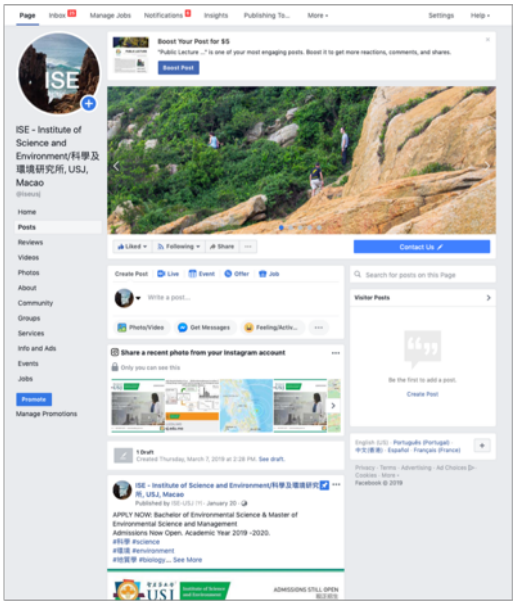
Sustainable Development and Shared Renewable Resources:

Environmental Education and Class Activities

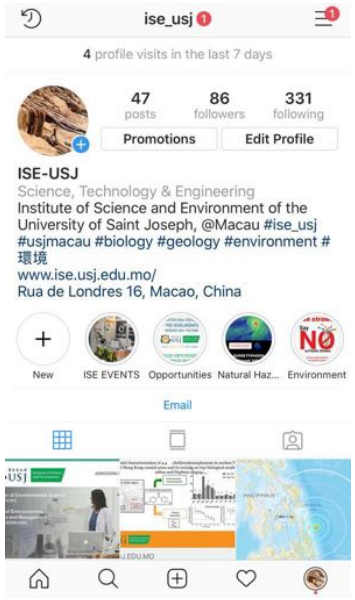
SOCIAL MEDIA



http://ise.usj.edu.mo/sustainability



http://www.facebook.com/iseusj/



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NAPE

COURSE OVERVIEW

1. Environmental sustainability

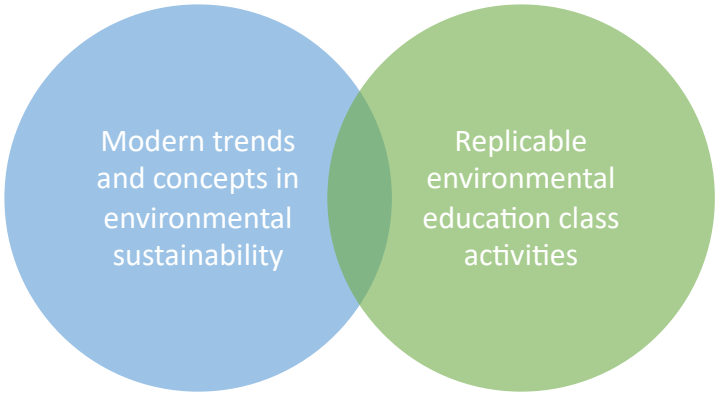
2. Renewable resources

Class activity: the tragedy of the commons

3. Non-renewable resources

Class activity: circular economy and recycling

COURSE GOALS



Activity | Understanding environmental issues

☑ Group
☐ Individual

Discuss within your group and write down your definition of:

Sustainable development:

Renewable resources:

Non-renewable resources:

Class objectives: stimulate critical thinking, ability to synthesize ideas

Sustainable development: development that meets the needs of today's generation without compromising those of future generations (Our Common Future, Brundtland report, 1987).

Renewable resources: resources that are replenished at a higher rate than consumption

Non-renewable resources: resources that are replenished at a lower rate than consumption

ENVIRONMENTAL DIMENSION OF SUSTAINABLE DEVELOPMENT

Activity | Understanding environmental issues

☑ Group
☐ Individual

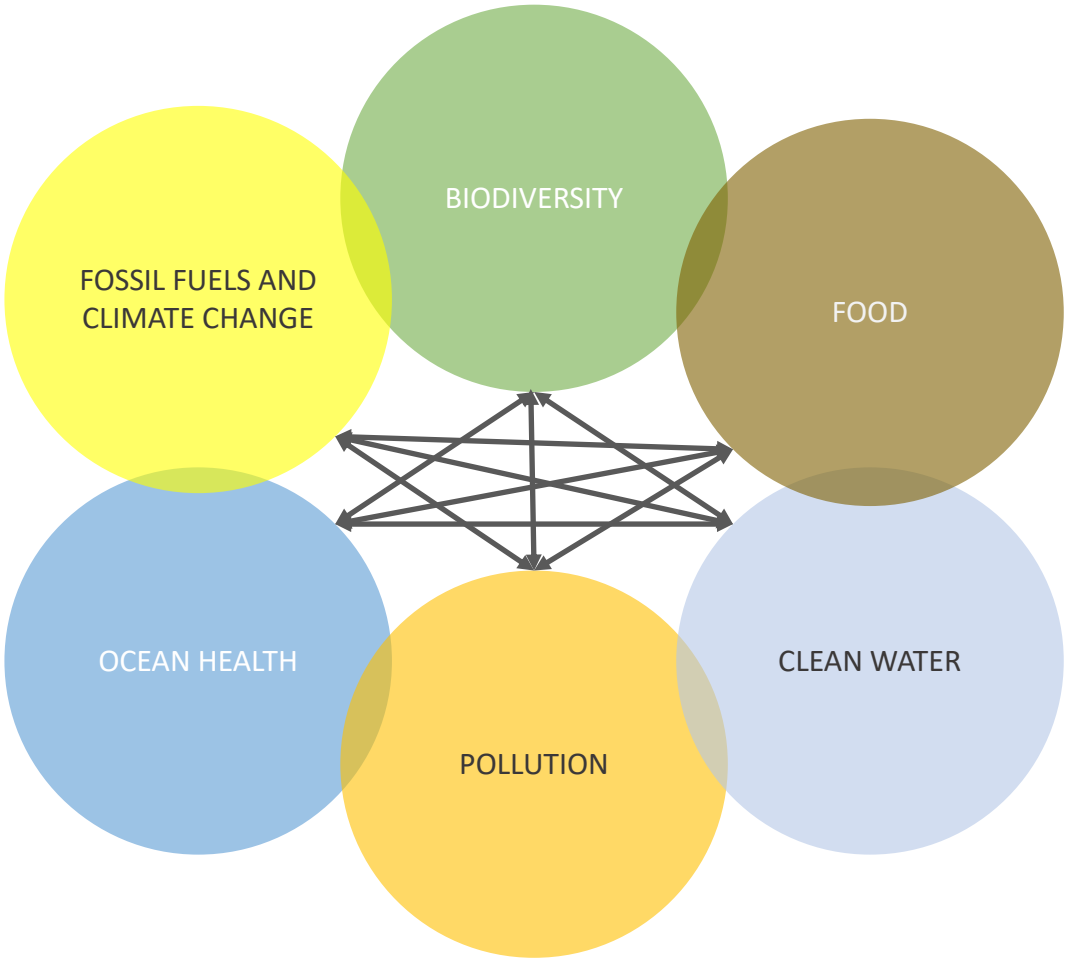
Organize the labels of environmental issues from the most to the least relevant, according to your understanding, for:

- ✧ Macao
- ✧ The world

You may add additional environmental issues using the blank labels. You may place more than one environmental issue at the same level.

