# Risk Premia for Carbon

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**Current approaches**

- Assume social welfare function
- Sample climate uncertainty distr'n
- Compute marginal damages of Carbon
- Compare risk averse utility with linear utility

Science based?

**Derive Lower bound on WTP from stabilization targets**

**Science Based Uncertainty Quantification**

http://www.nytimes.com/interactive/2012/11/24/opinion/sunday/what-could-disappear.html?_r=0

# 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.

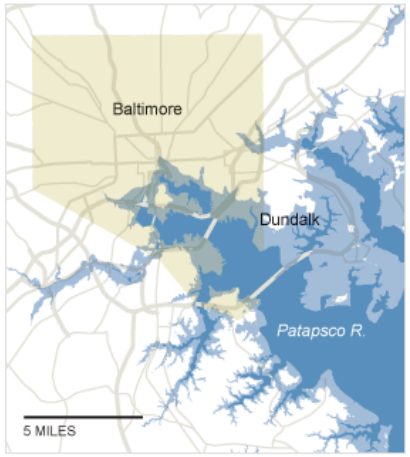
Today's waterways  Land submerged by rising oceans

**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.

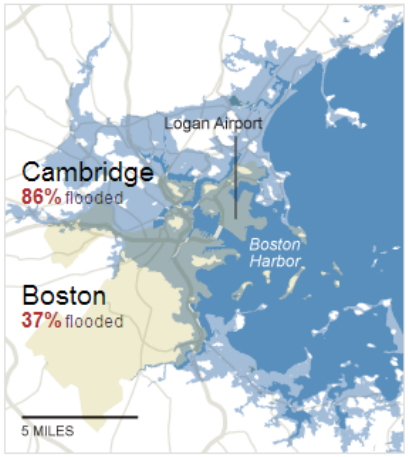
Notes on sea level estimates

## Baltimore 12% flooded




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

## Boston



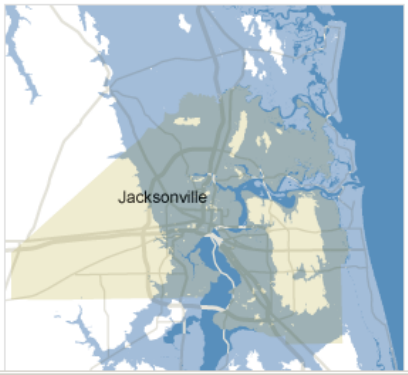

The downtown island shrinks to mostly Beacon Hill. Many shore communities are flooded.

## Charleston, S.C. 80% flooded

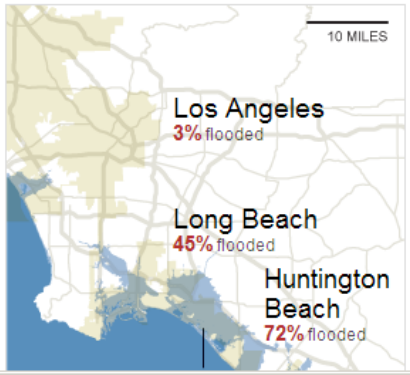

The coast moves up to 10 miles inland. The old city is submerged.

## Houston


## Jacksonville, Fla. 56% flooded




## Los Angeles area



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

Search by City, State, or

Share view: Like 4 Send

List: Cities | Counties

Water level +10ft

Things below +10ft in

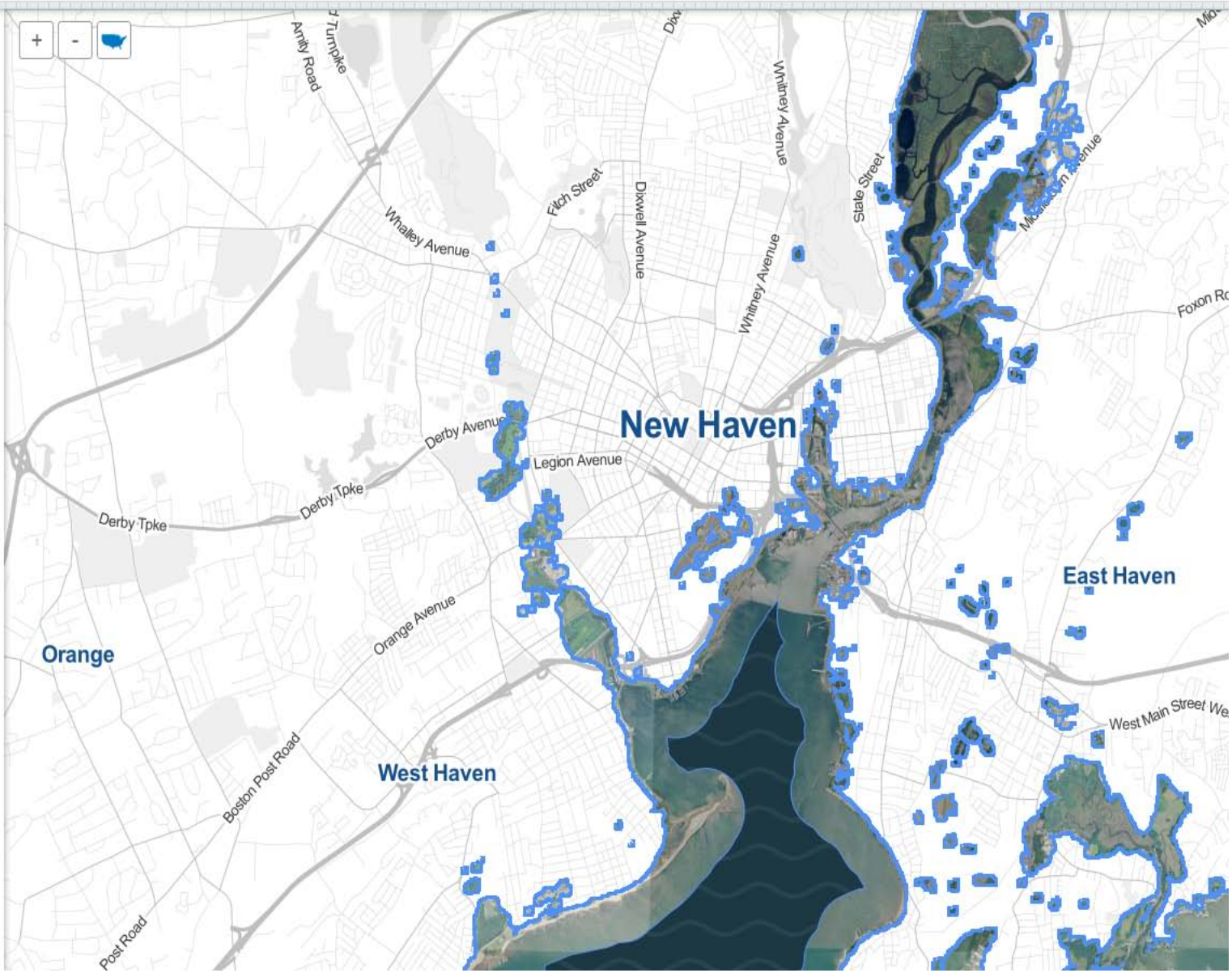
## Connecticut

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

Over 1 in 6 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 | plans
- Surging Seas report
- Map accuracy | speed tip



