

Intentional arrival

- Aim to be on time (we know campus is large!)
- Sit down and say Hi – make friends and influence people
- Make a quick “to do” list from your previous class/day
- Log on to your iClicker app
- Send that last important text then turn your notifications off – be ready to be intentional in your learning
- Download pdf of notes before class, and annotate/make your own notes
- Ask questions!

EOSC 114 Fragile Systems 3



Order-of-Magnitude Scales

Richter Scale (Earthquakes)

Moment Magnitude Scale (Earthquakes)

Volcanic Explosivity Index

Beaufort Scale (Wind and Waves)

Saffir-Simpson Scale (Hurricanes)

Enhanced Fujita Scale (Tornadoes)

Torro Scale (Tornadoes)

Torino Scale (Impacts)

Intensity vs. Frequency

More intense disasters occur less frequently

Energy and Frequency

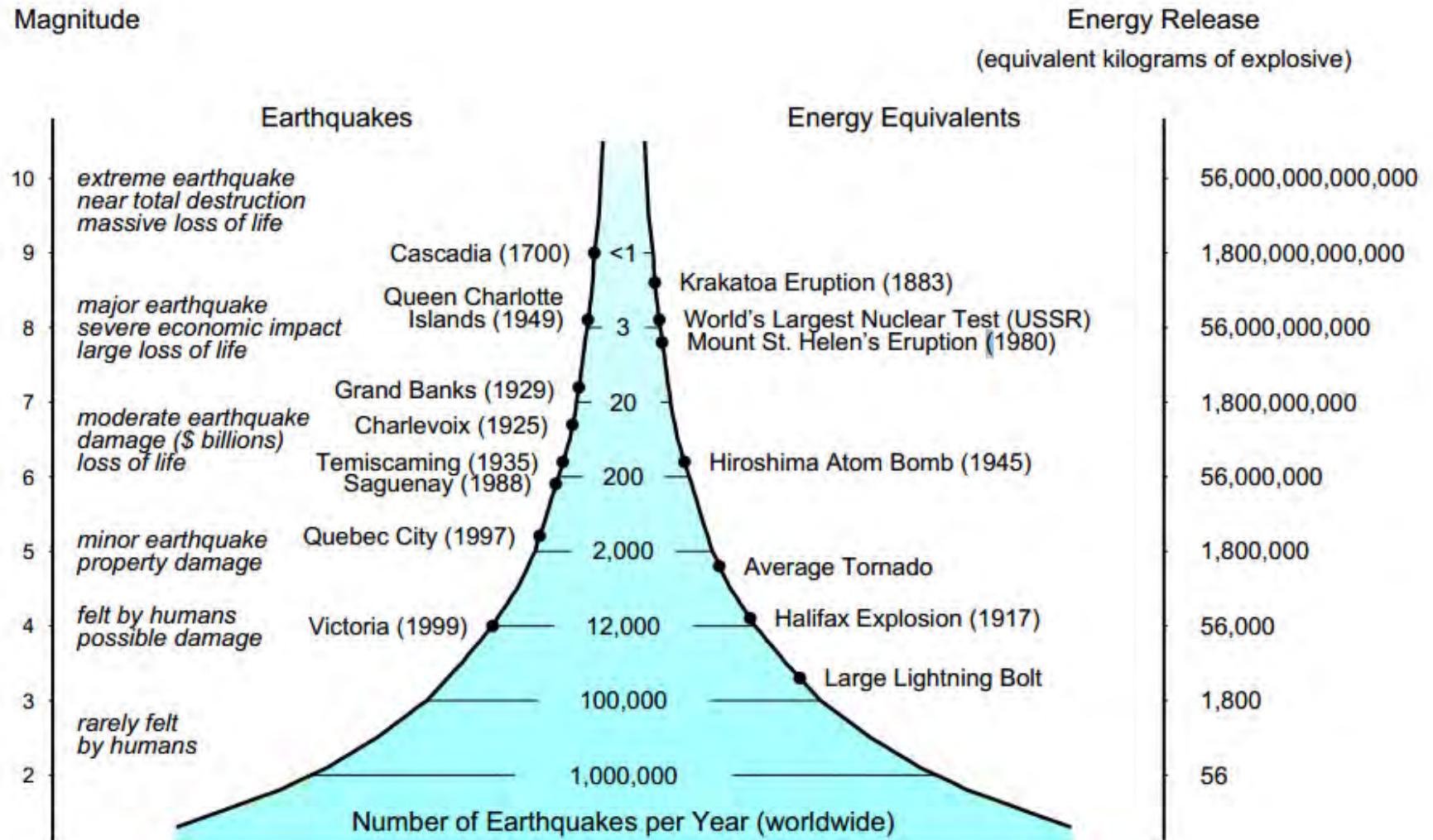


Image: NRCan

Natural Disasters are Rare Events

Return Period (RP)

RP = **average** number of years
between disaster events of the
same magnitude (M)

$$RP(M) = \text{_____}$$

Example Saffir-Simpson Category 5 Hurricane

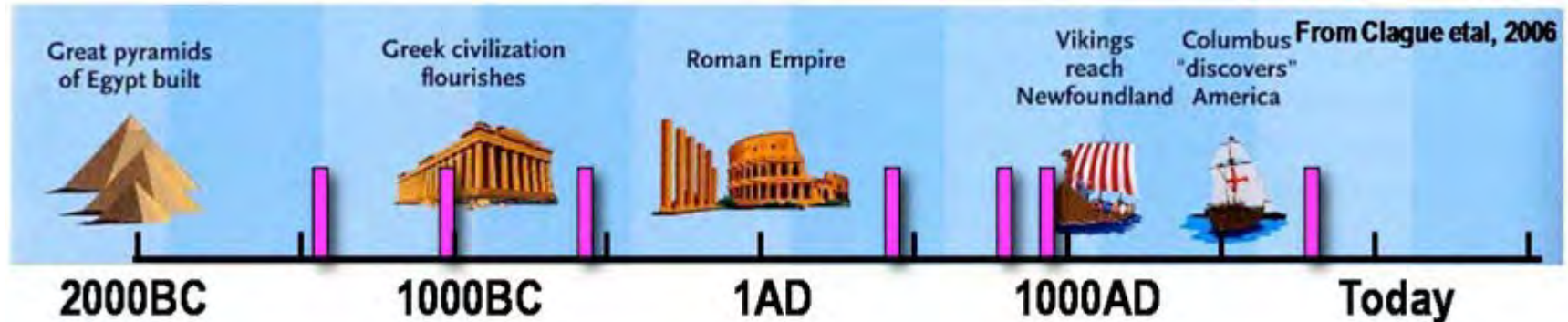
$$RP(M) = \frac{\text{time span of data}}{\# \text{ of cases of mag. } M}$$

$$RP(5) = \frac{70 \text{ years}}{2 \text{ cases}}$$

$$RP(5) =$$

Actual data:
Since 1924 there have
been 38 Category 5's
RP = 2.6 years

iClicker



For SW Canada, extremely destructive earthquakes ($>M_w 8$) have occurred as plotted above with magenta bars. Estimate the return period (in years)?

- A) ~150 years
- B) ~300 years
- C) ~600 years
- D) ~2000 years
- E) not enough info to answer

$$RP(M) = \frac{\text{time span of data}}{\# \text{ of cases of mag. } M}$$

Learning Goals (FS3)

- a) Scientific communication: course framework concepts and what types of science communication you encounter during this course
- b) Compare and contrast risk, perception of risk, hazard, and vulnerability.
- c) Discuss how poor humans are at judging risk and how your perceptions skew your ability to judge risk.
- d) Relate natural-disaster risk & intensity to frequency, return period, and consequences (costs).
- e) Describe population growth and the factors influencing the carrying capacity of Earth, and explain why this is important when considering natural disasters.