Class objectives: stimulate critical thinking and debate, raise environmental awareness

ENVIRONMENTAL ISSUES



Activity | Understanding environmental issues

Discuss within your group, and present to the class, what you think are some of the main drivers of the listed environmental issues.

☑ Group
☐ Individual

Class objectives: stimulate critical thinking, capacity to debate ideas, raise environmental awareness

Activity | Understanding environmental issues

☐ Group
☑ Individual

Use the table with the world population numbers in different periods of human history and millimetric paper to build a graph illustrating the variation in world population from year 0 to present. Population, in millions of habitants, should be represented in the Y-axis, and time, in years, should be represented in the X-axis.

Class objectives: develop analytical skills, raise environmental awareness

Visualizing Human Population Growth (video)

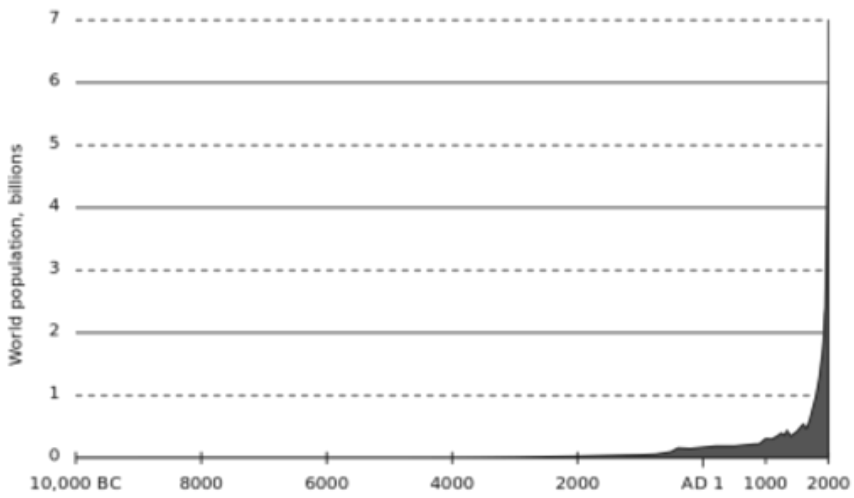
https://www.youtube.com/watch?v=PUwmA3Q0_OE

POPULATION

Before the 19th century the population growth was ~0.2% a year. After 1800's increased to 1.2-1.9%

- **Super-exponential growth** ("Hockey Stick" or J-curve)

Post-1960 was first time EVER that population doubled within a generation



Rule of 70 provides a quick and easy way to approximately determine how long it will take for an amount to double at a given **constant positive** growth rate by dividing the growth rate into 70:

$$\text{Number of years to double} = \frac{70}{\%\ \text{yearly growth rate}}$$

☐ Group
☑ Individual

Using the **rule of 70** and the countries growth rates for 2017 provided by the world bank, determine the number of years that will take for the population to double in the following countries/regions:

China, Hong Kong, Macao, Philippines, Angola, Nigeria, Spain, Germany, USA, Mexico, Brazil, Australia, Russia, Euro Area, North America, South Asia, World

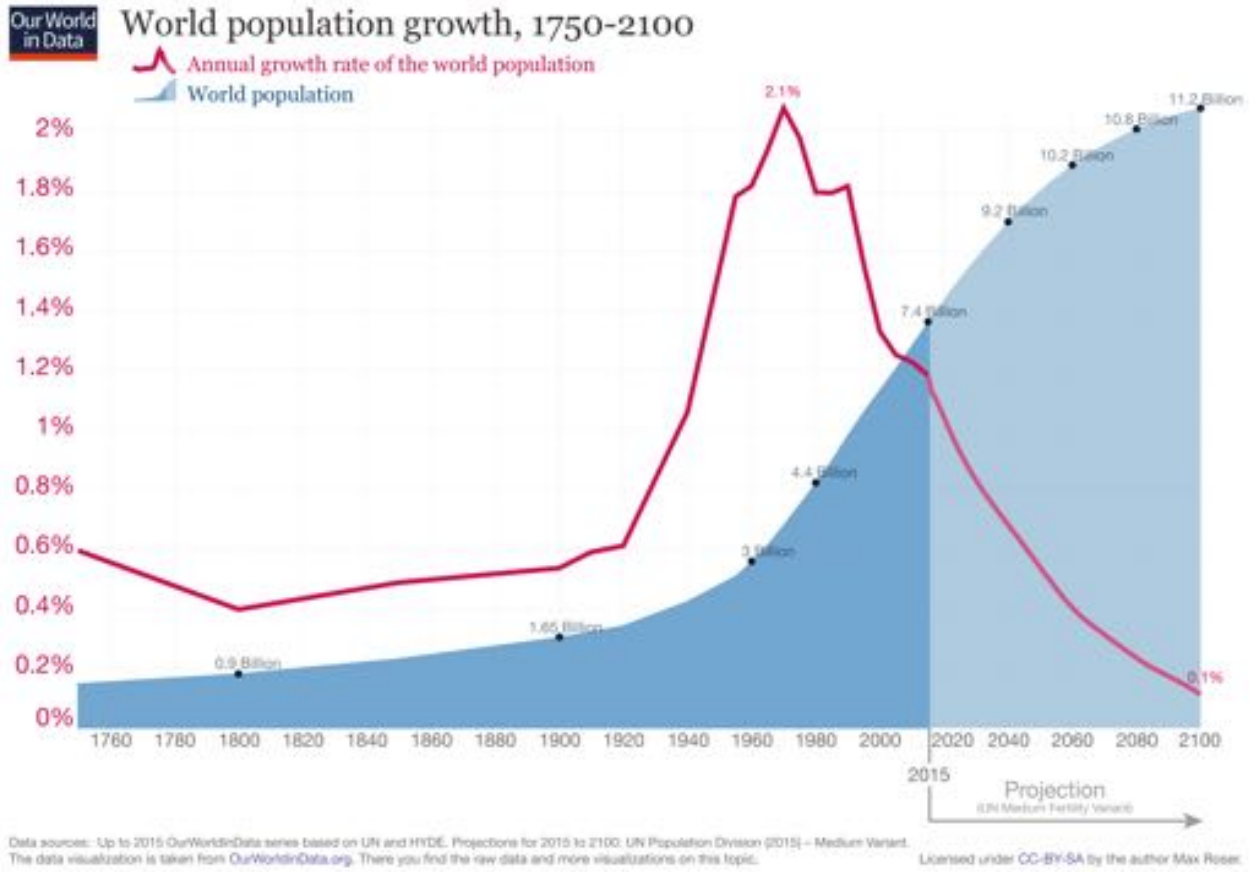
Class objectives: develop numerical skills, raise environmental awareness

