

# Climate Change

FMA 2023

Ivo Welch

October 2023

# Not a Talk about ESG.

- ▶ Though you should know this as background if you are interested in “E”

# Not a Talk about ESG.

- ▶ Though you should know this as background if you are interested in “E”
- ▶ ...unless you care only about ECV

# Very brief presentation of a very big topic.

1. Text Presentation (Science, Social, Tech)
2. “Fun” Scientific Graphs (with questions)
3. Open Questions

<https://www.ivo-welch.info/research/presentations/>

- ▶ Lots more (and even more balance) in textbook.
- ▶ (Hopefully soon tradebook).

# Big Takeaway

Surprisingly little worth disagreeing about

Shouldn't be very controversial *at all!*

# Talk (and Textbook and Course) Outline

1. Climate Change Earth Science Background
2. Social Science Perspective
3. Technological Situation

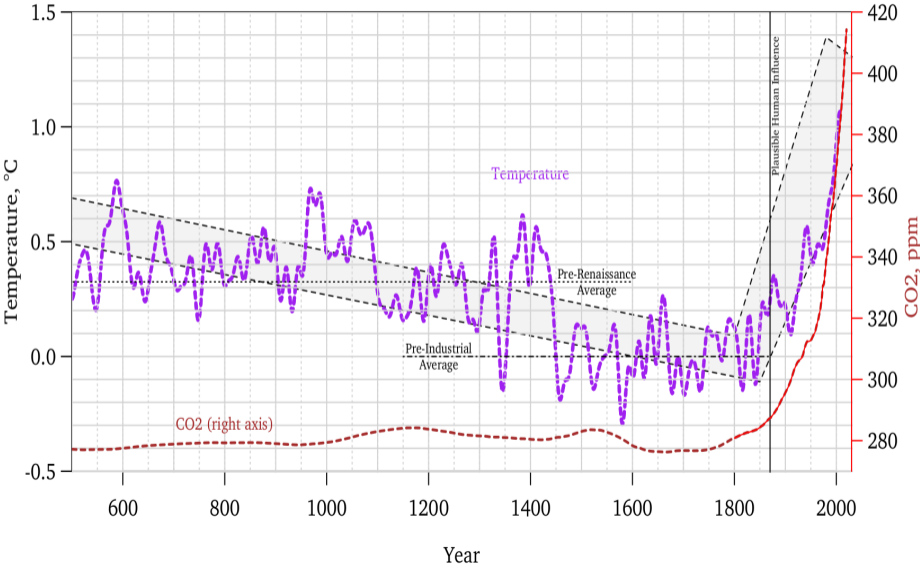
# 1. Climate Change (Earth Science)

- ▶ **Hold policy questions until “2. Social Science.”**
- ▶ **Until 2, science questions only, please.**

- ▶ I use data and predictions from the IPCC.
  - ▶ Reasonably good, despite some (reasonable) quibbles.
    - ▶ Like economics: Not everything is correct and unbiased — but it's way better than the alternatives.
    - ▶ Like economics: In flux. Not knee-jerk but reasonably disciplined.
    - ▶ What would even be reasonable alternatives?
  - ▶ More than good enough for agreement.
    - ▶ Disagreements and quibbles are minor and unimportant *for us*.
    - ▶ They are great to have for connoisseurs
  - ▶ PS: IPCC RCP (CMIPs) are great. IPCC SSPs are not.



# Strong Historical Evidence (Mann)



# Strong Current Predictions

- ▶ Earth is currently continuing to heat up
  - ▶ Measurable **contemp** in-out radiation imbalance
- ▶ Earth will continue to heat up
  - ▶ Lots of uncertainty about the **future**,
  - ▶ but only modest disagreement.

# Mean (Expected) Warming

- ▶ Climate-sensitivity: doubling CO<sub>2</sub> leads to 3°C (eqbm)
- ▶ We have increased by 50% so far, and will go above 100%
- ▶ Mean consensus: Think  $\approx$  2.5-3.5°C by 2150
  - ▶ 1°C already (Europe, already 2-3°C!)
  - ▶ Another 1.5-2.5°C will be coming
- ▶ Baseline year is difficult to keep straight

# Uncertainty, not Disagreement

- ▶ Climate sensitivity coefficients of **1-5**
- ▶ Temp Range: 1.0-4.5°C is >95% (2020 to 2150)
- ▶ More catastrophic scenarios, say up to 4°C, possible.
  - ▶ included: domino effects, feedback loops, tipping points, unknown unknowns (deep uncertainty).
  - ▶ 4% would be catastrophic and justify much higher CO<sub>2</sub> taxes
  - ▶ tail prob here and elsewhere is always unlimited...but end of times is exceedingly unlikely

