

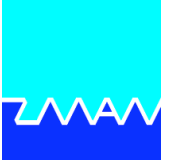
Economic Impacts of THC and WAIS Collapse

Richard S.J. Tol

Hamburg, Vrije & Carnegie

Mellon Universities

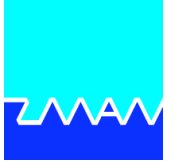




The Economics of Collapse

- Error types
- The thermohaline circulation
- Impact models and extreme scenarios
- The West-Antarctic Ice Sheet:
Model adjustments and results
- The West-Antarctic Ice Sheet:
Political science and adaptation
- Conclusions





Types of Errors

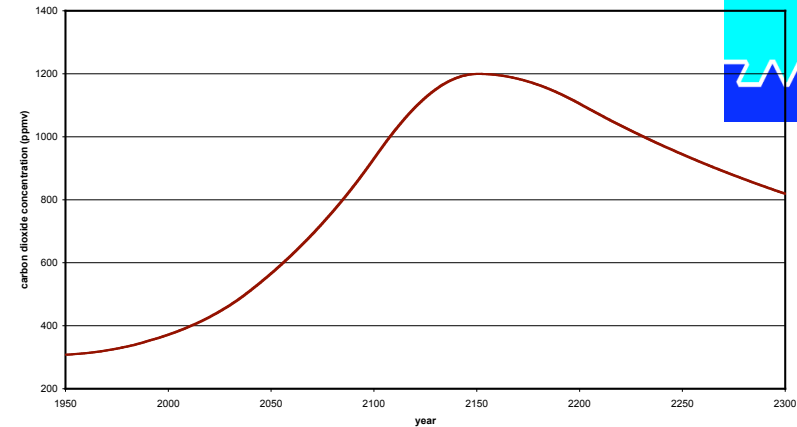
- Type I: Finding something that is not there
- Type II: Not finding something that is there
- It strikes me, that if it comes to stuff like the MOC, the Type II error is what you should worry about - while standard tests minimise the Type I error
- I will argue, however, that the MOC is a Type III error