TABLE 7.2 World Population Growth Rates and Doubling Times

Period	Approximate Growth Rate (percent)	Doubling Time (years)
Appearance of humans to early historical times	0.002	36,000
1650–1750	0.3	240
1850–1900	0.6	115
1930–1950	1.0	72
1960–1980	2.3	31
Present	1.3	54

Sources: Warren S. Thompson and David T. Lewis, *Population Problems*, 5th ed. (New York: McGraw-Hill, 1965), p. 384; Population Reference Bureau, *2001 World Population Data Sheet* (Washington, D.C.: Population Reference Bureau, 2001).

POPULATION



World population:
7.5b and rising

Population growth rate:
1.07% and falling

POPULATION

What are the primary determinants of population growth?

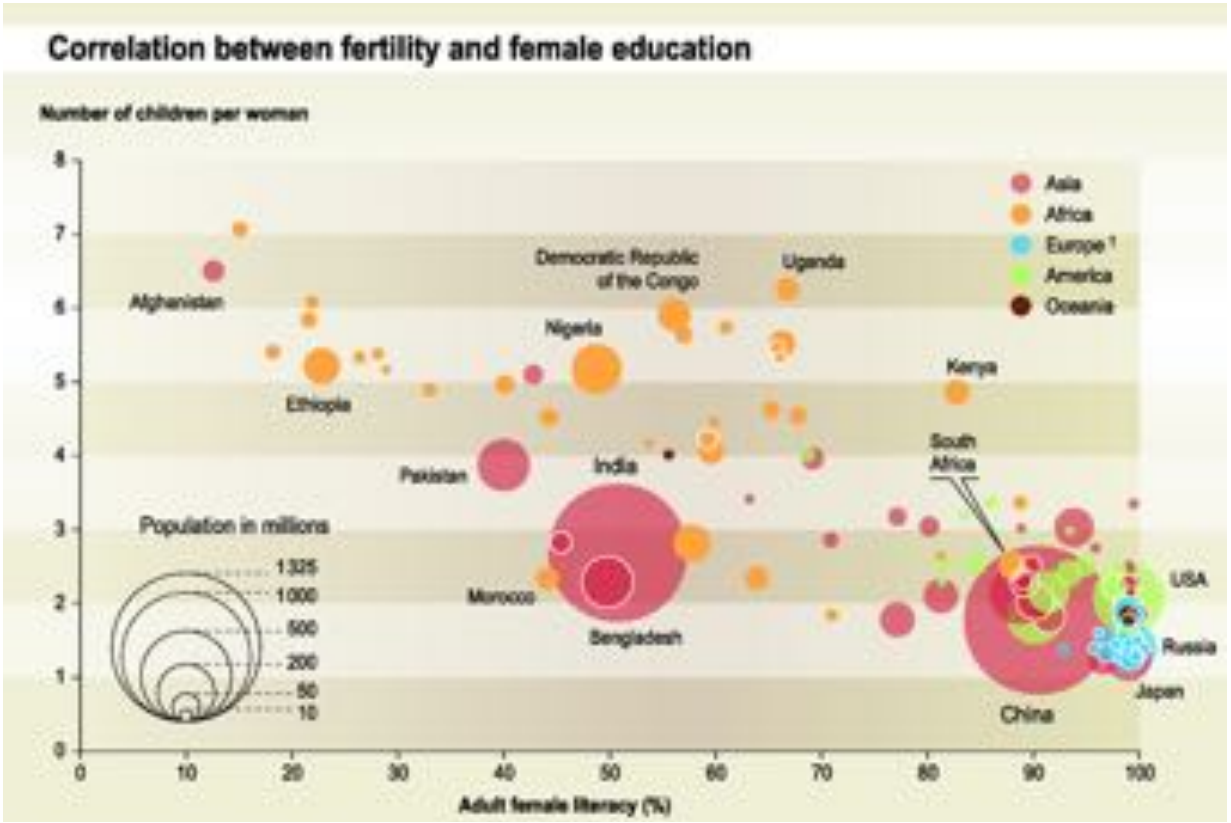
Total fertility rate (TFR) = average number of children born per woman during her lifetime

Replacement fertility = the TFR that keeps population size stable

For humans, replacement fertility is about 2.1.

But see Striessnig and Lutz 2014. How does education change the relationship between fertility and age-dependency under environmental constraints? A long-term simulation exercise. Doi: 10.4054/DemRes.2014.30.16