EOSC114 “framework” concepts

These are the four framework concepts that are recognized in all modules throughout the course.

Processes – what causes the event or how does it work?

Forecasts or predictions – how, or to what extent, can any aspect (location, time, severity. etc) be anticipated using technology, observations or any other means?

Consequences – how were people, communities or the environment impacted by the event?

Mitigation – how can we minimize the effects, OR recover as quickly and efficiently as possible?

Notes on Homework

Each module will have an article or websites and accompanying worksheet to guide you through different types of scientific writing.

Thinking about what you are reading, and the types of data presented is important in evaluating the merit of the information given.

We will be asking you to think about :

- 1) Our framework concepts
- 2) Purpose or intentions of the authors (who benefits?)
- 3) Types of article based on the sources of the work



Clicker Question?

Read this statement – which of the following framework concepts applies here?

The two category 5 hurricanes of the 2017 Atlantic hurricane season (Irma and Maria) are compared in terms of cost in lives and damage to infrastructure.

- A. Processes**
- B. Forecasts or predictions**
- C. Consequences**
- D. Mitigation**
- E. None of these**

Hazard vs. Risk

Hazard

Any event or situation that could cause human (Deaths, injuries) or economic harm (property and prosperity)

Hazard vs. Risk

Vulnerability – a weakness that could be affected by a disaster (or how badly it could be affected)

Hazard vs. Risk

Risk

Probability that any given hazardous event might occur and the chance of a potential loss

Could be simply written as:

$\text{Hazard} \times \text{Vulnerability} = \text{Risk}$

Risk

Risk is usually expressed as a probability

“Chance of x happening”

HAZARD

vs

RISK

A **HAZARD** is something that has the potential to harm you



RISK is the likelihood of a hazard causing harm



THINGS TO WORRY ABOUT

1. WAR
2. POVERTY
3. HUNGER
4. CLIMATE CHANGE
5. INJUSTICE

⋮

- 413,024. GOING TO THE BEACH AND GETTING SHOT BY A SWIMMING DOG CARRYING A GUN IN ITS MOUTH
- 413,025. LEARNING MR. ROGERS IS STILL ALIVE AND HE'S MAD AT ME
- 413,026. ALTERING JUPITER'S ORBIT BY ACCIDENT
- 413,027. WALKING UNDER A VOMITING SKYDIVER
- 413,028. CLOTHES GETTING SUCKED INTO THAT PNEUMATIC TUBE THING AT THE BANK
- 413,029. PRANK HOLOGRAPHIC MANHOLE COVERS

Perception of risk

A problem.

Humans do not deal well with probabilities

Human perception of risk is flawed!

LottoMax

7/7 numbers - 1 in 28,633,528

\$5 to play

For even chances to win the jackpot
must be:

\$143,167,640

But!

Importantly, humans are really bad
with big numbers too.

Discussion Groups of 4 (ish)

Estimate how many metres high a stack of 28,633,528 lottery tickets are.

1 minute

Class Discussion

Estimate how many metres high a stack of 28,633,528 lottery tickets are.

How thick is a ticket? Less than 1 mm, more than 0.1mm....say 0.3mm

$$\begin{aligned} 0.3 \text{ mm} \times 28,633,528 &= 8590058 \text{ mm} \\ &= \sim 8.6 \text{ km} \end{aligned}$$