Type III error: Barking up the wrong tree

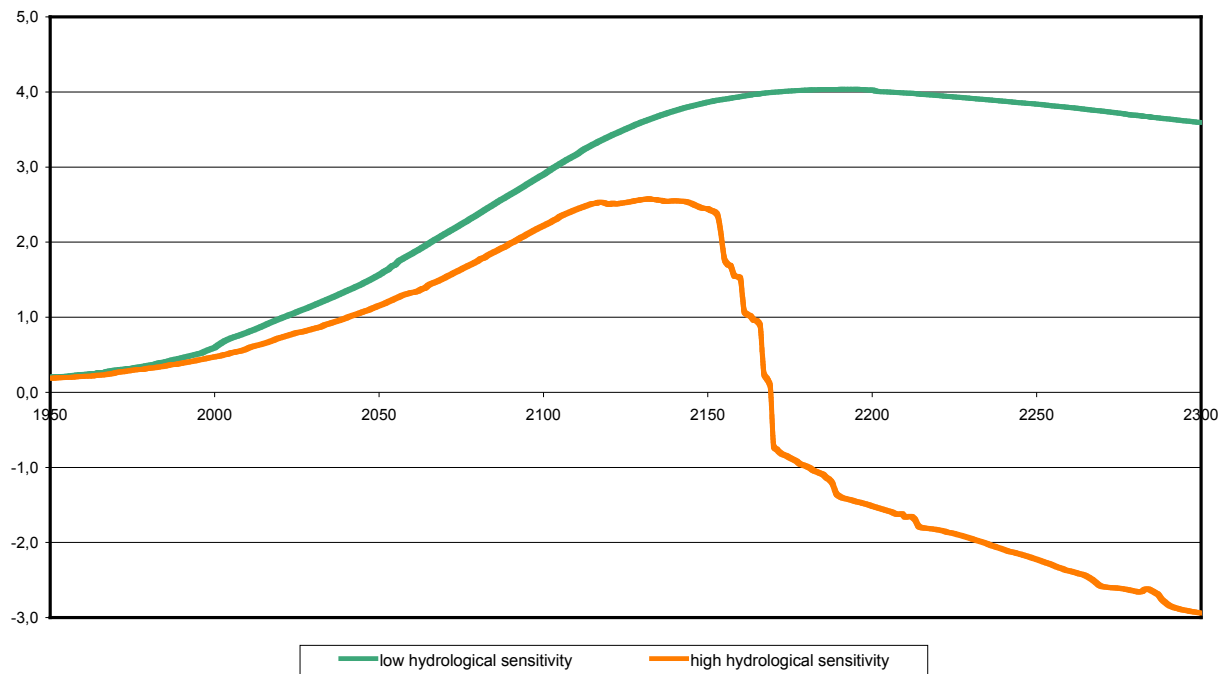




Today, everyone's favourite bogeyman is the collapse of the RND THC

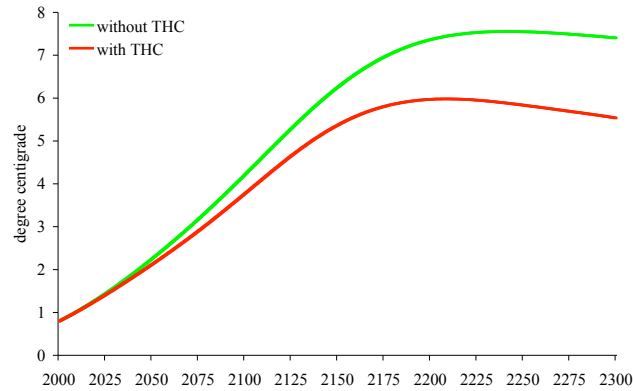
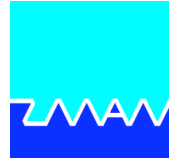


CO2 concentration

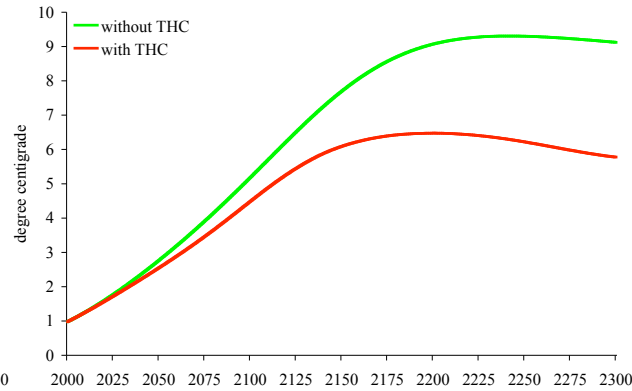


Winter surface air temperature over the North Atlantic Ocean at 56°N (after Rahmstorf & Ganopolski, 1999)