POPULATION



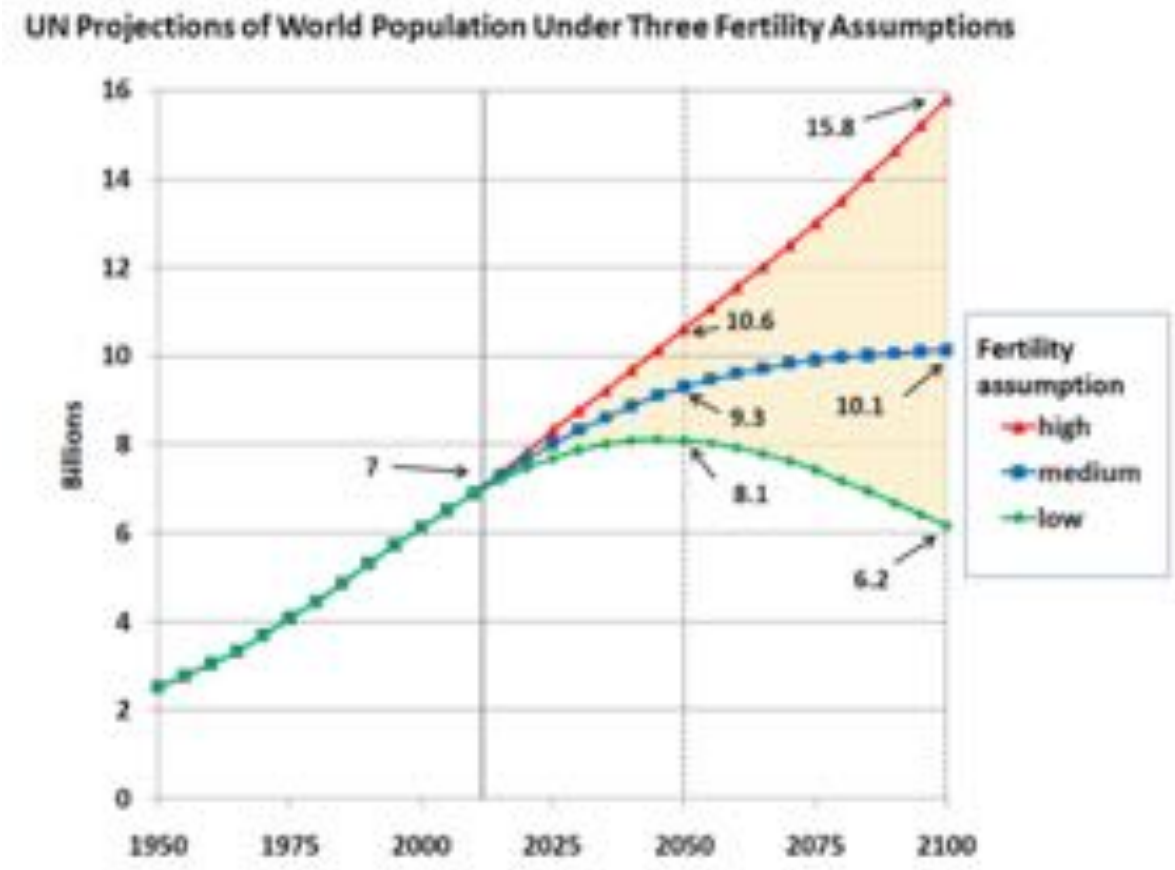
Female literacy and school enrollment are correlated with total fertility rate:

More-educated women have fewer children.

Visualizing population size, growth rates, births and deaths.

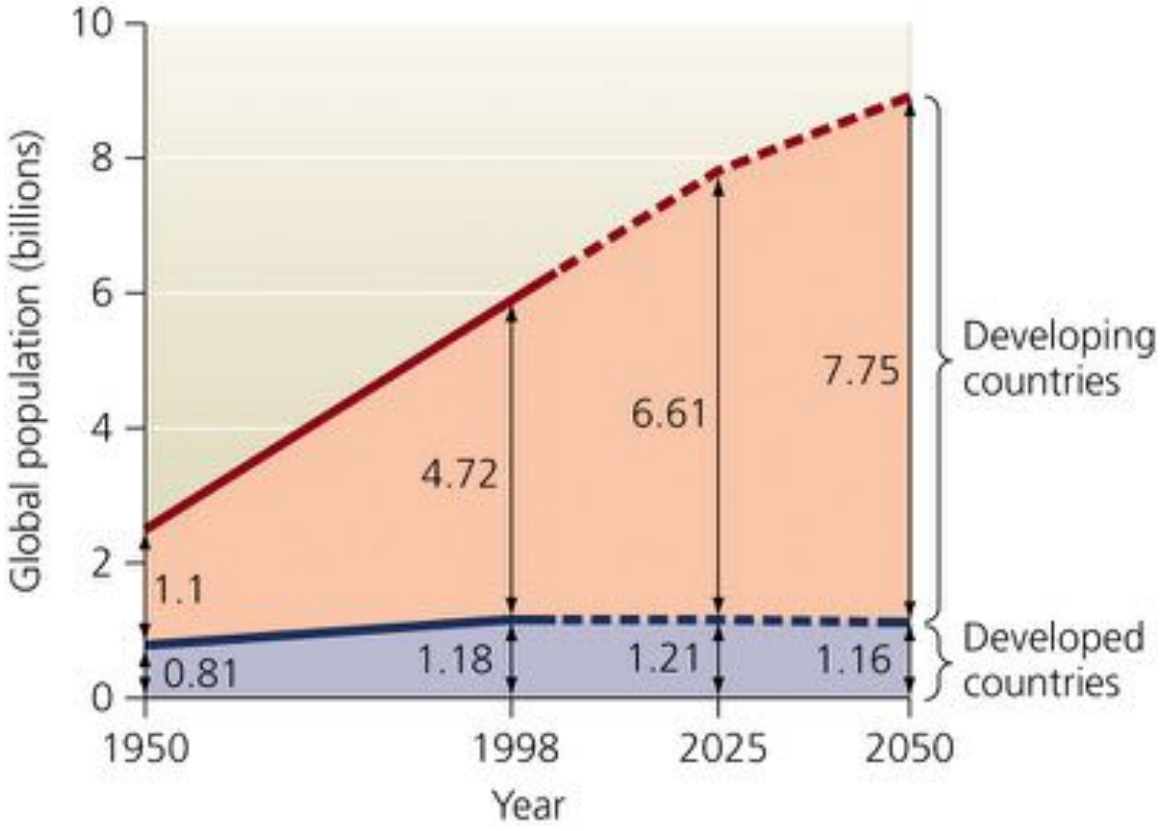
https://ourworldindata.org/future-population-growth