# Surging Seas

*Sea level rise analysis by* CLIMATE CENTRAL

Search by City, State, or Zip

Share view: Like 1 Send

List: **Cities** | **Counties**

Water level **+10ft**

Things below **+10ft** in

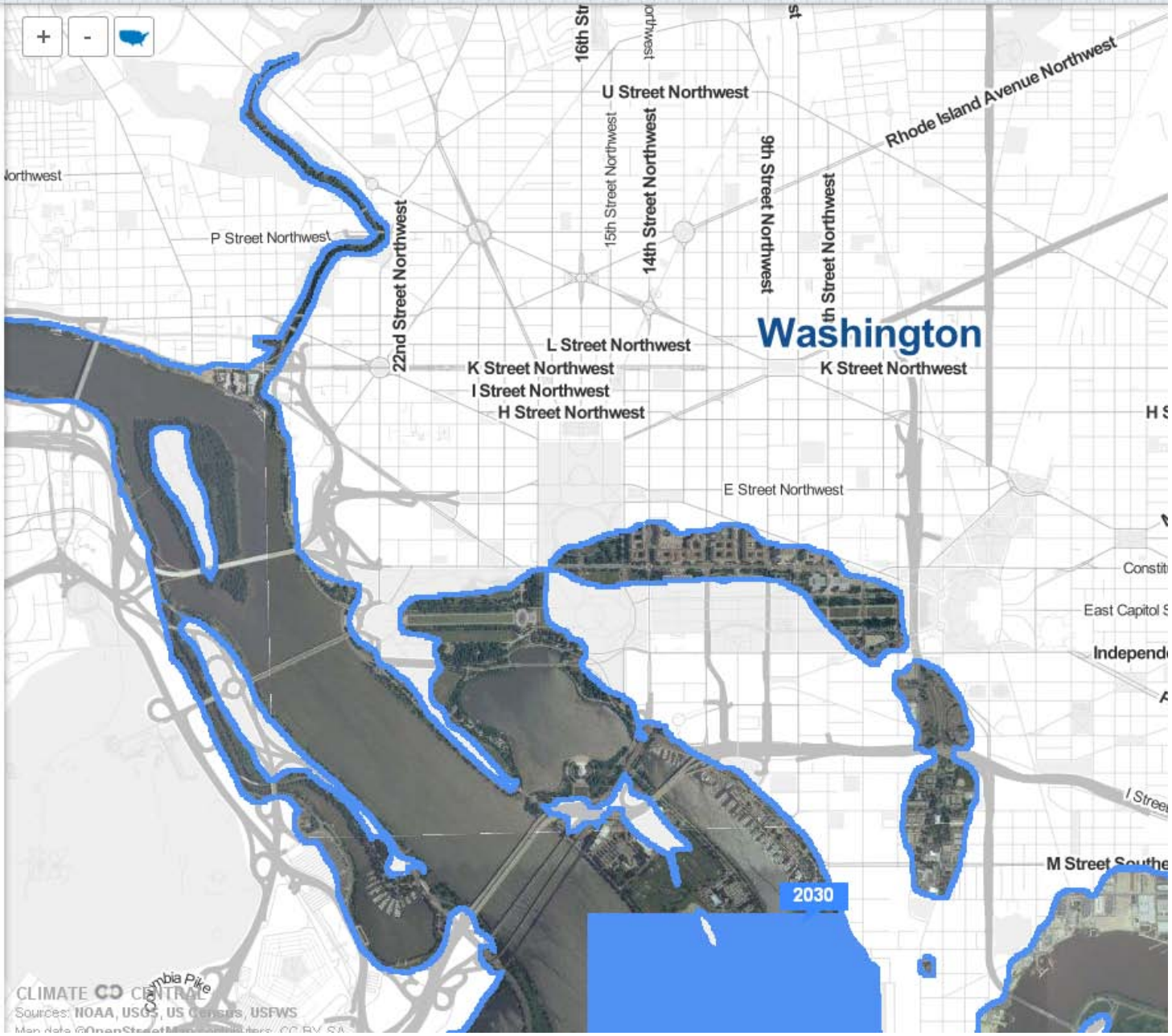
## Washington, DC

| | | |
|---|---|---|
| **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

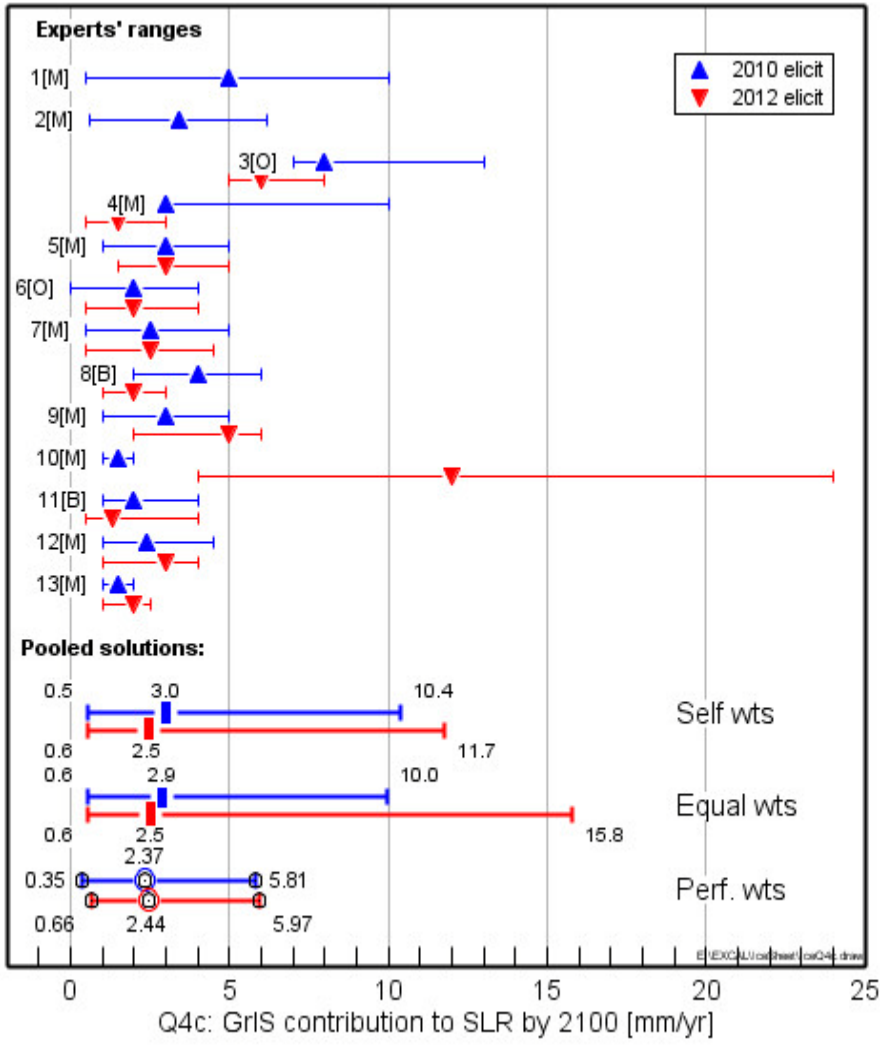
http://www.dailymail.co.uk/news/article-2307185/Waterworld-How-Americas-cities-look-centuries-sea-level-rises-predicted-scientists-prove-correct.html