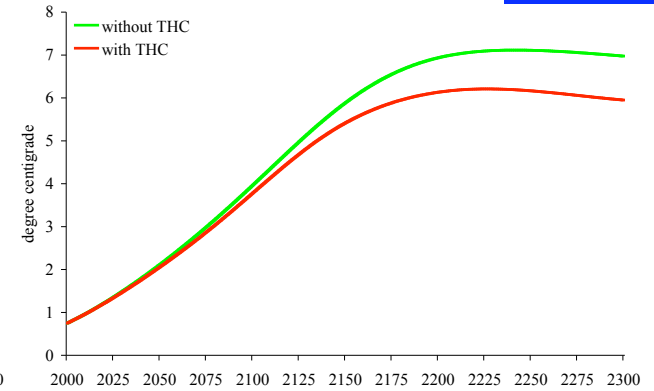




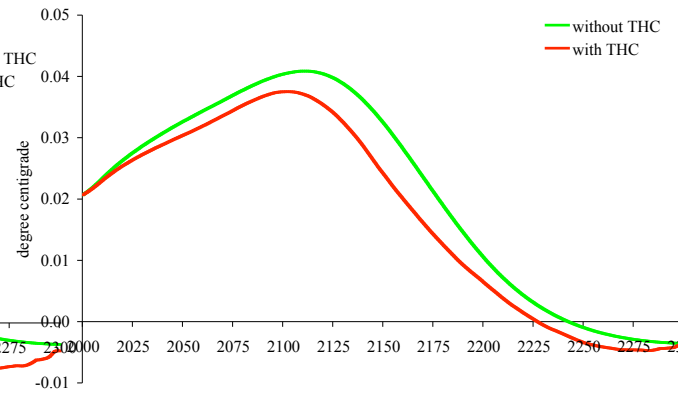
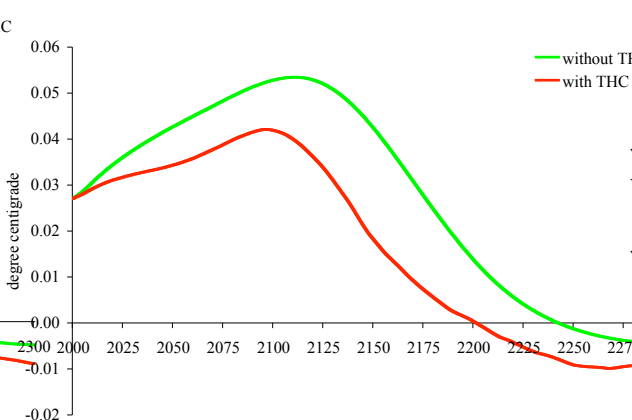
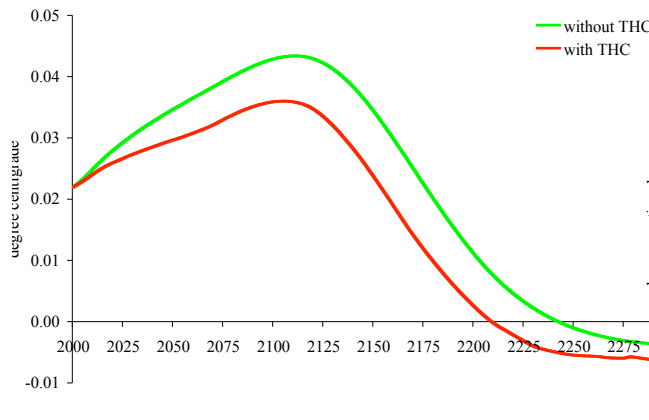
USA



Canada

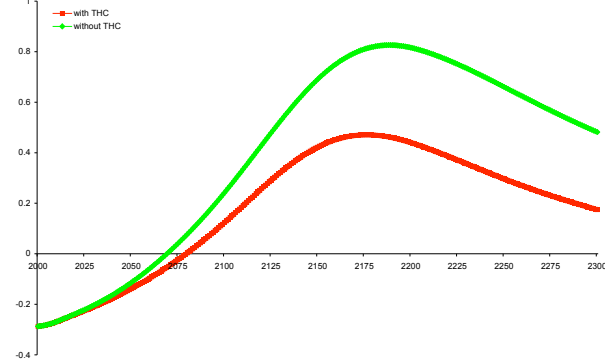


W-Europe

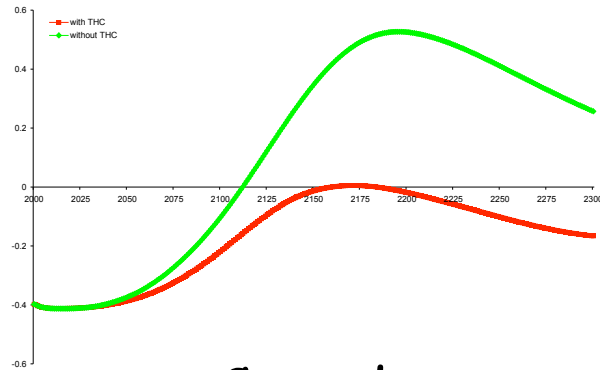


Annual mean surface air temperature over the Atlantic regions of FUND (top) and its rate of change (bottom)

