Climate Damages and Uncertainty:

Florida's Future Flooding





Frank Ackerman

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Who we are



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- Founded in 1996 by CEO Bruce Biewald
- Research and consulting firm specializing in energy, economic, and environmental topics
- Services include economic and technical analyses, regulatory support, research and report writing, policy analysis and development, representation in stakeholder committees, facilitation, trainings, and expert witness services for public interest and government clients
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Big Bend Report

The Proposed Plant at Big Bend

A Review of Climate Impacts

Prepared for Sierra Club February 11, 2019 (revised 04/01/2019)

AUTHORS

Frank Ackerman, PhD Bruce Biewald



485 Massachusetts Avenue, Suite 2 Cambridge, Massachusetts 02139

617.661.3248 | www.synapse-energy.com

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The climate economics puzzle

Climate change in science

Climate change in economics

Fundamental threat to future of human society; evidence is getting stronger, response is urgent Second-order policy problem; be sure to avoid spending too much, pricing carbon too high

Both are talking about the same issue!

One of them must be wrong

Massive, well-funded effort to debunk climate science finds only typographical errors, so...



We need a new climate economics, consistent with the urgency of climate science

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Why Florida?

- Geography
 - That's where hurricanes happen it's the worst-hit of the 48 states, by far
 - Long, low coastline, huge value of property at risk from storm surges, sea level rise
- Opportunities for change
 - Untapped potential for clean energy renewables, efficiency to reduce emissions
 - Next month's webinar takes a closer look at Florida resource planning





The need for a number

- Standard approach to economic policy depends on cost-benefit analysis
- Comparing costs and benefits requires monetary valuation of everything that matters
- How bad (expensive) will climate damages be?
 - Science: uncertain, but ominous worst-case risks
 - Economics: social cost of carbon (SCC) = present value of cumulative damages per ton of CO₂ emitted
- Obama administration's Interagency Working Group: SCC \approx \$51 (today's dollars) for 2020 emissions



All important impacts, no matter how disparate, must be weighed on the same (monetary) scale for cost-benefit analysis.

Who needs insurance?

- Alternative policy framework: buying insurance
- Average U.S. housing unit: 1 fire every 360 years
 - 0.3% probability you'll have a fire next year
 - Almost all homeowners have fire insurance
- Annual probability of death < 1% until age 60
 - Probability of death < 0.2% until 40
 - Most young parents have life insurance
- Why not cancel your insurance?
 - Spend the premium on something you'll really enjoy
 - Standard of living goes up, unless you have a fire (or die)
- How likely is catastrophic climate change?
 - Uncertain timing, but tipping points become "less unlikely" every year as the world warms
 - Should we buy insurance for the planet?



Climate policy as global self-insurance



- Insurance never passes a cost-benefit test
 - Insurance company's profit = customers' aggregate losses
 - If customers as a whole are not losing money, an insurance company will face bankruptcy
 - Insurance customers willingly pay for catastrophic risk reduction, despite "losing" money on average
- Limits of insurance analogy
 - No galactic insurance agency will offer us a loaner planet to use while ours is towed back to the shop for repairs
- Global self-insurance
 - Spend money on climate-proofing, resilience, emission reduction to mitigate catastrophic risk
 - Must be global to be effective

Inside the SCC: A tale of three models

- SCC calculation averages results of 3 models
 - DICE, PAGE simple/transparent, *very* aggregate estimates of global damages
 - FUND disaggregated detail; idiosyncratic treatment of important categories
- National Academy of Sciences definitive critique, proposals for better SCC modeling
- Catastrophic risk limited treatment in PAGE, absent in DICE, FUND
- Not the best models, but the best-known
 - Famous for being famous, the Kardashians of climate economics?
 - DICE is useful for transparency, not precise detail



Long before climate economics models, the oracle at Delphi offered cryptic forecasts of an uncertain future

More detail is not always helpful

- FUND model estimates 15 categories of impacts, some with multiple subcategories.
- Estimates of 12 of the 15 categories are always near zero.
- Big net benefits in agriculture are due to an outdated estimate of carbon fertilization.
- Excess detail distracts attention from dynamics of the model.
 Even a complicated model may give simple, unvarying answers.



How fast will the climate get worse?

- Climate damages = f(temperature, sea level)
 - What is the shape of f?
 - How to extrapolate from low temperatures to high?
- DICE: aggregate damages assumed to be quadratic function of temperature
- PAGE: calibrated to DICE, slightly different forms for aggregate damages
- FUND: individual functions for sector damages
 - Usually estimates lower damages than DICE
- Other researchers have modified model assumptions
 - Use a different damage function or estimate of high-temperature losses
 - Many people will not survive 10°- 12° C warming; implies steeper damage function
- Resulting SCC can be many times larger than usual estimates
 - Highest estimates are too likely to ignore, may not be most likely outcomes
 - Need for insurance calculation: what is the credible worst case?







Real vs. fake uncertainty

- There are deep scientific reasons for uncertainty about how bad climate change will be, how soon
 - Among many other sources, see my *Worst-Case Economics*, chapter 10
- These have *no* relationship to fake uncertainty peddled by climate deniers
 - Trump administration revives denial, promotes unsupported, contrarian views
- Rigorous/hostile vetting of climate science finds only typographical errors
 - One scenario can be rejected: no real damage from climate change



From climate risk to policy choice

- Adopt insurance, or credible worst case, paradigm for climate policy
 - In worst case, how great is the damage per ton of CO₂ (i.e. the SCC)?
 - Hundreds of dollars per ton of emissions, at least
 - Possibly growing worse, as shown by new research on climate risks
- The self-insurance decision: which emission reduction strategies cost less per ton than worst-case damages?
 - Costs of emission reduction are dropping rapidly
 - This makes wind, solar, storage technologies a bargain
- Does every feasible emission reduction cost less than \$500/ton CO₂?
- Could worst-case damages exceed \$500/ton? (Yes)
- If so, do everything feasible, ASAP

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Selected examples of Florida climate damages

Tourism losses

Tourism: Florida's leading industry. Roughly 10% of state GDP, 17% of employment.