POPULATION



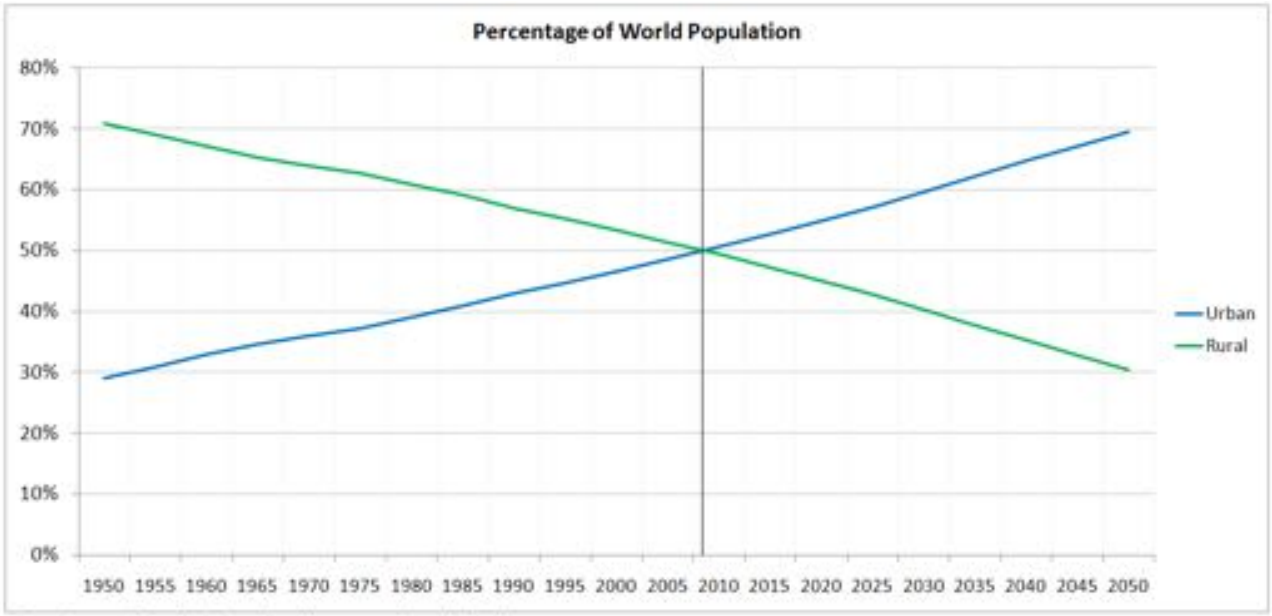
How will the future be? Projections on human population variation by the United Nations

POPULATION



98% of the next billion people born will live in developing nations

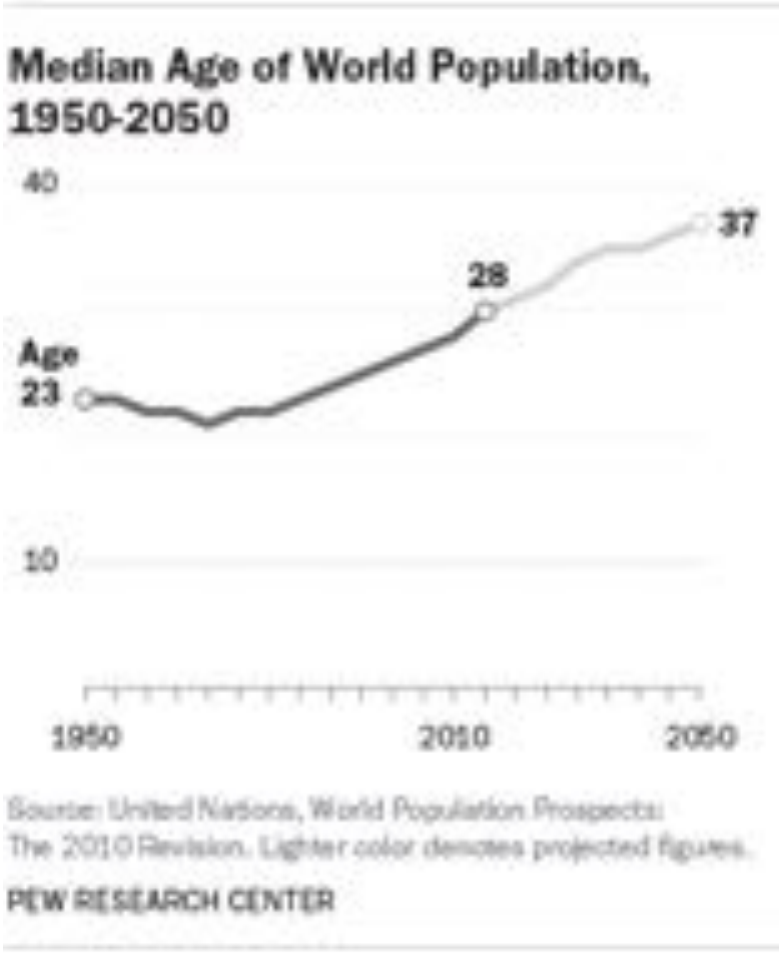
POPULATION



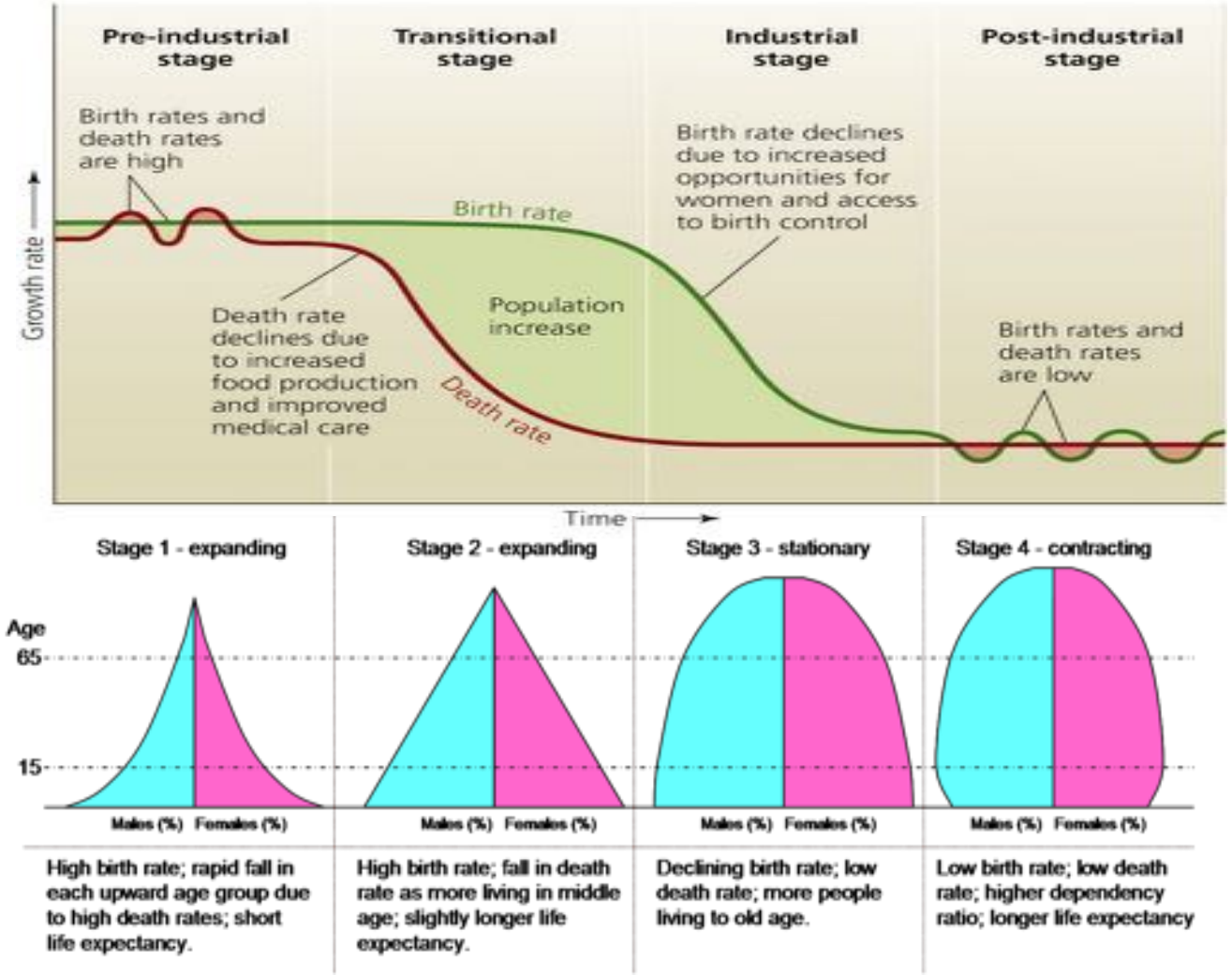
Data Source: United Nations, http://esa.un.org/unup/p2k0data.asp