Popular tourist destination: The art deco district of Ocean Drive in Florida as it looks today

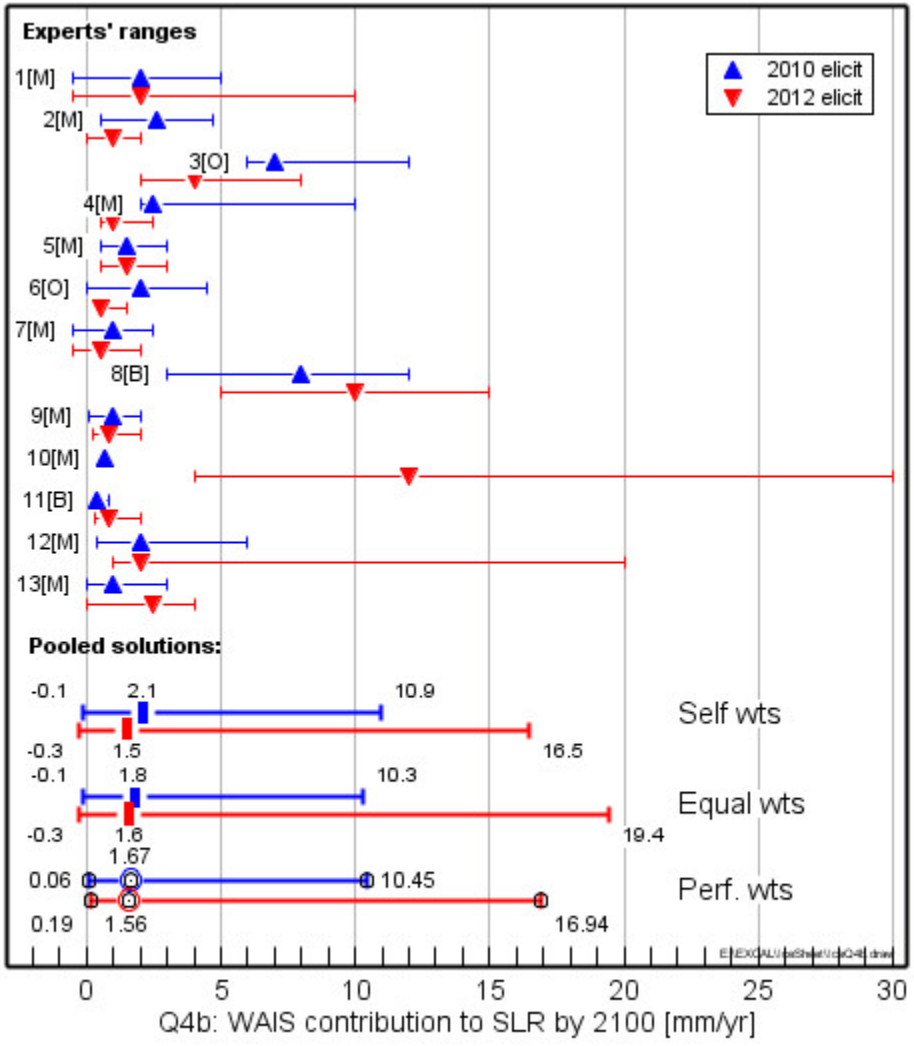
# Ice Sheet contribution to SLR @3C, 2100 [mm/yr]