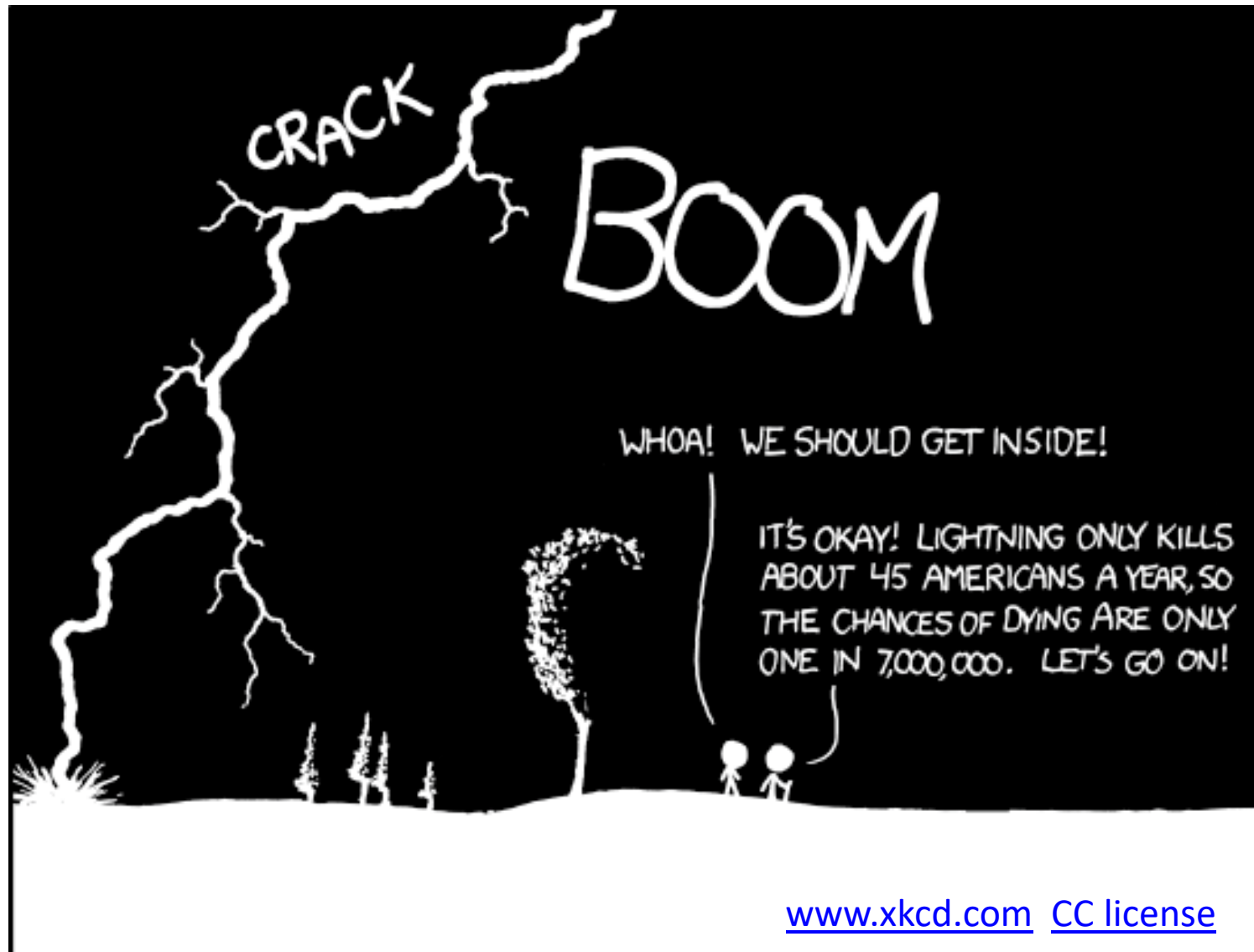


Photo [Yorkali Walters](#) CC License

Odds (U.S. Stats)

Type	#Deaths/year	Risk/year
Motor Vehicle	36676	1/7,700
Motor Cycle	3112	1/91,500
Train	931	1/30,600
Bicycle	695	1/410,000
Commercial Flights	138	1/2,000,000

**Data is a little old now – note that the absolute numbers are not important!



www.xkcd.com CC license

THE ANNUAL DEATH RATE AMONG PEOPLE
WHO KNOW THAT STATISTIC IS ONE IN SIX.