We are moving to cities

POPULATION



We are getting older



Stages of demographic transition and population pyramids

https://www.populationpyramid.net/

The "IPAT" model

Shows how **P**opulation, **A**ffluence, and **T**echnology interact to create **I**mpact on our environment.

$$I = P \times A \times T$$

Further factors can be added to the original equation of Holdren and Ehrlich to make it more comprehensive.

Do you agree with this? Is it possible to transform this formula into:

I=(P X A) / T

Activity | Understanding environmental issues

Get the following measurements.

☑ Group
☐ Individual

First, let's all stand in a straight line without touching each other. Let's use the measuring tape to estimate the average space between each one of us.

Second, let's all hold hands in a circle and estimate the final diameter of our circle using the measuring tape.

Class objectives: visualizing data, numerical skills, interpersonal skills

Activity | Understanding environmental issues

1. Using the data you collected while we were standing in a straight line, and knowing that the Earth circumference at the equator is 40,075 Km, calculate how many people are needed to go around the Equator. And how many winds around the equator would it take to fit all human population*?

2. Using the data you collected while we were forming a circle, calculate the diameter of a similar circle but now with the whole human population*. Draw that circle around planet earth keeping the right proportions, knowing that the earth's diameter is 12,742 Km.

☑ Group
☐ Individual

* Assume the world population to be 7.53 billion.

Class objectives: visualizing data, develop numerical skills, interpersonal skills

Activity | Understanding environmental issues

Estimate the total land area occupied by the human population in 2100 under a high fertility assumption (˜16b) and assuming each person occupies:

☑ Group
☐ Individual

- $1m^2$
- $10m^2$
- $50m^2$

Cut a square representing the area occupied by the total human population for each of these values and place it on the provided world map. Which is the smallest continent where you could fit your squares?

Class objectives: visualizing data, numerical skills

The diameter of a nuclei of an atom is, on average, 100,000 smaller that its diameter. If we get rid of all that empty space, we could fit all nuclei of all atoms of all humans in...

The diameter of a nuclei of an atom is, on average, 100,000 smaller that its diameter. If we get rid of all that empty space, we could fit all nuclei of all humans in...

...an m&m!

The ecological footprint

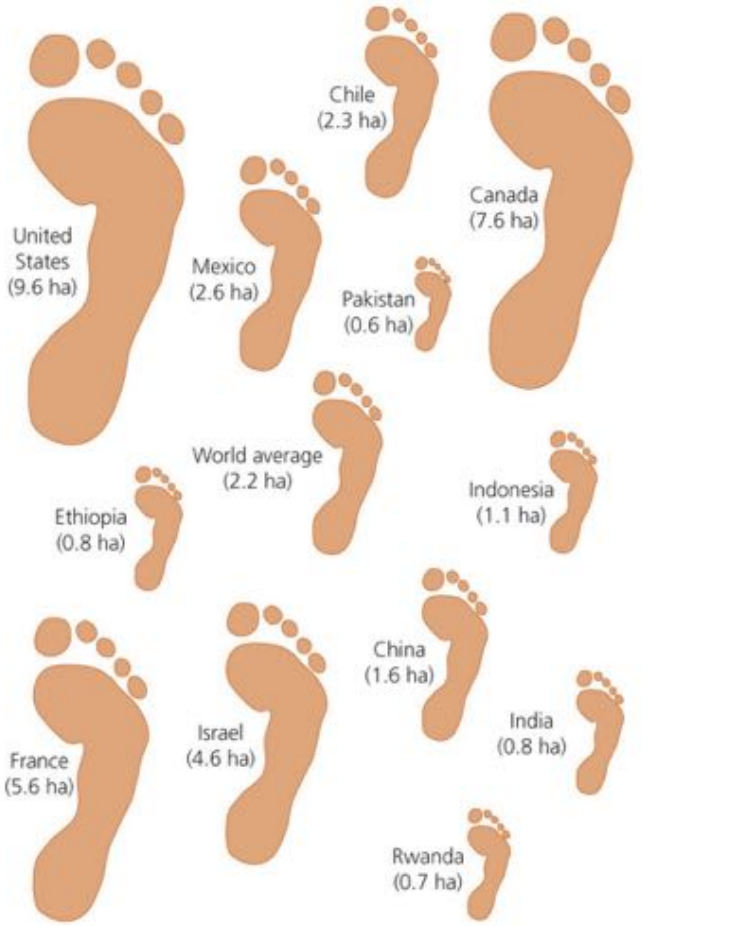
☐ Group
☑ Individual

The cumulative amount of Earth's surface area required to provide the raw materials a person or a population consumes and to dispose of or recycle the waste that is produced.