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

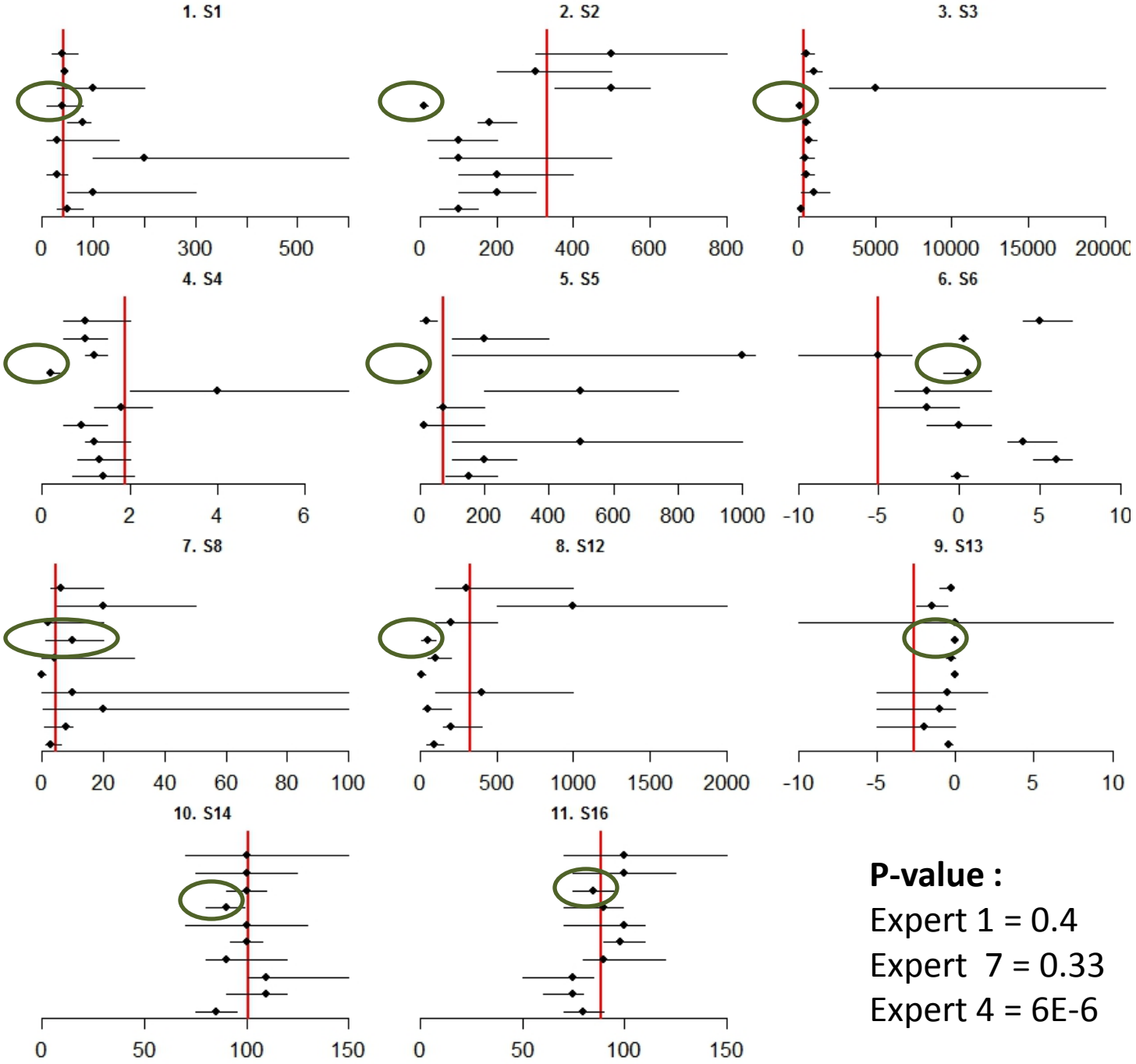
## Greenland




## West Antarctica



# Elicitation Nov. 2012




**P-value :**

Expert 1 = 0.4

Expert 7 = 0.33

Expert 4 = 6E-6

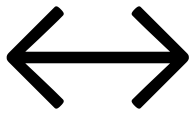
# Inter agency memo on SCC

- 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**

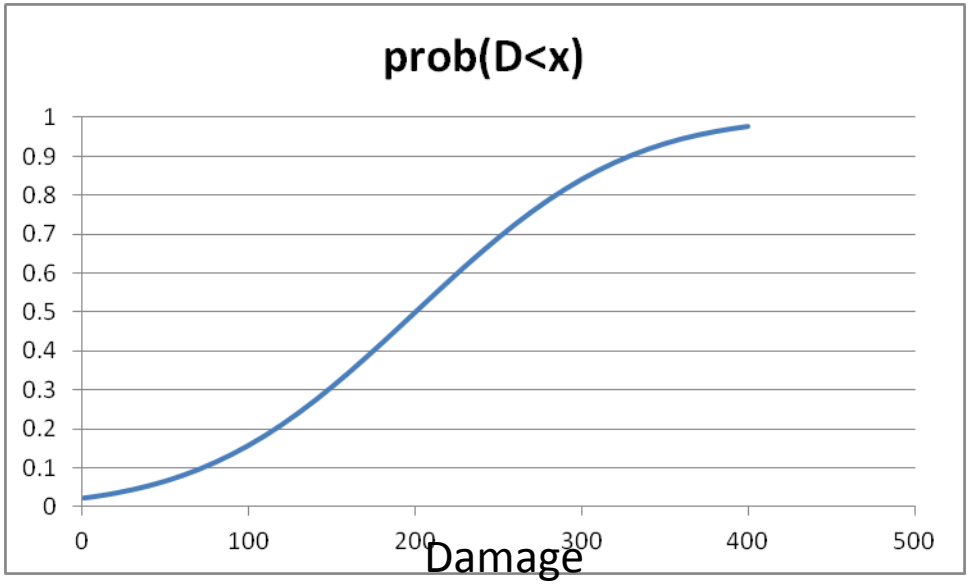


**risk of emissions path satisfying:**

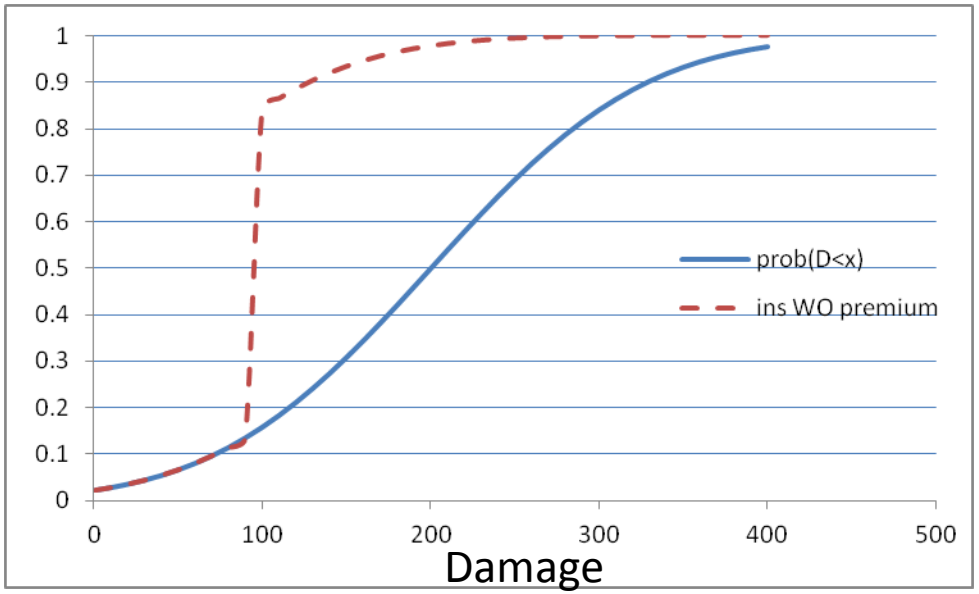
*the probability of raising mean temperature by more than 2°C in 200 years should not exceed 19%.*

What would a risk neutral insurer charge?

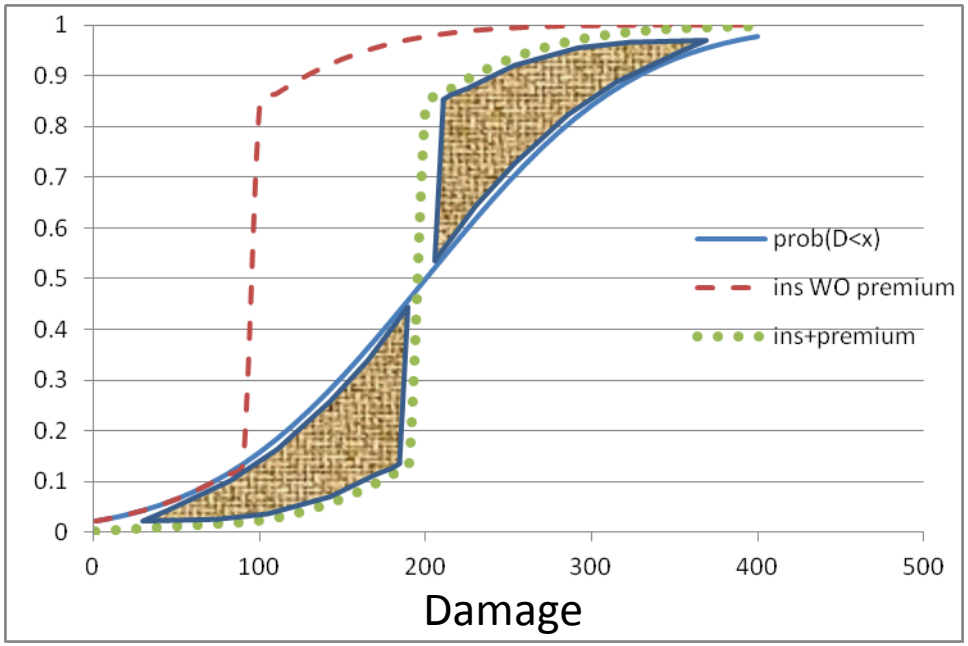
# Current Climate Risk (BAU) is distributed as:



# We would like our climate risk to be:



# What would a risk neutral insurer charge?



# We get lower Expected disutility

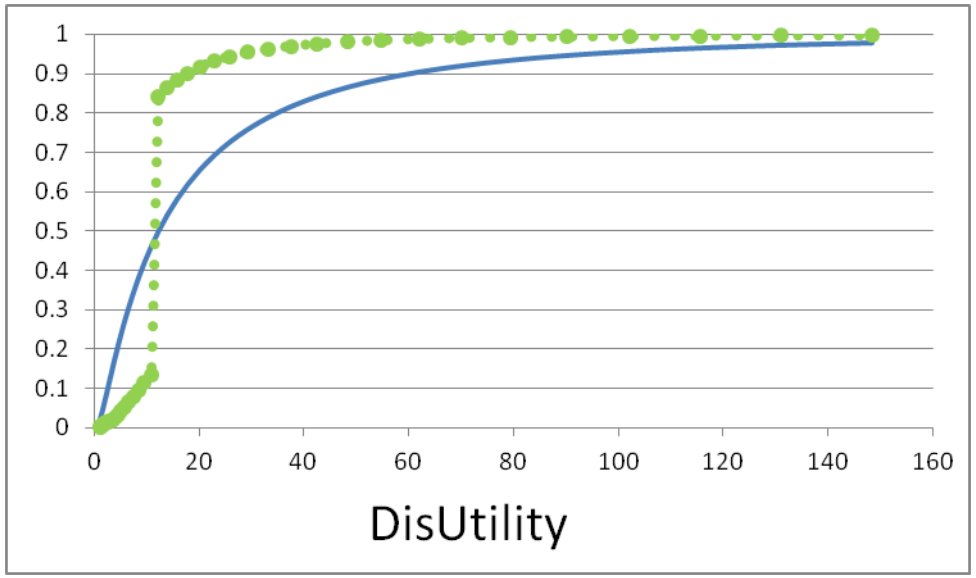
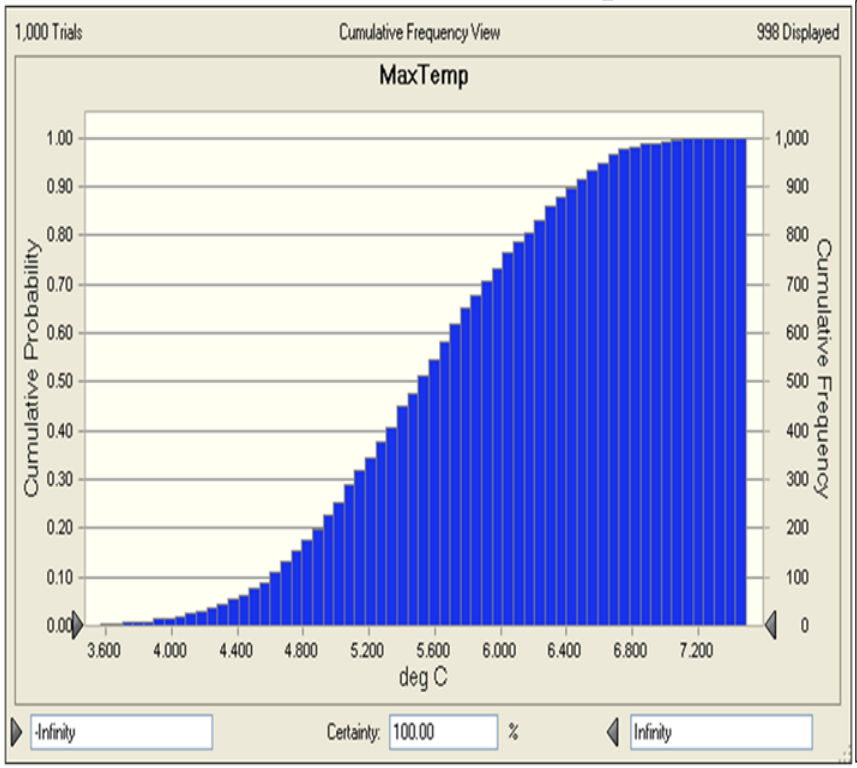


**Figure 2: Temperature Distribution in 200 years for BAU (left) and DICE optimized (right). The horizontal axis is maximum temperature in 200 years, the vertical axis is cumulative probability.**



