

Climate Change and Carbon Footprints

Class 2
07/16/2023

Plan for Today's Class

1. Discuss the **capstone project**
2. Evaluate different solutions and global scenarios for **combating climate change**
3. Solve a “Fermi Problem” to estimate carbon **footprint of shipping**

Part 1: Capstone project!

Most Sustainable Bubble Tea Cups

Our “client” is a small Boba Shop in Cambridge, MA. The owner would like to make her shop **as sustainable as possible** while still being able to **stay in business**.

Your task is to propose the most sustainable solution for the **bubble tea cups**





Should she use the usual plastic cup and plastic straw combination?
Change to paper straws and/or paper cups?
Serve in glass cups and get a dishwasher?
Start a loyalty program and sell multi-use plastic cups?



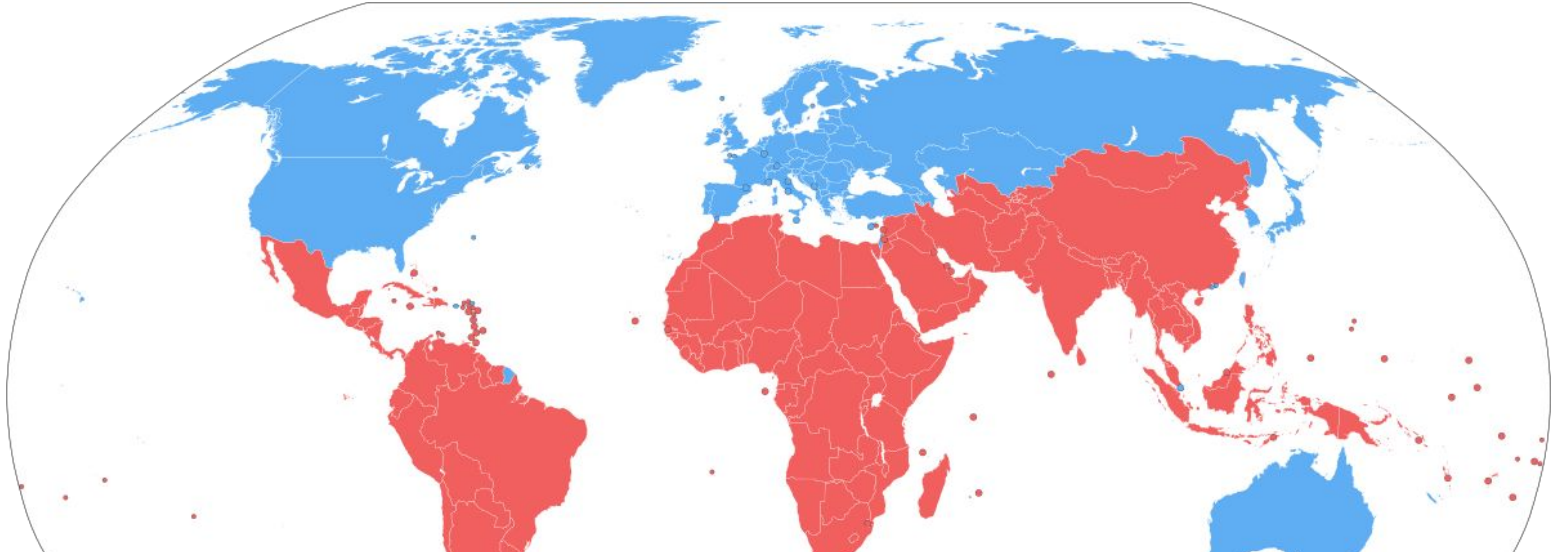
Your Tasks Are:

1. Come up with the design for the **cup and straw** that you think is the most sustainable. **1-slide presentation during Class 3**
2. Evaluate your solution based on these **four metrics**:
 1. Carbon Footprint
 2. Material Footprint
 3. Energy Efficiency
 4. Profitability
3. Present your final design and show how it scores on the metrics in the last class! **3-slide presentation during Class 6**

Part 2: Climate Change Solutions

There is a very significant difference in the
quality of life and access to resources across the
world.

Inequality: Global North and Global South



Global North is responsible for 92% of GHG emissions that are currently in the atmosphere

So what's the deal with the 1.5 degrees?





<https://ocean.si.edu/conservation/climate-change/maldives-cabinet-meeting-underwater>

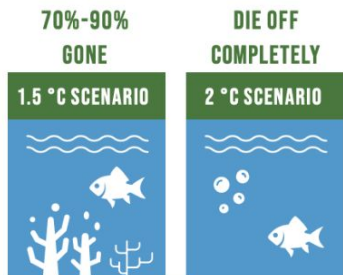


CLIMATE CHANGE

IS HUMANITY'S **"CODE RED" WARNING**

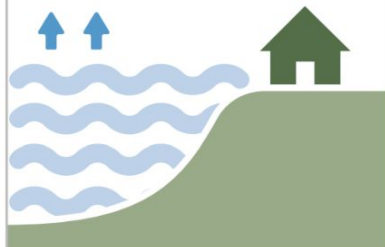
OUR WINDOW TO AVOID CLIMATE CATASTROPHE IS CLOSING RAPIDLY

DIFFERENT TEMPERATURE SCENARIOS FOR CORAL REEFS



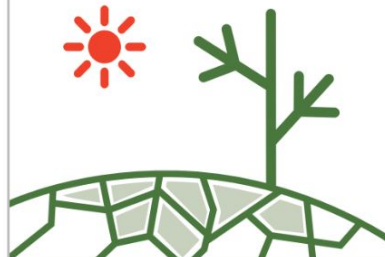
CORAL REEFS

SEA LEVEL WILL RISE
30-60 CM BY 2100



SEA LEVEL RISE

DROUGHT ESTIMATED TO
DISPLACE 700 MILLION
PEOPLE BY 2030



DROUGHTS

MEDIUM- TO LARGE-SCALE
DISASTERS WILL INCREASE
40% FROM 2015 TO 2030



DISASTERS

Climate Solutions Simulator

How do we actually get to 1.5 C threshold?