Calculate your Ecological Footprint at:
http://www.footprintcalculator.org/
See also Borucke et al 2013 paper

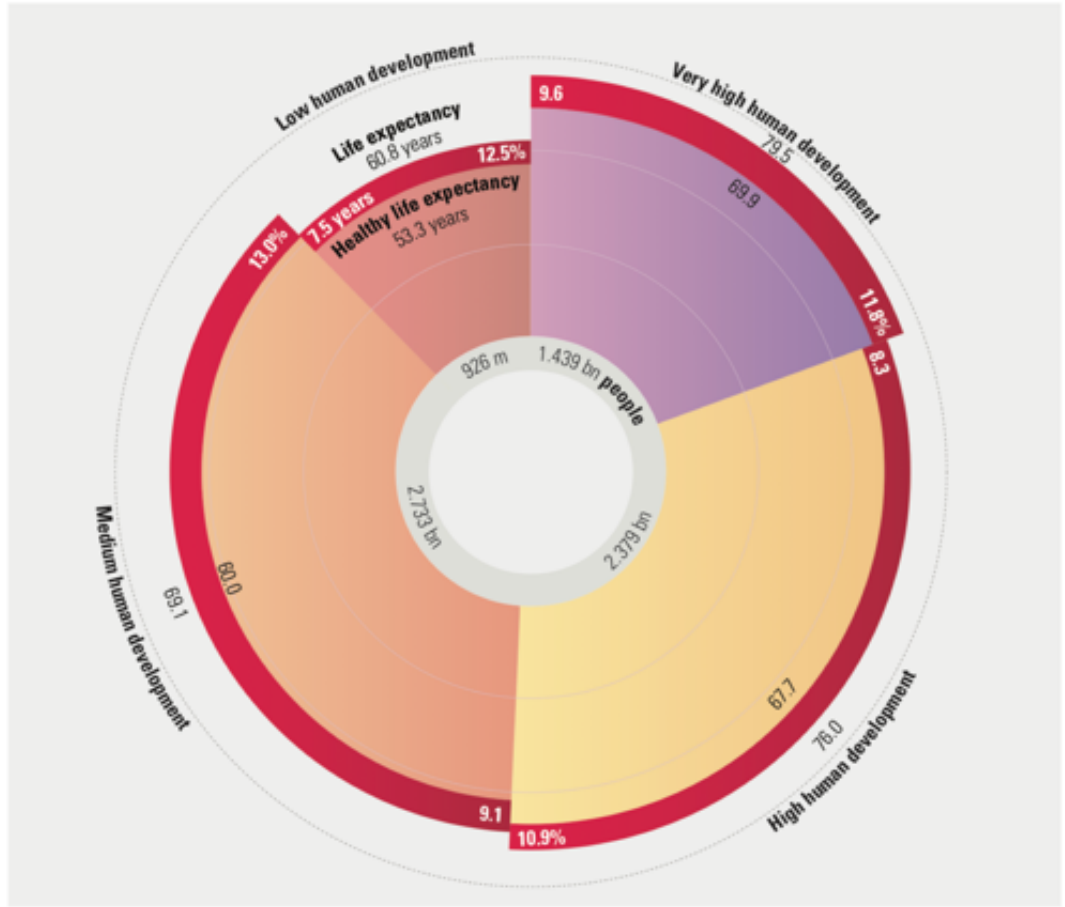
Class objectives: raise environmental awareness

ECOLOGICAL FOOTPRINT



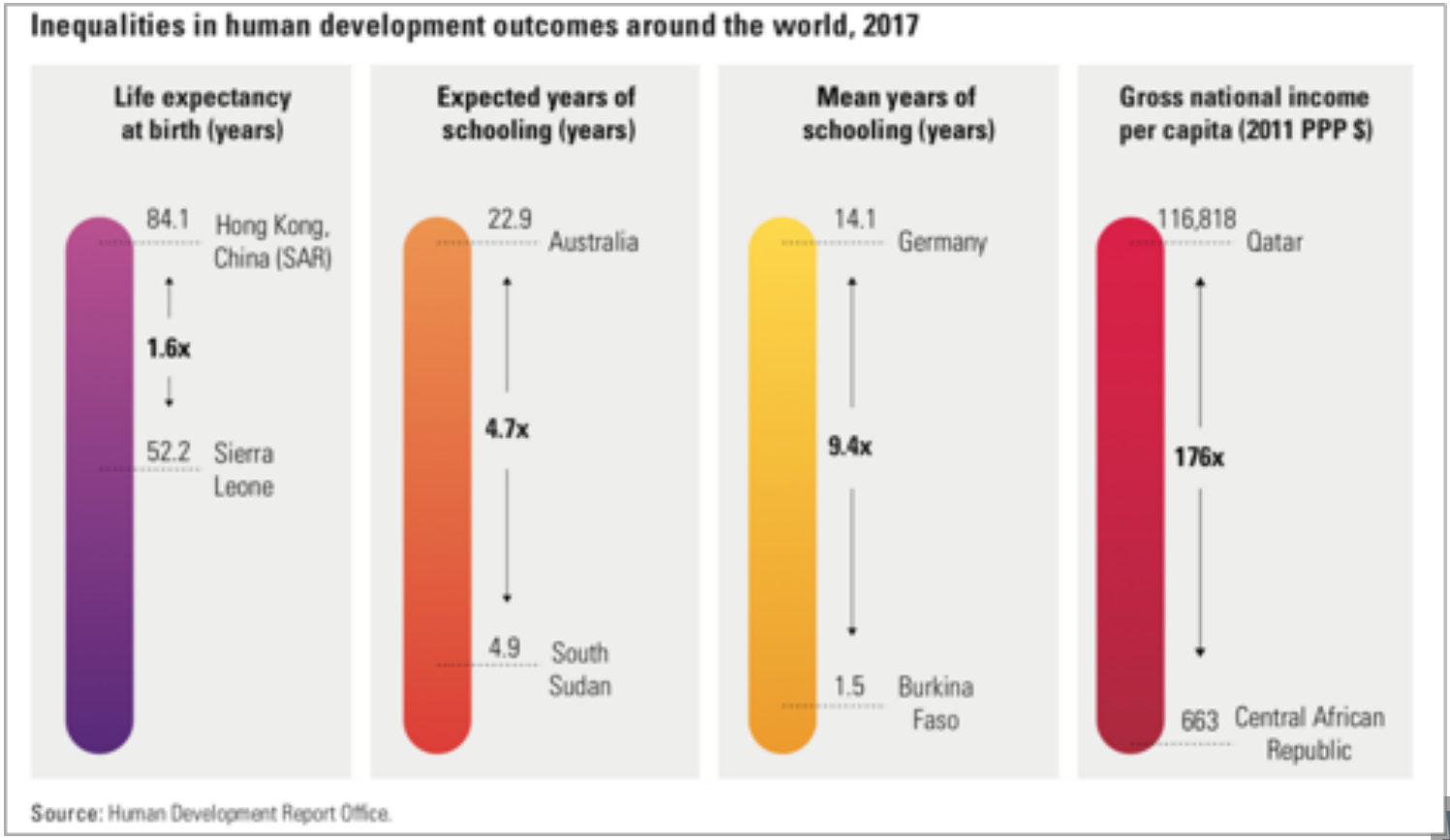
I N E Q U A L I T Y

Healthy life expectancy and overall life expectancy, by human development group, 2017