# Don't Fixate

- ▶ What about global epidemics?
- ▶ What about nuclear war?
- ▶ What about biotech weapons?
- ▶ What about Arnold?
- ▶ Apophis, April 13, 2029 / 2036
  - ▶ inside geostationary satellites, >> all nuclear arsenals
  
- ▶ Nothing good on Earth is certain

# Meaning of °C Climate Change

- ▶ Think 100-mile distance for every 1°C.
- ▶ 2°C: Boston → NY → DC → Raleigh
- ▶ 4°C: Munich → Milan → Palermo
  - ▶ Think Scandinavia → Germany → Italy → Israel
  - ▶ Not uninhabitable, but different
  - ▶ Very costly transitions, of course, but *we* are already very rich and will be even richer; winners and losers.

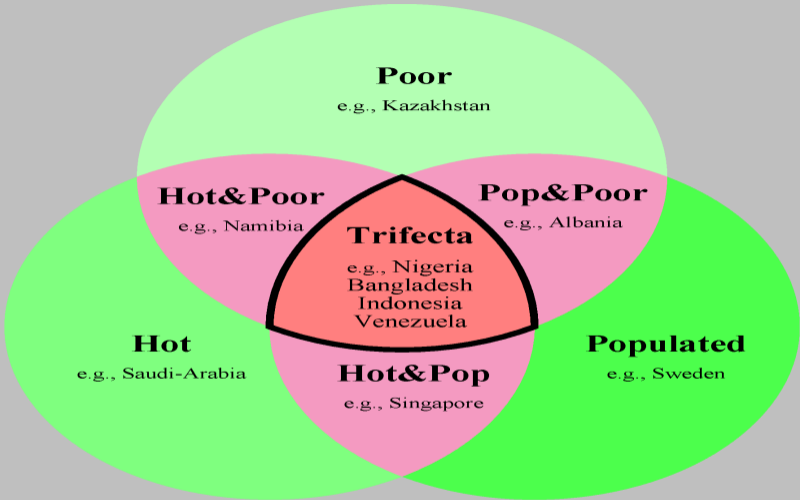
# So What Can We Do?

- ▶ Fighting **sensibly**: much better for humanity *overall*

# Meaningful Reductions in Emissions (IPCC)

- ▶ RCP 4-5: Aggressive Activism: +2°C
- ▶ RCP 6-7: Complaisant Neglect: +2.5°C
- ▶ Fighting Difference: only 0.5°C.
  - ▶ Think 50 miles on 200-300 mile expected move.
- ▶ Fighting sensibly = much better for *all* humanity
- ▶ Econ Growth: soon 4.5x or 5.0x richer than today?
- ▶ Warning:
  - ▶ don't take sketch models too seriously
  - ▶ and every econ quantity here is big for headlines





**Poor**

e.g., Kazakhstan

**Hot&Poor**

e.g., Namibia

**Pop&Poor**

e.g., Albania

**Trifecta**

e.g., Nigeria  
Bangladesh  
Indonesia  
Venezuela

**Hot**

e.g., Saudi-Arabia

**Populated**

e.g., Sweden

**Hot&Pop**

e.g., Singapore

**Rich&Cold&Empty**

e.g., Antarctica

# Causes of Harm

- ▶ All changes require adjustment costs
- ▶ Others surprisingly not easy to predict.
- ▶ Diseases, deaths plausible — though odd.
  - ▶ reducing emissions to fight disease???
  - ▶ science progress?
  - ▶ shipping of medicines, food, etc.
- ▶ More deaths where more births (?)
  - ▶ reasonable guesses possible (next page)

# How to Help Africa and India?

- ▶ Problem: huge population growth
  - ▶ Africa: 1900 = 0.1b. 2000 = 0.6b. 2100 = 3.0b (5x2000)
  - ▶ modern fertilizers have helped, but
  - ▶ land, rain, crops have not increased by factor of 30
  - ▶ An ecological disaster in the making.
  - ▶ CC will make it worse.
- ▶ 4.5x or 5.0x more wealth will help.
  - ▶ But economic growth today hugely important to get it!

# MSL

- ▶ Expected Mean Sea Level (MSL) Rise:  $\approx$  1-2 feet.
  - ▶ probably much slower but also unstoppable
  - ▶ will/could be 6 feet if glaciers melt. (200 years?)
  - ▶ 240 feet since last ice age
  - ▶ fight climate change? 10 cm exp avoidance
  - ▶ argue? nah...leave it to Koonin. unimportant.