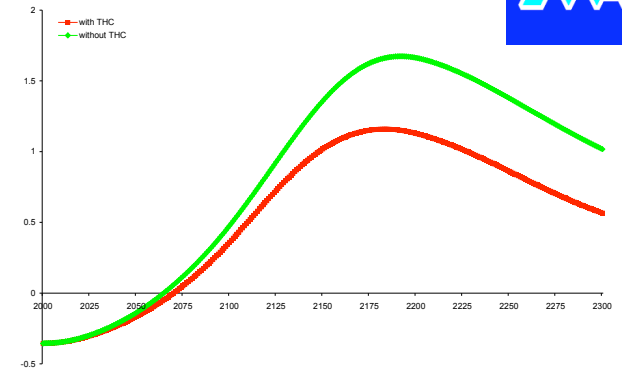




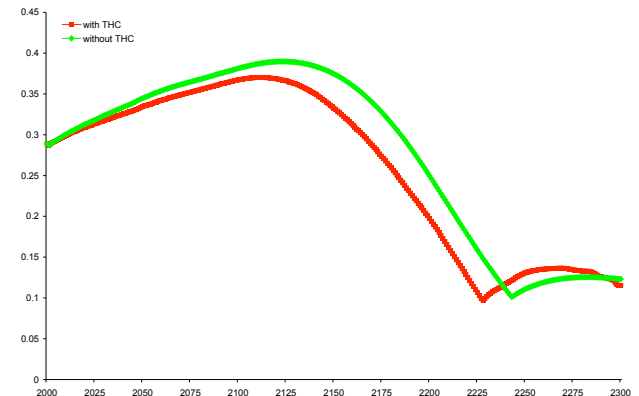
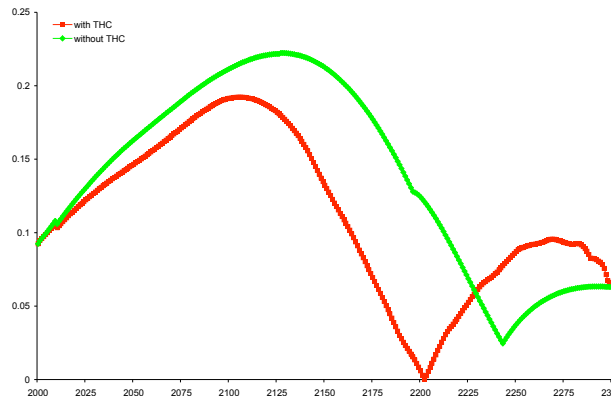
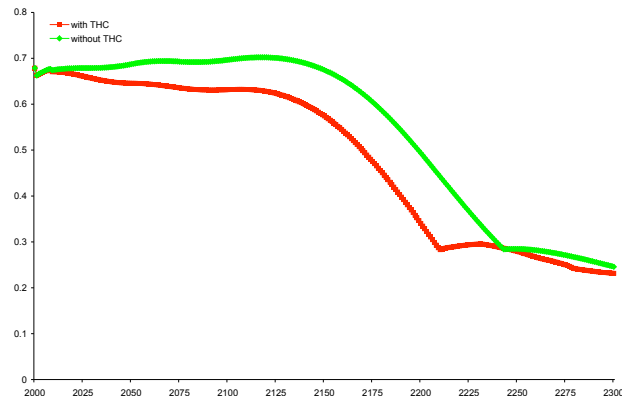
USA



Canada



W-Europe



Annual damage costs (%GDP) of climate change in the Atlantic regions of FUND; top: market; bottom: non-market impacts





Extreme scenarios

Case	\$/tC
Base	18
THC	17
Younger Dryas	20
2689 MT CH ₄	23
8667 MT CH ₄	30
4.5	101
7.7	269
9.3	359

The marginal damage cost of CO₂ emissions is an indicator for the seriousness of climate change. It gives the optimal carbon tax, the willingness to pay for emission reduction. these numbers are for the FUND scenario, GreenBook discounting.





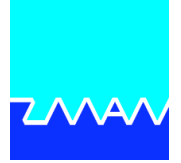
Caveats

- The above study should be repeated at a higher resolution: Iceland, Ireland, Norway may well have cooling, as may the North-American Atlantic seaboard
- Fisheries have been omitted
- Sea level rise has been omitted
- But this would refine the conclusions, probably not change them
- (And then there are all the usual caveats about estimating the economic impacts of climate change ...)