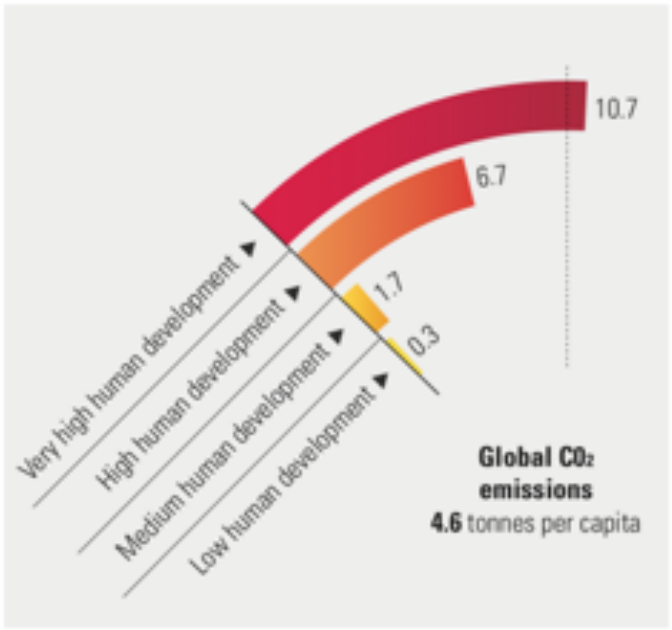
Source: Human Development Report Office.

INEQUALITY


Inequalities in human development outcomes around the world, 2017
Life expectancy at birth (years)
84.1
Hong Kong, China (SAR)
1.6x
52.2
Sierra Leone
Expected years of schooling (years)
22.9
Australia
4.7x
4.9
South Sudan
Mean years of schooling (years)
14.1
Germany
9.4x
1.5
Burkina Faso
Gross national income per capita (2011 PPP $)
116,818
Qatar
176x
663
Central African Republic
Source: Human Development Report Office.

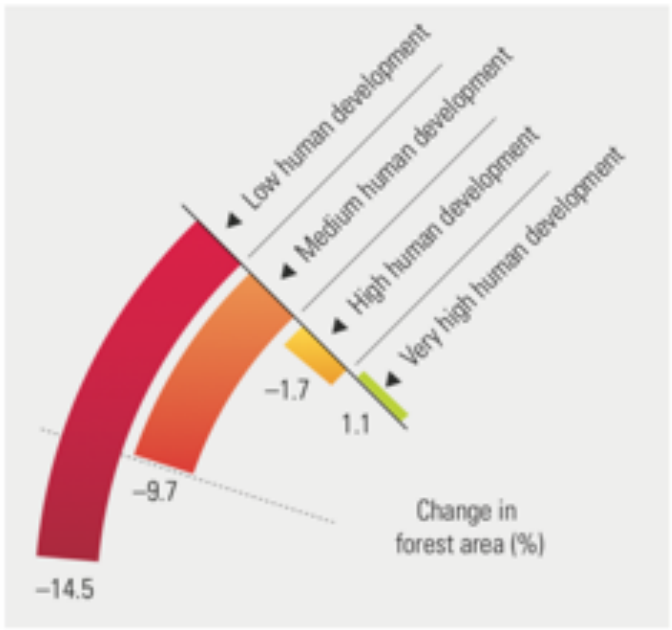
INEQUALITY

Carbon dioxide emissions per capita, by human development group, 2014 (tonnes)



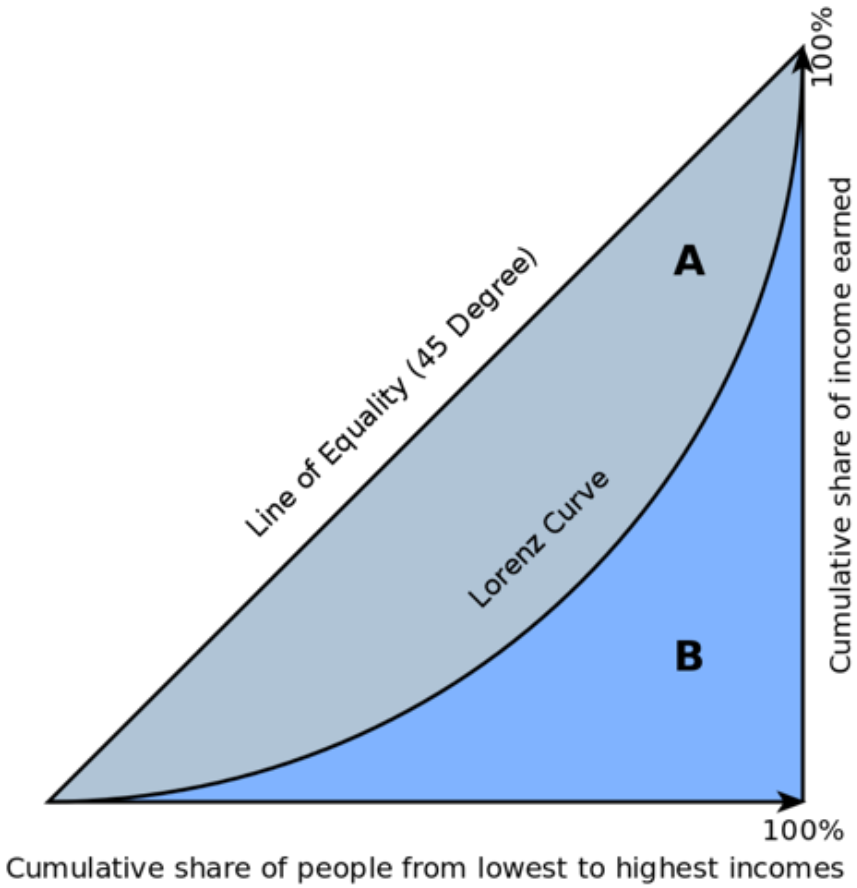
Source: Human Development Report Office.

Change in forest area, by human development group, 1990–2015



Source: Human Development Report Office.

I N E Q U A L I T Y



The Gini coefficient

http://www.gapminder.org/world

Let's check the relationship between GDP per capita and the Gini Coefficient using GapMinder. Use the illustrated guide provided.

☑ Group
☐ Individual

Can be used to build a quiz for the class with environment-related questions.

e.g. Which country has the highest per capita CO2 emissions: China, USA or Norway?
e.g. Is there a correlation between GDP per capita and CO2 emissions?
e.g. How did CO2 emissions changed with world population growth?

Class objectives: visualizing data, get to know gapminder, understand interconnectivity on environmental issues