# CC Earth Science Summary

- ▶ Likely bad, esp where hot&poor
  - ▶ would be better for collective to reduce emissions
- ▶ Likely not the end of the world
  - ▶ nothing is guaranteed
- ▶ Please don't argue ideology, left or right.
  - ▶ you are not an advocate in court.
  - ▶ let's consider actions rationally, not emotionally
  - ▶ although this is all about human misery

# Economic Workhorse Models

- ▶ Integrated Assessment Models (IAM)
- ▶ Nordhaus, Stern IAMS
  - ▶ seminal and great (but) sketch models.
  - ▶ CC is economically harmful. SCC (not /tC but /tCO<sub>2</sub>).
  - ▶ Best “carbon” tax should start at \$30-\$50/tCO<sub>2</sub>.
  - ▶ Add in CC uncertainty, tax should start \$45-\$80 / tCO<sub>2</sub>
    - ▶ convex damages
  - ▶ Tax should be rising in the future, think \$5-\$10/year.

## Textbook Treatment of IAMs

- ▶ The textbook gives explanations of different perspectives.
  - ▶ Some disagreement on discount rate etc. (Too literal?)
  - ▶ Textbook is fair to many different valid perspectives that can reasonably disagree.
- ▶ Optimal: \$30-\$100/tCO<sub>2</sub> tax, increasing by \$5/year.

## Note: “Curse” of Emission Fighting

At high CO<sub>2</sub> levels, emission changes become less effective

- ▶ at 300 ppm, 100 years of zero OECD emissions would have made a big temp difference (perhaps 0.6°C).
- ▶ at 600 ppm, makes only 0.3°C temp difference.
- ▶ at 1200 ppm, makes only a 0.15°C the temp difference.
- ▶ relevant marginal emission is last one



# Question: Constraint to Policy?

- ▶ What's the relevant constraint to reducing emissions?
- ▶ Is it disagreement about CC science and IAMS inputs?

Really?

# Really?

- ▶ Not in my mind.
- ▶ Problem is not about what “we” *should* do
  - ▶ Problem is also not even about blame or ethical considerations
- ▶ Problem is about what “we” *will* do
  - ▶ And problem is about what we can promote.

# Book: Main Constraint on CC Policy

- ▶ 200 self-interested countries
- ▶ World is not the Borg
- ▶ Worldwide tax on CO<sub>2</sub> is cart before the horse.

---

ca 2050-2100	OECD	Not OECD
Population	12%	88%
GDP	50%	50%
Emissions	28%	72%

---

## Book: OECD

- ▶ OECD is only 1/3 of emissions, soon 1/4.
- ▶ Emissions are not a “luxury” problem.
- ▶ It wouldn't even solve the problem if we could wipe out the OECD.
  - ▶ slow down clean tech(!)
- ▶ Whose tax (well, social cost of carbon = SCC)?
  - ▶ 2% (whole world) or 10% (OECD pays)?
  - ▶ 1 mo rent vs 5 mo rent?

# Need It More Obvious?

Countries have militaries for the same reason why they will not decarbonize.

Spend all military expenses on CC instead!

# Arguing over Disagreements?

1. Arguing about whether a nuclear war will kill 1 or 5 billion people is irrelevant.
2. Arguing about the optimal world choice is irrelevant.
3. Arguing about what can realistically be done *asap* to reduce the probability of nuclear war may not be ideal — but it is the only relevant discussion.

(Too) obvious?



# Revealed Preference

Who wants to bet on such abatement policies?

As of 2020s, three decades by now:

- ▶ World can suck out at  $< \$10/\text{tCO}_2$  *on the margin* today, perhaps 1 GtCO<sub>2</sub>. Who is volunteering to pay?
- ▶ Who wants to pay to suck out China's and India's increasing GDP emissions?
- ▶ USA and EU are secondary. Corporate disclosures and ESG are unimportant. "Fair shares" are unimportant.

black cat?

# 1+2: Realistic Remedies

1. Must work around the world. 6-7bn people.
2. Must work over decades and generations.
3. Must not be too much against self-interest.
4. Must be able to sustain majority support.

Only Clean Tech stands a realistic chance. Everything else is a black cat.