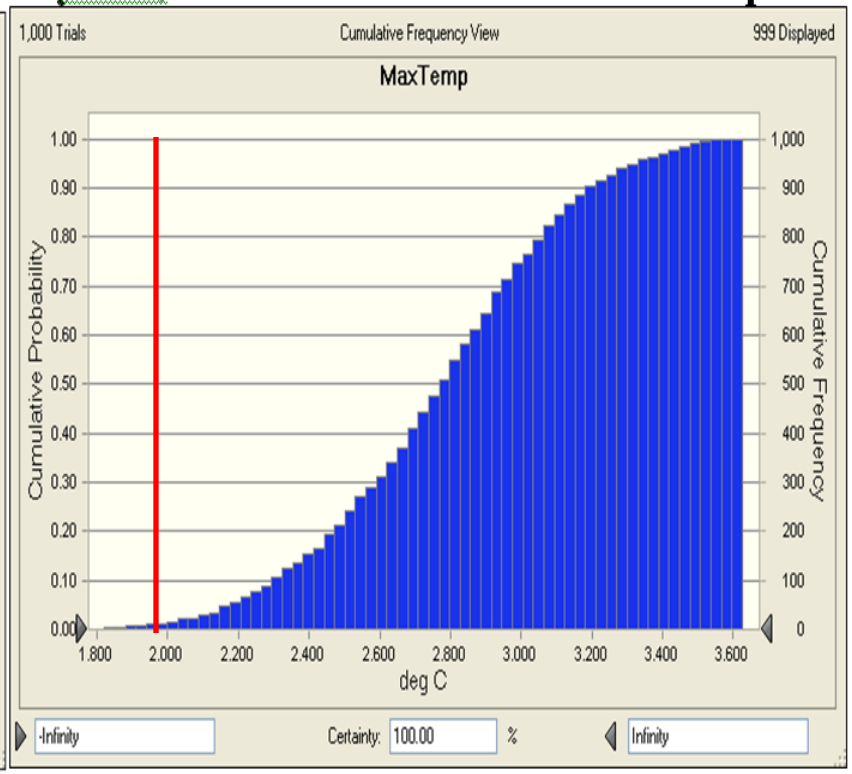
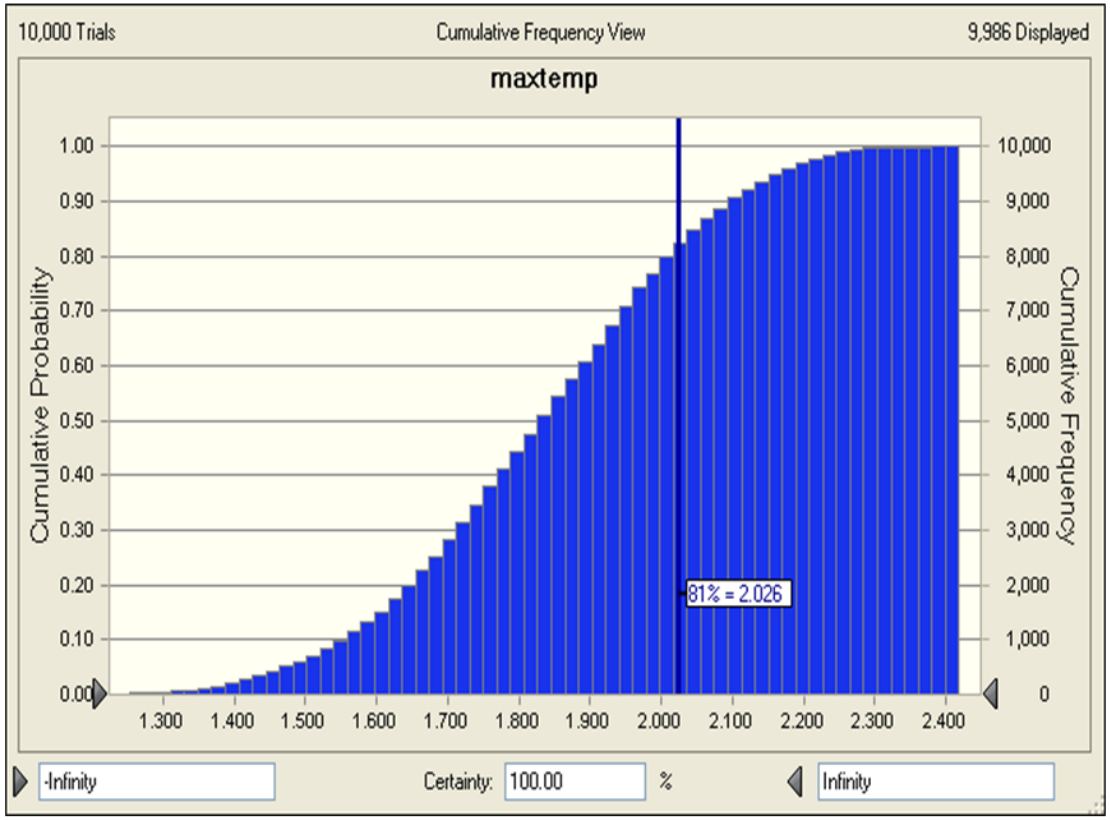



**Figure 3 Cumulative distribution for maximum temperature for min cost risk compliant emissions path for 2.5% discount rate**



# Damage allocation

- Damages depend on previous and future emitters
- Shapley value for allocating damages to periods

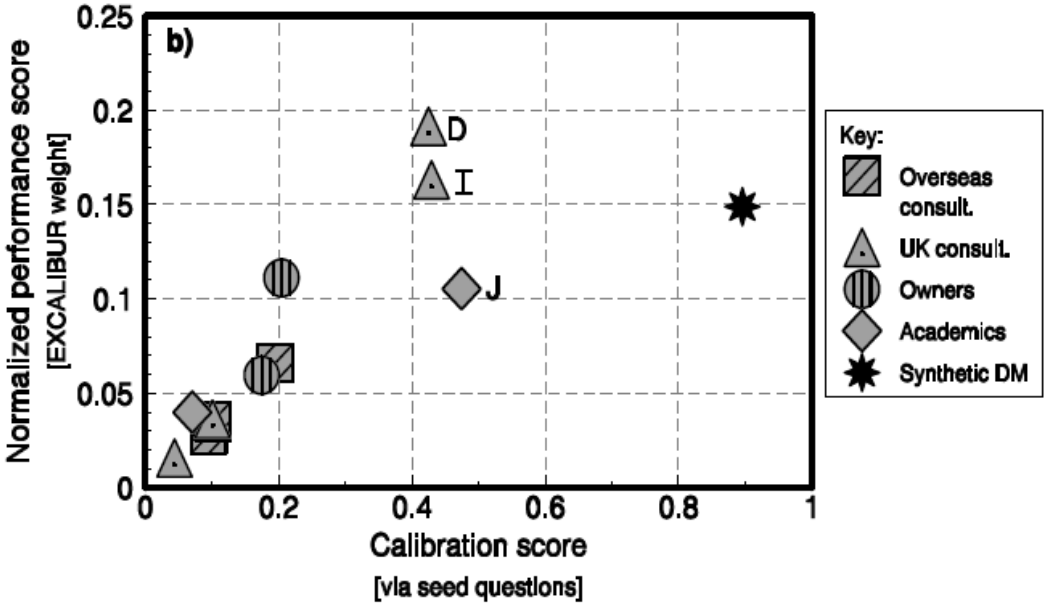
# SCC [2008$/$GtCO_2$]