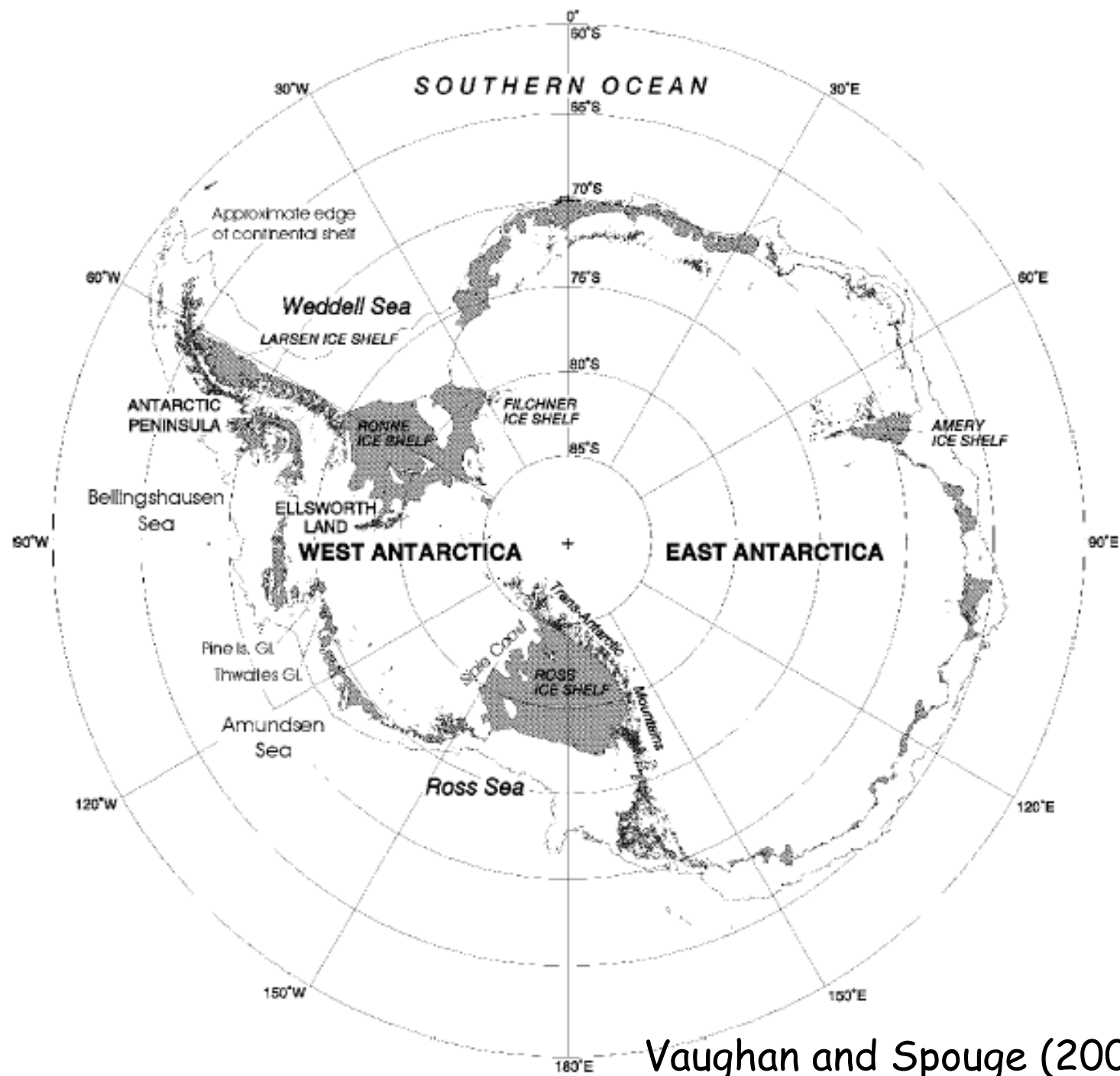


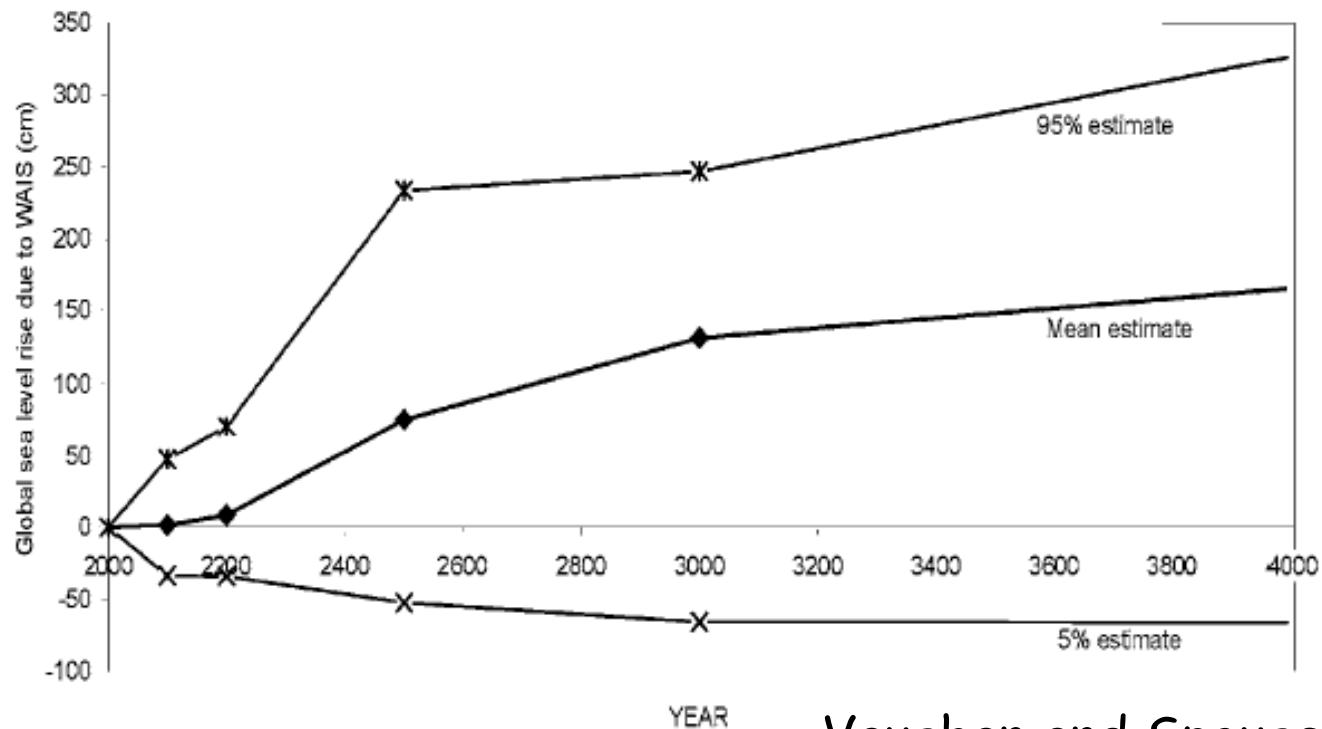