Damaged by storm surges, beach erosion, uncomfortably hotter temperatures

Expensive adaptation measures will be required.





In August 2013, a cluster of three locallyacquired cases of dengue fever was confirmed by the Florida Department of Health. ... This is the second introduction of dengue in Martin County in two years. ... there is a continued risk for future dengue introductions and outbreaks in Martin County. ... another mosquito-borne disease, chikungunya, recently arrived in the nearby Caribbean Islands and continues to spread.

- Florida Department of Health

Human health impacts

- Florida could have 30 76 days per year over 95°F by mid-century, causing thousands of additional heat-related deaths per year.
- Higher temperatures increase vulnerability to mosquito-borne tropical diseases, such as dengue fever.
 - More months of the year will be above the temperature thresholds that allow transmission of these diseases.

Ecological health



- Climate change will cause temperature and precipitation changes, reducing the reproductive capacity, and hence the populations, of native Everglades wildlife.
- The region will become increasingly vulnerable to invasive species.

Built to flood? Gas plants at the water's edge

- Florida's economy, population, energy needs all continue to expand
- Private utilities propose massive expansion of gas-burning power plants, at waterfront
 - Florida Power & Light (FPL) Dania Beach, Fort Lauderdale (top)
 - Tampa Electric Company (TECO) Big Bend, Tampa (bottom)
- Sunk costs of building plants utilities will want to run them for decades, emitting greenhouse gases through midcentury or later
- Waterfront location saves money in short run, but sea level rise / storm surge constraints will be important (expensive) over plant lifetimes





Blog series:

http://frankackerman.com/blogs-and-op-eds

In-depth discussion:

http://frankackerman.com/worst-case-economics





For more information:

http://synapse-energy.com

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Additional (optional) slides

Carbon pricing, pro and con SCC calculation Climate justice and sustainability Discount rate

Carbon pricing: part of the answer...

- A price on carbon emissions will create visible incentive for reduction
 - Not based on exact value of expected damages, due to risk, uncertainty
 - Pragmatic question: what price is politically acceptable, economically effective?
- Two mechanisms: carbon tax, or cap and trade
 - Some activists passionate about tax, attack phony offsets in cap and trade systems
 - But same flaws could arise in carbon tax, if pork-barrel exemptions are added
 - Some cap and trade systems set prices too low to matter much; easily fixed
- More similarities than differences
 - Offsets/exemptions can be allowed, or not, in either approach
 - Public sector can receive, decide how to spend revenues
 - Border adjustments, other features, can be added under either one
- Carbon price level is crucial, not the mechanism that creates it



Carbon pricing: ... not enough by itself

- Ongoing need for regulations, public initiatives, along with carbon price
 - In imaginary, textbook world of perfect markets, everyone would respond immediately, correctly, to price incentives, no need for other rules
 - We don't live in that world. Not even close.
- Basic research, low-carbon infrastructure require public support
 - Transition to electric vehicles depends on dense network of charging stations
 - Long-distance transmission of renewable energy helped by high-voltage DC lines
- Price-based calculations can be complex; efficiency standards are simpler
 - Lengthy number-crunching of lifecycle costs for every appliance, vehicle purchase?
 - Or just buy something that meets mandated energy efficiency standards?
- Proposal to adopt carbon tax, abolish many regulations is dangerous
 - Trade the real benefits of regulations for a not-so-popular tax???





What is the social cost of carbon?





Conceptual drawings, not to scale!

- Start with baseline emissions scenario (top graph, blue dots)
- Second scenario adds emissions spike in one year (top graph, orange line)
- Calculate climate damages from the emissions scenarios (bottom graph, orange and blue lines)
- Calculate difference between scenario damages (green line)
- SCC = NPV of differences, divided by tons of CO₂ in emissions spike



Climate justice and sustainability

- Climate change threatens us all but not all in the same way.
- We are all on the same boat, in perilous waters. But some of us have much nicer cabins than others.
- How can we achieve equity in impacts of climate policy, ensure support from low-income communities, nations?
- What level of comfort is globally sustainable in a low-carbon world?

Tyranny of sunk costs

- Describing a sustainable world is easier than getting there from here
- Sunk costs shape energy use, emissions
 - Housing can last a century
 - Business investments last decades
 - Lock-in to past locations, assumptions
 - Most of US too low-density for transit?
- Incentives have to create discomfort, inspire change in energy use
 - Risks worsening existing inequalities
 - Can inspire political pushback (Yellow Vests defeat gasoline tax in France)
 - Cap and dividend? Other refunds?
- Partial recovery of stranded assets?



What would success look like?

- Historical responsibility for emissions
 - US, Europe responsible for damages, costs of reduction, in other countries as well as their own
 - Acceptance of broader responsibility will have to evolve alongside immediate climate initiatives
 - No chance of prior agreement on global responsibilities
- What would success global sustainability look like?
 - Rapid urbanization of developing countries
 - What kind of urbanism is sustainable, affordable?
 - Not Houston (upper picture)
 - Perhaps Tokyo (lower picture)?





And don't forget the discount rate! Affects relative weight of future vs. current impacts