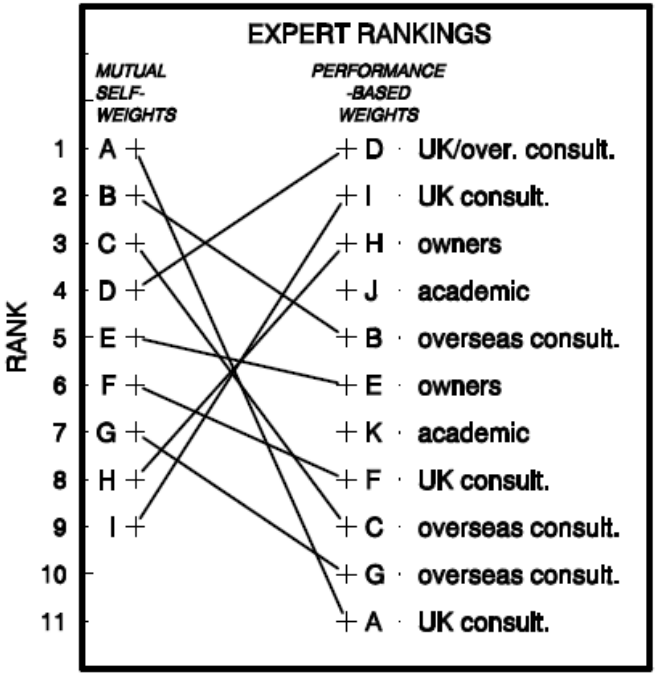
| | | Marginal + Premium | | | marginal damages | | | Risk Premium | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | discount rate | | | discount rate | | | discount rate | | |
| Total Risk compliant | | 0.025 | 0.03 | 0.05 | 0.025 | 0.03 | 0.05 | 0.025 | 0.03 | 0.05 |
| 2015 | Mean | 96 | 66 | 21 | 68 | 48 | 17 | 29 | 17 | 3 |
| 2025 | Mean | 93 | 63 | 18 | 64 | 44 | 14 | 30 | 18 | 4 |
| 2035 | Mean | 89 | 59 | 15 | 59 | 40 | 11 | 30 | 19 | 4 |
| BAU Marginal | | | | | | | | | | |
| 2015 | Mean | 75 | 53 | 19 | | | | | | |
| 2025 | Mean | 70 | 48 | 15 | | | | | | |
| 2035 | Mean | 63 | 43 | 12 | | | | | | |