# Quick Abbreviated Tour of Tech

- ▶ Electricity (can be 2/3 of power, 1/2 of emissions):
  - ▶ Generate-as-available: already cheaper for clean E
  - ▶ ON-demand E: soon (batteries)
- ▶ Transportation
  - ▶ Grid-near: soon, happening
  - ▶ Off-grid: hopeless right now (stupid, too)
- ▶ Heat (1/3?):
  - ▶ Much harder: FF is one-trick pony

# Electricity Costs (LCOE), Rough:

- ▶ Retail: \$200-300/MWh (incl xmit, billing)
- ▶ Coal Plant:
- ▶ Nuclear Plant:
- ▶ NatGas Plant:
- ▶ Solar / Wind:
- ▶ Battery:
- ▶ Grid Problems

# Propaganda and Truth

- ▶ Fossil fuels are nasty stuff. kill millions.
- ▶ Don't trust surrogate propaganda
  - ▶ World has more than enough clean resources
  - ▶ but expect short-term hiccups
  - ▶ some/many self-induced (NIMBY, regs)

# Propaganda

- ▶ We would have to plaster the entire state of Massachusetts with solar panels.
- ▶ Utter non-sense:
  - ▶ Battery building is too dirty
  - ▶ Landfills will overflow



# Nuclear

- ▶ Not safety, disposal, etc.
- ▶ Simply not economically competitive right now
  - ▶ NatGas obsoleted it,
  - ▶ not just NRC (though they are not helping),
  - ▶ but think not just USA and EU
- ▶ Great to do RDD. Not great to deploy.



# Hydrogen

- ▶ Everybody's conceptual darling,
- ▶ but technology is *very far away*.
  - ▶ 5-10 times the cost of NatGas unsubsidized
  - ▶ *Both* fixed and variable costs are » Natgas
  - ▶ plus, highly corrosive, tough to hold
  - ▶ crazily huge IRA subsidies in US

# Industrial CO<sub>2</sub> Sequestration

- ▶ When implemented *today* (rather than just researched), it deserves stupid spending (golden fleece) award
- ▶ trees for timber can sequester CO<sub>2</sub> 10 times cheaper

# Many Other Cheap Improvements (OECD)

## Urgent Government Interventions:

- ▶ Developed: Improve electrical grids
- ▶ Developed: Time-of-day pricing
- ▶ Developed: Concierge service for permits
- ▶ Everywhere: Add locally justifiable FF taxes

# Part 1: Points to Remember

- ▶ World is warming...rapidly, largely unprecedentedly.
- ▶ Will create big harm in poor and hot countries.
  - ▶ economic wealth helps to mitigate heat damage
- ▶ “Deep Uncertainty”
  - ▶ but one among many existential very-low-prob issues
  - ▶ can't fixate on one problem

- ▶ Collectively, better off if we slow down emission growth
  - ▶  $> 2/3$  non-OECD,  $< 1/3$  OECD emissions
  - ▶ OECD alone could not solve the problem
- ▶ Collectively does not buy us dinner
  - ▶ OECD alone could not solve the problem, and
  - ▶ exp actions cannot be too much against self-interest,
  - ▶ even more so outside of the OECD
  - ▶ ... though appetite for real sacrifices is low even in the OECD.
- ▶ Locally, better with fewer FFs, due to other pollutants
  - ▶ Please tax darn FFs reasonably and immediately *locally*

- ▶ Non-OECD countries must want to skip FF stage
  - ▶ Trust politics? Really?
  - ▶ Trust global treaties? Really?
  - ▶ Trust sacrifice (and large transfers)? Really?
  - ▶ Trust US SEC ESG regs (r u kidding??)? Really?
  - ▶ Outcome will be not a matter of “we should” but of “we can”
- ▶ Only good approach / realistic chance: Drive Tech!
  - ▶ Other approaches are insufficient,
  - ▶ or, worse, counterproductive virtue-signaling distraction.

- ▶ The tech is remarkably close, and environmentalists / business could *intelligently* do a lot more to get clean tech where we need it to be and displace FFs asap
- ▶ Stupidity won't do the job. Let's be smart and curb FFs.
  - ▶ What could environmentalists be doing more smartly?
  - ▶ (Many things: talk self-interest, don't talk UN.)
- ▶ WTH *realistically* is there to disagree about??
  - ▶ death sucks, but we cannot change it.

# Textbook Part 1: Conclusion

- ▶ Much more detail and backup in our free textbook.
- ▶ Easy to teach CC now; in great undergrad demand.
- ▶ Prereq to ESG careers?
- ▶ Grab free book in the rear...
  - ▶ (and free corpfina textbook at reception)
- ▶ Resources
  - ▶ <http://climate-change.ivo-welch.info/>
  - ▶ <https://www.climate-change.ivo-welch.info/home/16-cribsheet.html>



## Part 2: Fun Figures, Odds and Ends

<https://www.ivo-welch.info/research/presentations/figs/>

## Part 3: Open Questions