[https://en-roads.climateinteractive.org/scenario.html?
v=23.6.1](https://en-roads.climateinteractive.org/scenario.html?v=23.6.1)

Evaluating Impacts

> what are some of the **impacts** that you think are the most worrying?

> **is it possible** to keep the temperature below 1.5°C? How hard do you think it will be?

Realistic Solutions

Carbon tax is one of the most impactful interventions

> can you explain why we can't just ramp it up to the max value? What are some unintended consequences?

Part 3: Carbon Footprint of Supply Chains

Poll time!

What do you think uses **more fossil fuels**?

1. Shipping 1 kg of bananas **from Ecuador to Boston** on a cargo ship and then trucking them to a Cambridge supermarket

2. Delivering 1 kg of bananas from a (magical) greenhouse in Pittsfield in **Western Massachusetts to Boston** farmers market

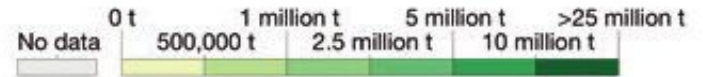
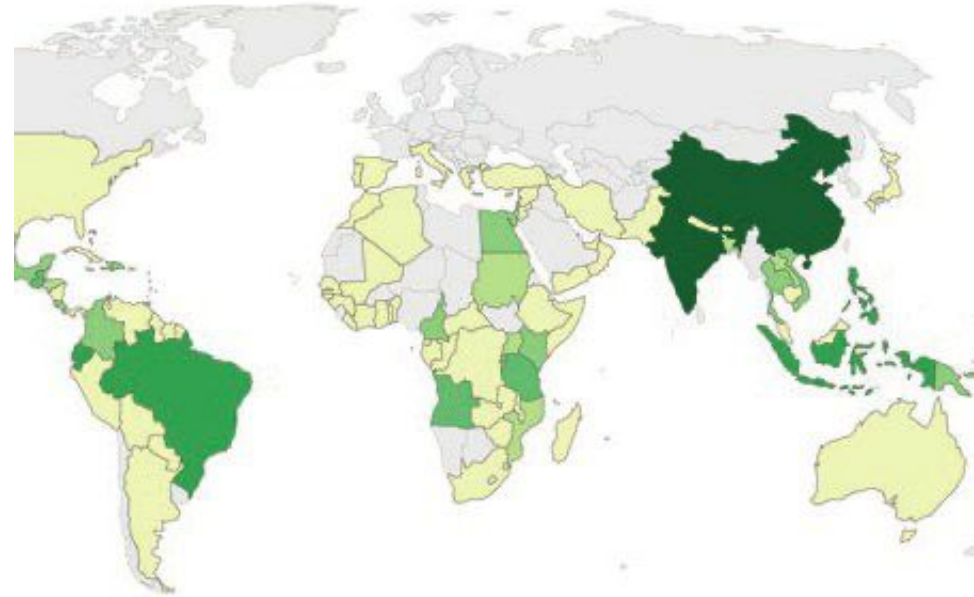
> why don't we just grow bananas in
Massachusetts (or sew clothes, mine iron, or
assemble smartphones)?

Compare

Are they pretty close or drastically different?

Production, 2014

Production, measured in tonnes per year.



FAO Agriculture Organization (FAO)

Fermi Problems: something is better than nothing

Real world is very complicated, so we often need to develop **simplified models** to make any estimations

They **won't be 100% accurate** but that's better than no number at all

In Fermi Problems, the goal is to get a rough **order-of-magnitude estimate**

How far is it?

Use Google Maps to find the distance in MA and <https://sea-distances.org/advanced> to map the route between Boston and Guayaquil, Ecuador

Please use km!

Magic of Cargo Containers

(almost)
standardized
across the
world!

TEU –
twenty-foot
equivalent
unit



Shipping Bananas

1 box = 18 kg

w:l:h = 16":20":10"

1 pallet: 48":40"

1 container: 8':20':8'

How many pallets in one
container?

How many kg of bananas per
pallet?

How many tons of bananas per
container?



We need Reefers - ships that carry refrigerated containers

Capacity of average reefer is about
450 TEU containers

102 g of CO₂ emissions per 1 TEU-km

How many grams of CO₂ would be emitted
for one reefer trip from Guayaquil to
Boston?

How much is it per 1 kg of bananas?



What if we sourced local bananas?

Estimate the carbon per kg of bananas emitted for trucking bananas from Western Mass?

Assume a large truck that is equivalent in size to a TEU and that it emits 0.6 kg CO₂ per 1 TEU-mile



Are we accurate?

> What were the **main simplifications** that might've affected the final result?

> Which **extra factors** could significantly affect the result?

Eat Local?

> what do you think could be improved in this supply chains?

**Next Time: Single-Use Plastics and Waste
Management!**