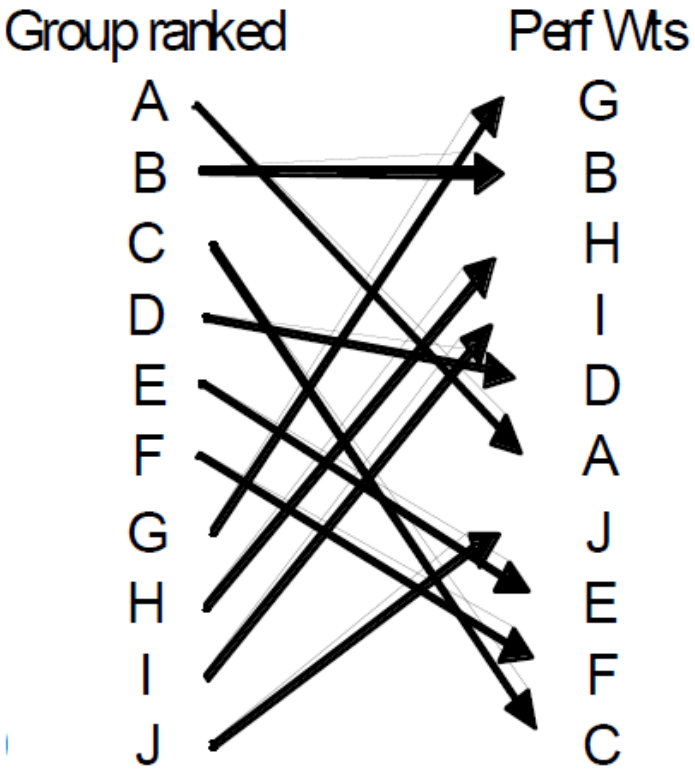
# Thanks Michael

# 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)





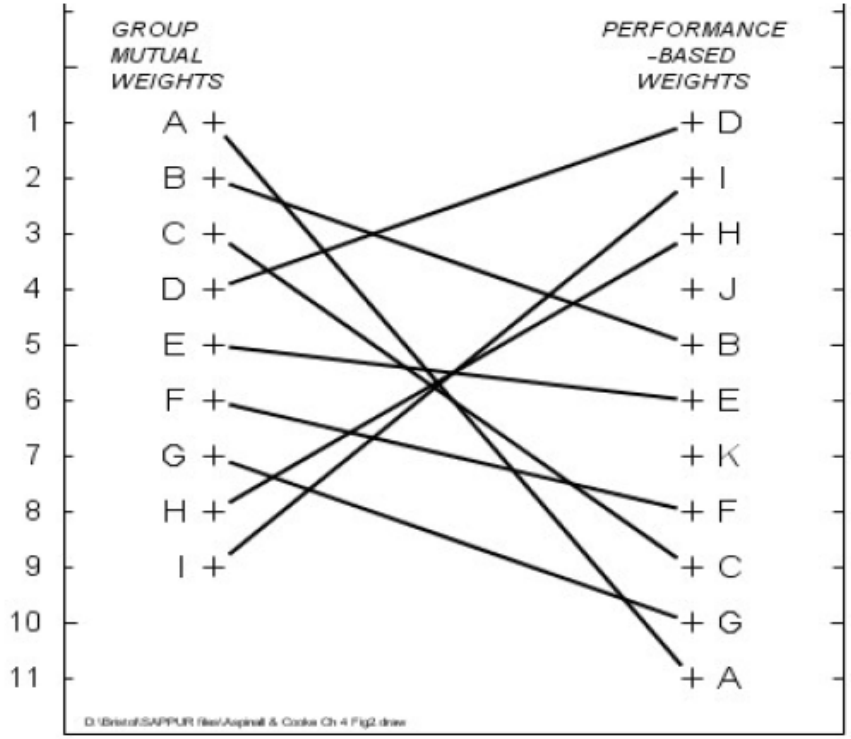
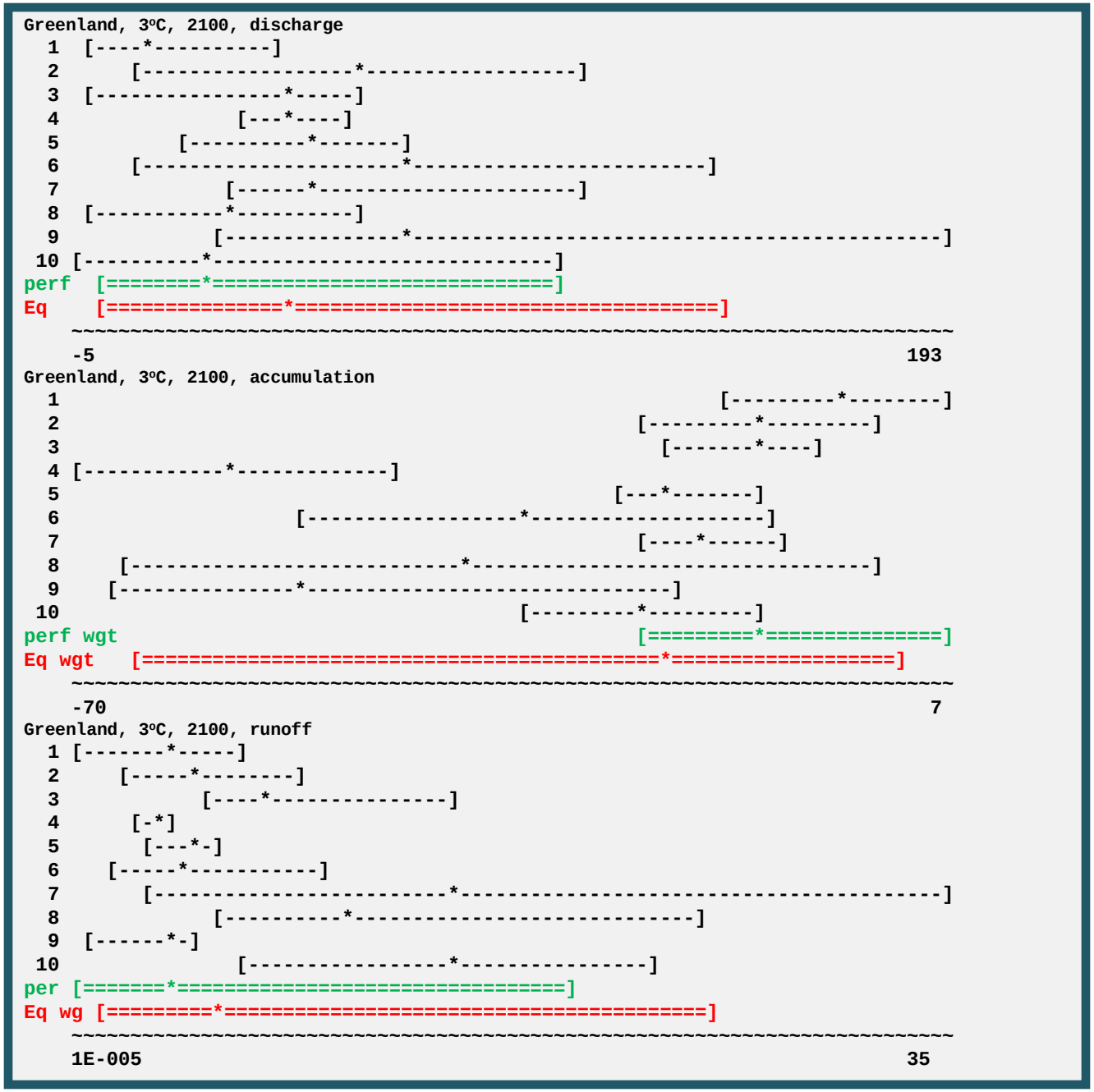
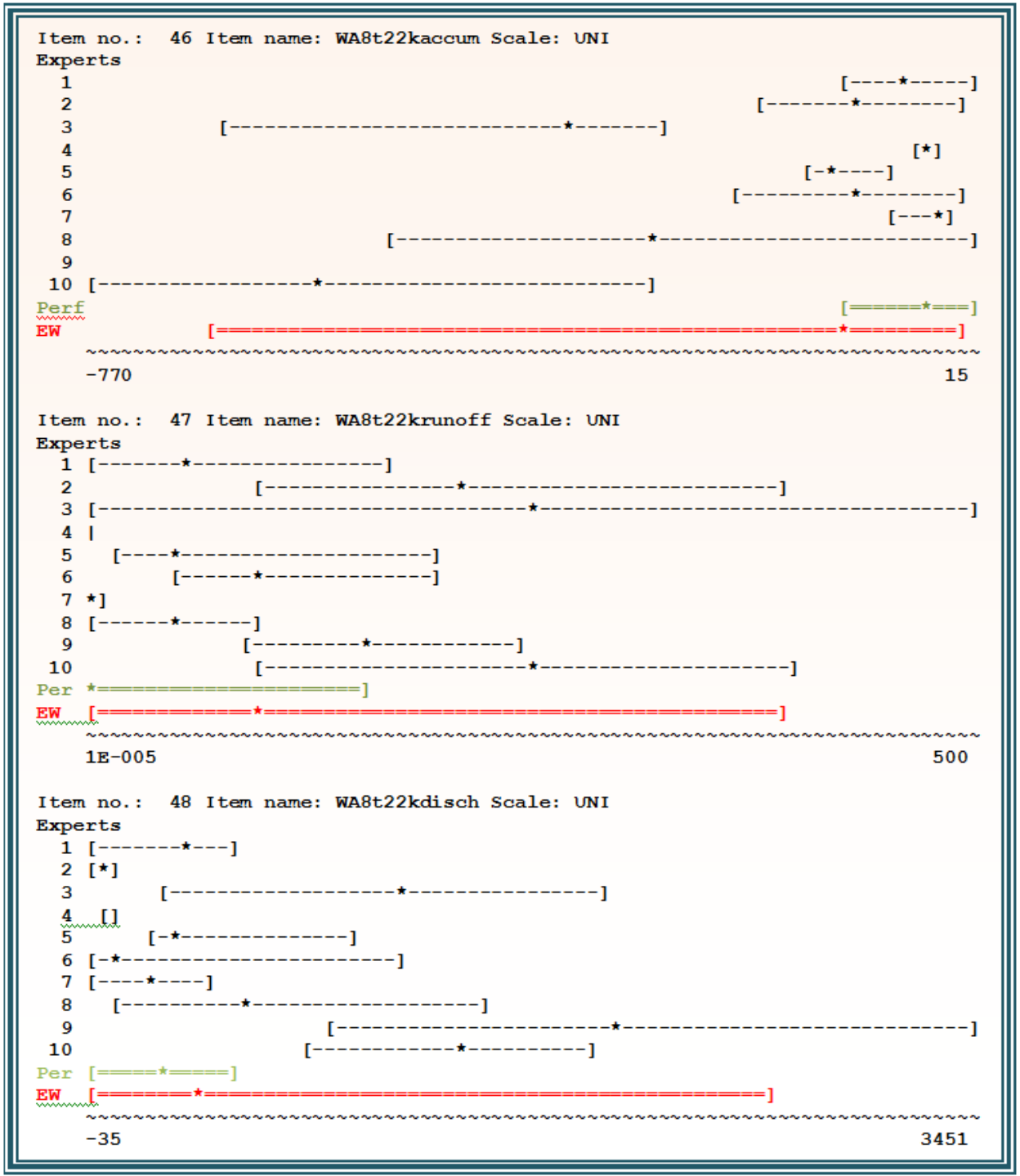




**Figure 3: Expert mutual self-weights and performance ranking, Ice sheets (Nov 2012) left and Dam safety right (Aspinall and Cooke, 2013)**

# Some Variables of Interest; ice sheet elicitation Nov. 2012




Item no.: 46 Item name: WA8t22kaccum Scale: UNI
Experts
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Item no.: 47 Item name: WA8t22krunoff Scale: UNI
Experts
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Item no.: 48 Item name: WA8t22kdisch Scale: UNI
Experts
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