Risk Premia for Carbon

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Resources for the Future,
Dept Math TU Delft
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Current approaches

• Assume \textit{social welfare function}.
• Sample \textit{climate uncertainty distr’n}.
• Compute marginal damages of Carbon.
• Compare risk averse utility with linear utility.

Derive Lower bound on WTP from stabilization targets.

\textit{Science Based Uncertainty Quantification.}
What Could Disappear

Maps show coastal and low-lying areas that would be permanently flooded, without engineered protection, in three levels of higher seas. Percentages are the portion of dry, habitable land within the city limits of places listed that would be permanently submerged.

- **Today’s waterways**
- **Land submerged by rising oceans**

### Select sea level rise over current level:
- **25 feet**: Potential level in coming centuries, based on historical climate data.
- **12 feet**: Potential level in about 2300 if nations make only moderate pollution cuts.
- **5 feet**: Probable level in about 100 to 300 years.
- **0 feet**: Today’s sea levels and land area.

**Notes on sea level estimates**

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**Baltimore** 12% flooded

Flooding extends over much of downtown and many waterfront communities, like Dundalk.

**Boston**

Cambridge 86% flooded

The downtown island shrinks to mostly Beacon Hill. Many shore communities are flooded.

**Charleston, S.C.** 80% flooded

The coast moves up to 10 miles inland. The old city is submerged.

**Houston**

Galveston 100% flooded

**Jacksonville, Fla.** 56% flooded

**Los Angeles area**

Los Angeles 3% flooded

Long Beach 45% flooded

Huntington Beach 72% flooded
Surging Seas
Sea level rise analysis by CLIMATE CENTRAL

List: Cities | Counties

Water level +10ft

Things below +10ft in Connecticut

Population 54,543 1.5%
Homes 28,495 1.9%
Acres 24,918 0.8%

Over 1 in 8 chance sea level rise + storm surge + tide will overtop +10ft by >2100 at nearest flood risk indicator site: New London - Thames River, 33.3 miles away.

Learn more:
- Connecticut data download
- Connecticut map | facts | plan
- Surging Seas report
- Map accuracy | speed tip

http://sealevel.climatecentral.org/surgingseas/place/states/CT#show=cities&center=9/41.5031/-72.7575&surge=10
Surging Seas
Sea level rise analysis by CLIMATE CENTRAL

List: Cities | Counties

Water level +10ft

Things below +10ft in Washington, DC
Population: 6,070 (1.0%)
Homes: 2,656 (0.9%)
Acres: 2,549 (6.5%)

Over 1 in 6 chance sea level rise + storm surge + tide will overtop +10ft by 2030 at nearest flood risk indicator site: Washington - Potomac River, 2.2 miles away.

Learn more:
- Washington data download
- DC map | facts | plans
- Surging Seas report
- Map accuracy | speed tip

Map Beta release.
Get map widgets | Report a bug | Tell your story

CLIMATE CENTRAL
Sources: NOAA, USGS, US Corps, USGS
Use data @openStreetMap and Commons By-SA
Ice Sheet contribution to SLR @3C, 2100 [mm/yr]

http://www.nature.com/nclimate/journal/v3/n4/full/nclimate1778.html

Greenland

West Antarctica
Elicitation Nov. 2012

P-value:
Expert 1 = 0.4
Expert 7 = 0.33
Expert 4 = 6E-6
Inter agency memo on SCC

- Damages
- Roe Baker cs
- DICE, PAGE, FUND
Risk Swap

Anderson and Bows’ (2011): international agreements express society’s desire to swap:

current climate risk along with BAU path

↔

risk of emissions path satisfying:

the probability of raising mean temperature by more than 2°C in 200 years should not exceed 19%.

What would a risk neutral insurer charge?
Current Climate Risk (BAU) is distributed as:

![Graph showing the probability distribution of damage](chart.png)
We would like our climate risk to be:
What would a risk neutral insurer charge?

![Damage distribution plot]

- prob(D<x)
- ins WO premium
- ins+premium

Damage
We get lower Expected disutility
Figure 2: Temperature Distribution in 200 years for BAU (left) and DICE optimized (right). The horizontal axis is maximum temperature in 200 years, the vertical axis is cumulative probability.
Figure 3 Cumulative distribution for maximum temperature for min cost risk compliant emissions path for 2.5% discount rate
Damage allocation

• Damages depend on previous and future emitters
• Shapley value for allocating damages to periods
## SCC [2008$\text{/GtCO}_2\text{]}$

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Thanks Michael
Reservoir engineers: performance-based scores, and mutual weightings

Note big discrepancies between performance-based ranking and a priori ranking from mutual weighting exercise (RH panel)
Figure 3: Expert mutual self-weights and performance ranking, Ice sheets (Nov 2012) left and Dam safety right (Aspinall and Cooke, 2013)
Greenland, 3°C, 2100, discharge

Greenland, 3°C, 2100, accumulation

Greenland, 3°C, 2100, runoff