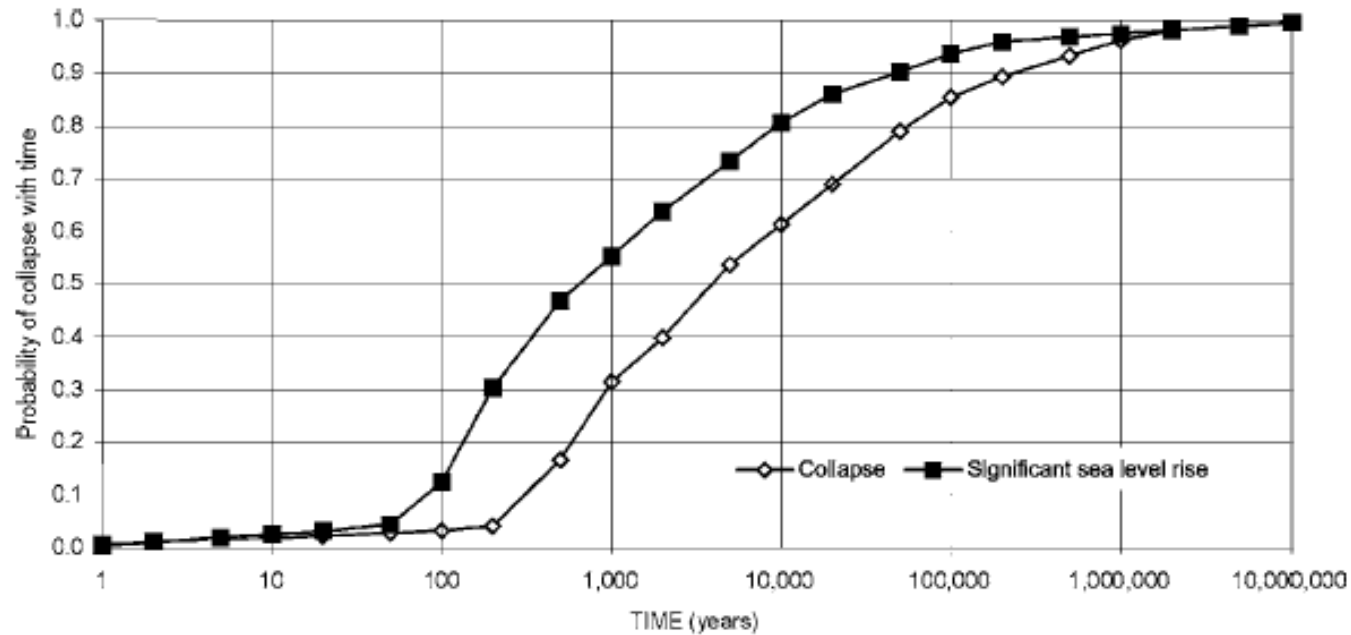
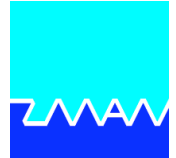
WAIS