Odds (U.S. Stats)

Type	#Deaths/ year	Risk/year	Risk Exposure Deaths/distance
Motor Vehicle	36676	1/7,700	1.3 per 100,000,000 miles
Motor Cycle	3112	1/91,500	31.3 per 100,000,000 miles
Train	931	1/30,600	1.3 per 100,000,000 miles
Bicycle	695	1/410,000	?
Commercial Flights	138	1/2,000,000	1.9 per 100,000,000 miles

Perspective. ~2300 people die **EVERY DAY** from Heart Disease

Walking near cars

US data for 2020,

A pedestrian hit by a car every 4 mins

104,000 had minor injuries

~7,000 were killed

Globally in 2023:

Deaths from earthquakes

Deaths from volcanoes

Deaths from floods

<https://ourworldindata.org/grapher/number-of-deaths-from-natural-disasters>

https://www.cdc.gov/transportationsafety/pedestrian_safety/



Discussion Groups

What factors can skew human perceptions of risk?

2 minutes

Risk?

Big M8 Earthquake

Here:



What is the risk? (high medium or low)

Risk?

Earthquake?
Here:



What is the risk? (high medium or low)

Risk?

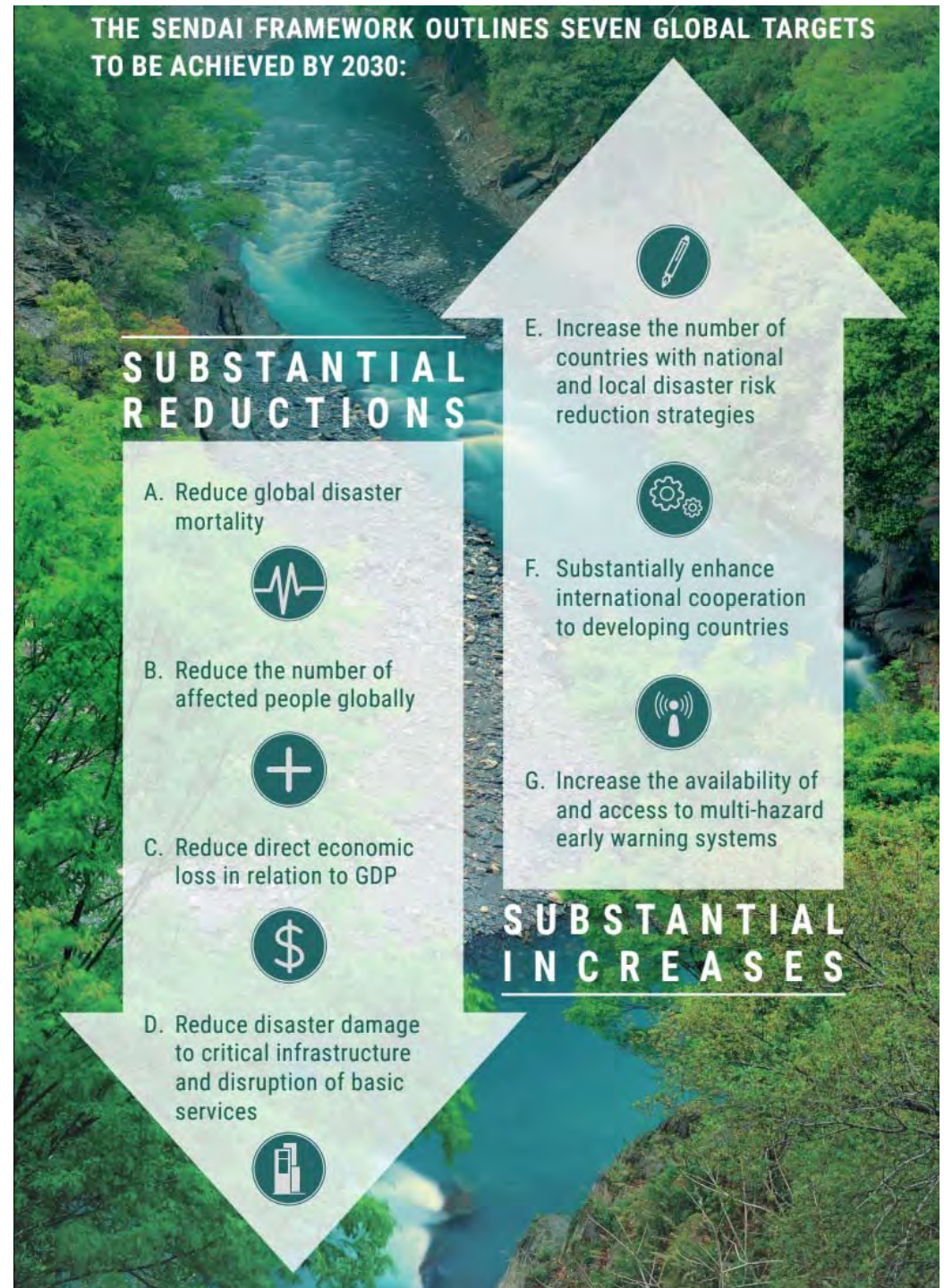


Risk Reduction – United Nations

Sendai Framework for Disaster Risk Reduction 2015-2030

AIM: The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

<https://www.undrr.org/implementing-sendai-framework/what-sendai-framework>



Population Issues

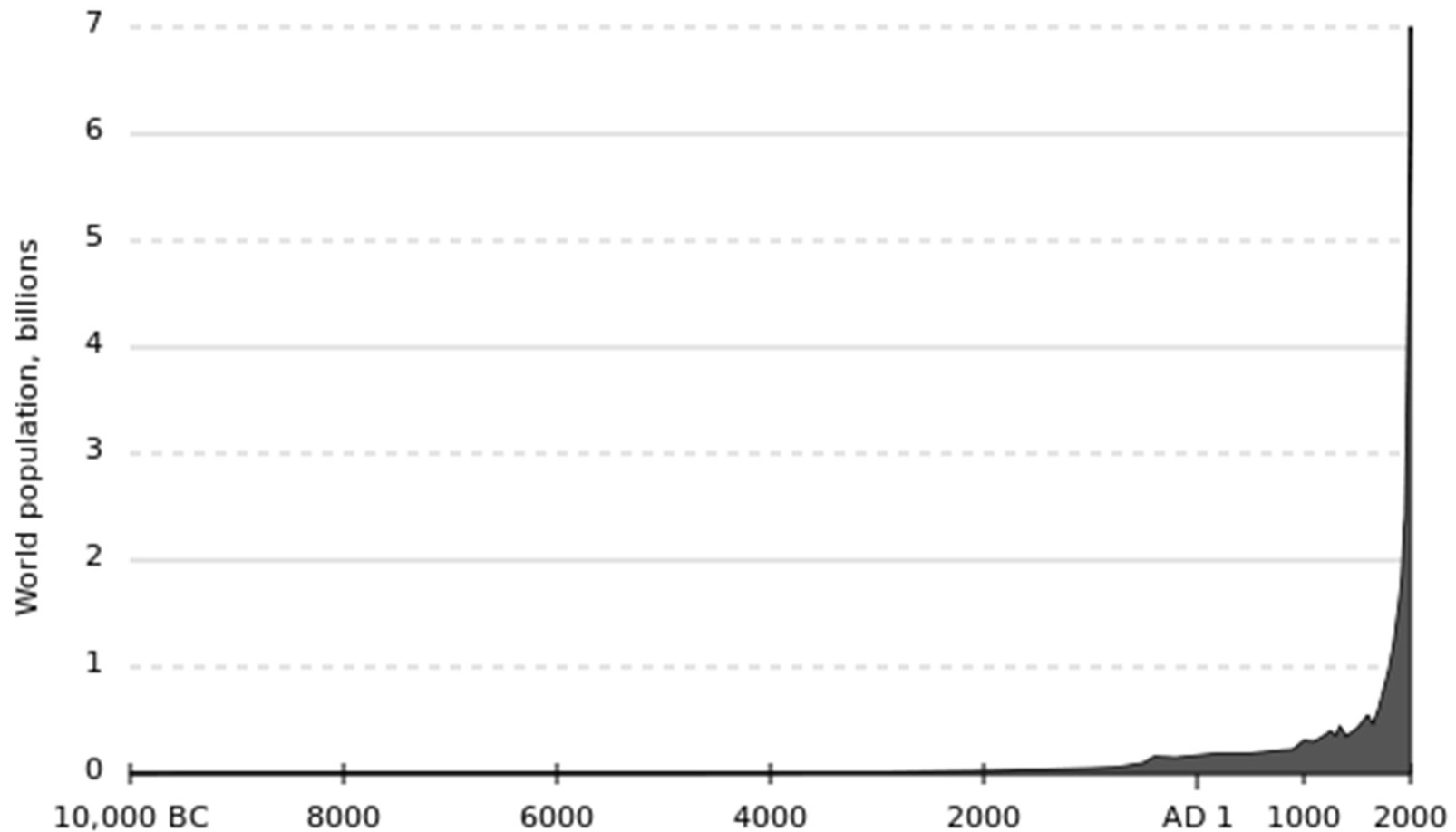


Are disasters increasing?



Remember, what makes a natural event a disaster....

Historical Population Growth



Historically there has been exponential growth!

Growth of ~1.1% per year!

Population doubles every ~70 years

Population

At this growth rate,
930 years from now,
529 trillion humans
would cover the
continents standing
shoulder to shoulder.



www.worldometers.info/world-population/

Population

Overpopulation

- Population that exceeds the carrying capacity
- What happens then?



<https://www.sciencealert.com/here-s-elon-musk-s-spectacular-plan-to-start-colonising-mars?perpetual=yes&limitstart=1>

Class Discussion Carrying Capacity

Carrying Capacity

The population that can be sustainably supported within a given domain (e.g., earth)

Depends on:

Population

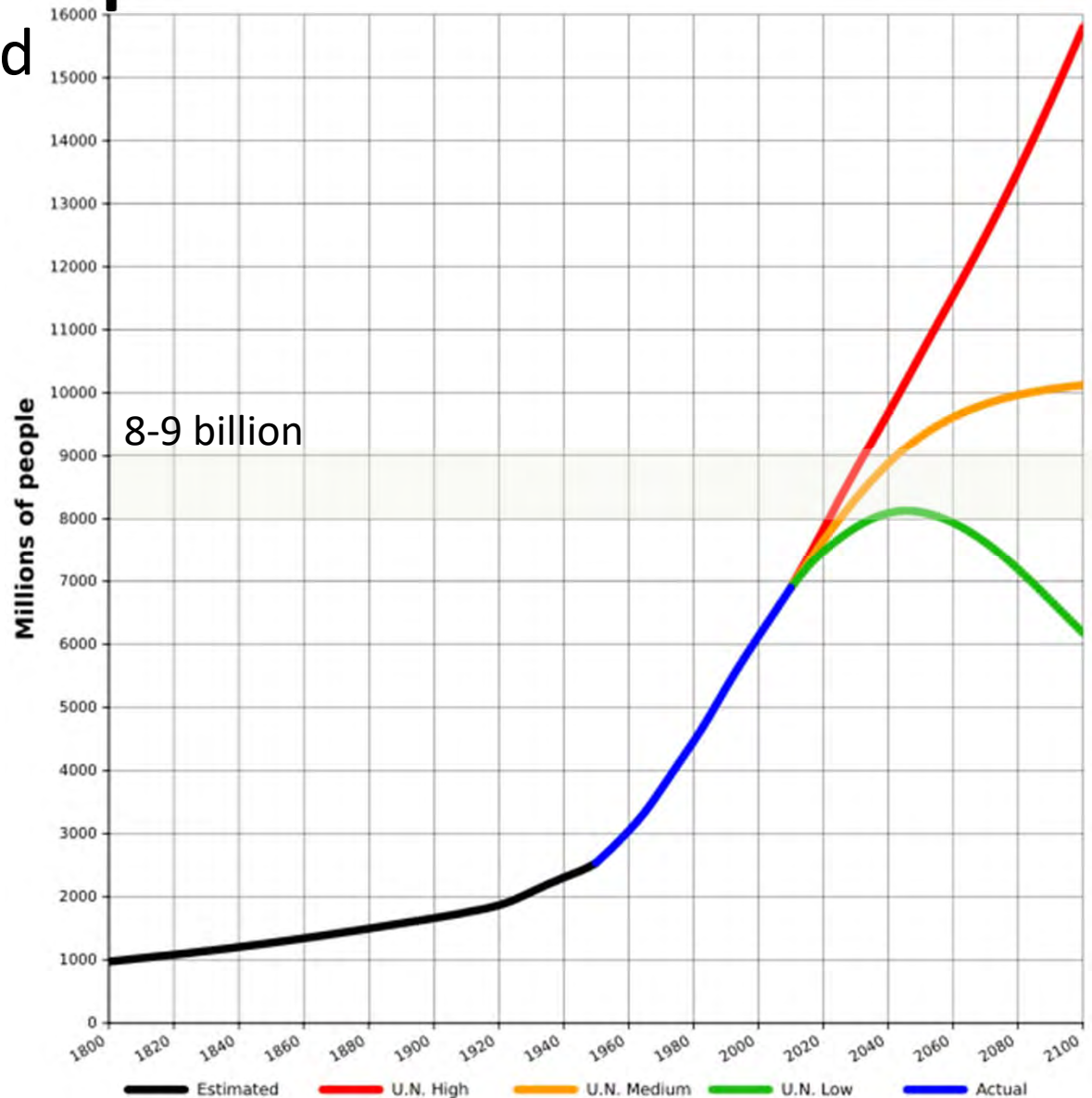
Luckily growth seems to be slowing

Now “only” linear

1 billion more people every 13
years

Population

- Current* 2024 world population is ≈ **8,174,163,000**
- Growth rate will continue to decrease as earth's carrying capacity is approached.
- Recent projections are 9.7 billion people By 2050.



* www.worldometers.info/world-population/

Climate Change – United Nations



The Paris Agreement

<https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

Driving forces behind climate change

<https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>

How might this be related to population growth?

In the rest of the modules we will take a brief look at how climate change may influence the frequency/intensity of our natural disasters.



Relation to Disasters?

At present:

- With warning, people can be saved
- But infrastructure is destroyed

In future:

- With more people, infrastructure becomes more important and vulnerable and people are less likely to be evacuated



Fragile System

Earth – A Fragile System?

Earthquakes, volcanoes, landslides, hurricanes, tornadoes, floods, tsunami, asteroid impacts ...

...are NOT disasters to the Earth. They are normal components of the Earth System

But they are disasters to us

CONCLUSIONS?

- **The Earth is not a fragile system, but the Human population is!**

The rest of the semester

Earth's history

Long periods of calm punctuated by brief, localized events of shear terror.

In this course, we will study that terror.

Upcoming Deadlines

- Register your iClicker in Canvas iClicker Cloud – will be grading from Wednesday!
- Due September 15th - Complete the “Explore Your Background Part A” homework
- Add/drop date September 16th
- Due September 22nd – “Explore Your Background Part B”(read feedback and try again for a better mark – top mark from Part A/B will count)
- Midterm 1 September 25th in normal class time