- The West-Antarctic Ice Sheet contains about 10% of all Antarctic ice, equivalent to 5-6 metre of sea level (displacement)
- Marine ice sheet, resting on land below sea level
- Precipitation and melting / calving maintain the balance; perhaps buttressed by Ronne and Ross ice shelves
- Increased precipitation could increase pressure, reduce resistance; ice shelves may disintegrate, and the entire WAIS would slide into sea

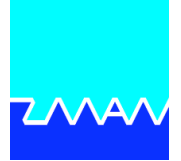






Vaughan and Spouge (2002)

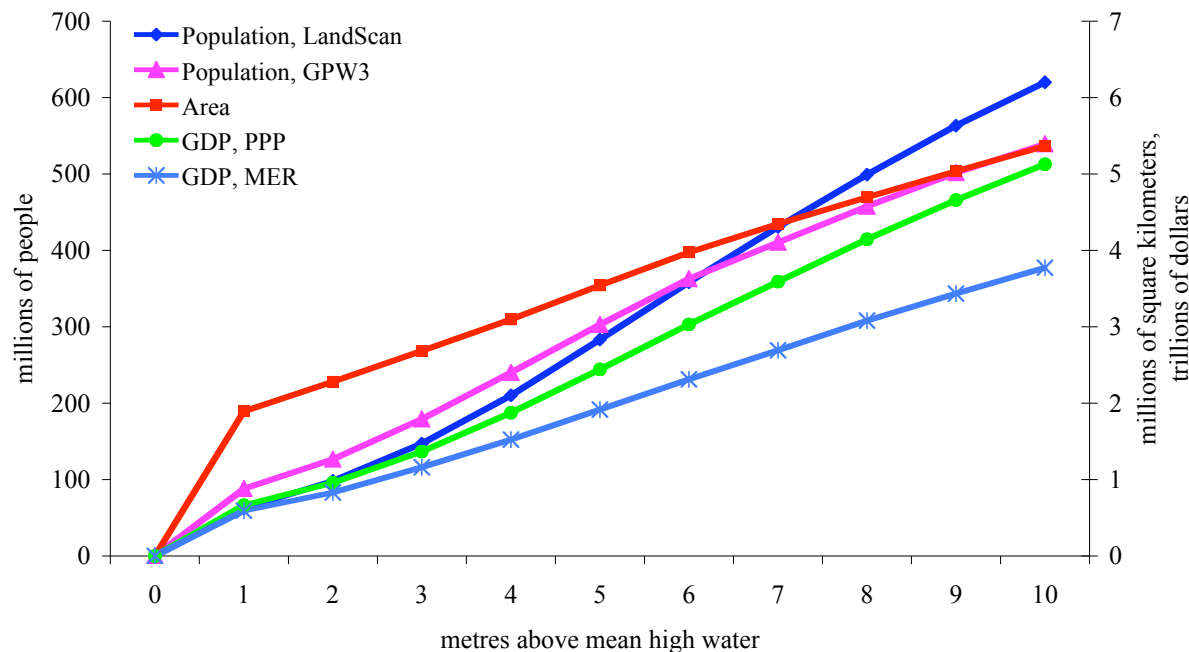




Impact Methods

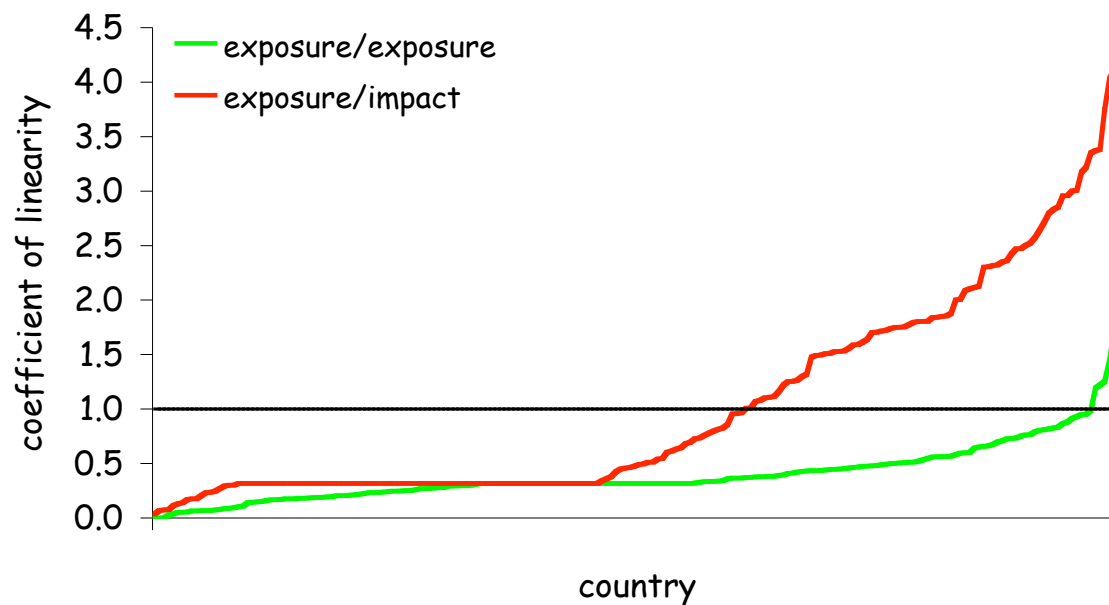
- The above analysis is straightforward: the "extreme" scenario is not that extreme, and the scenario is within the valid domain of the impact model (or at least not more outside than a standard climate scenario)
- This is not true for really extreme scenarios, such as a collapse of the West-Antarctic Ice Sheet
- Current sea level rise impact models work up to 1 metre / 1 metre per century; higher / faster sea level rise violates the data to which the model is calibrated

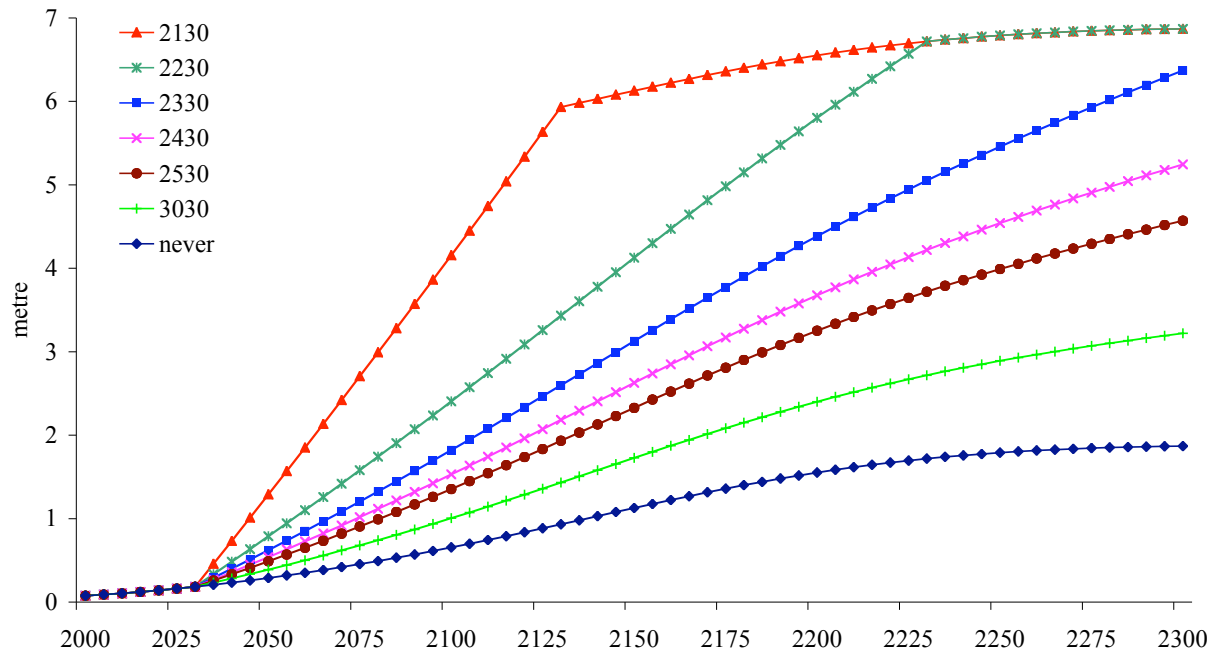




Exposure is more or less linear in elevation, except for land, which is less than linear.

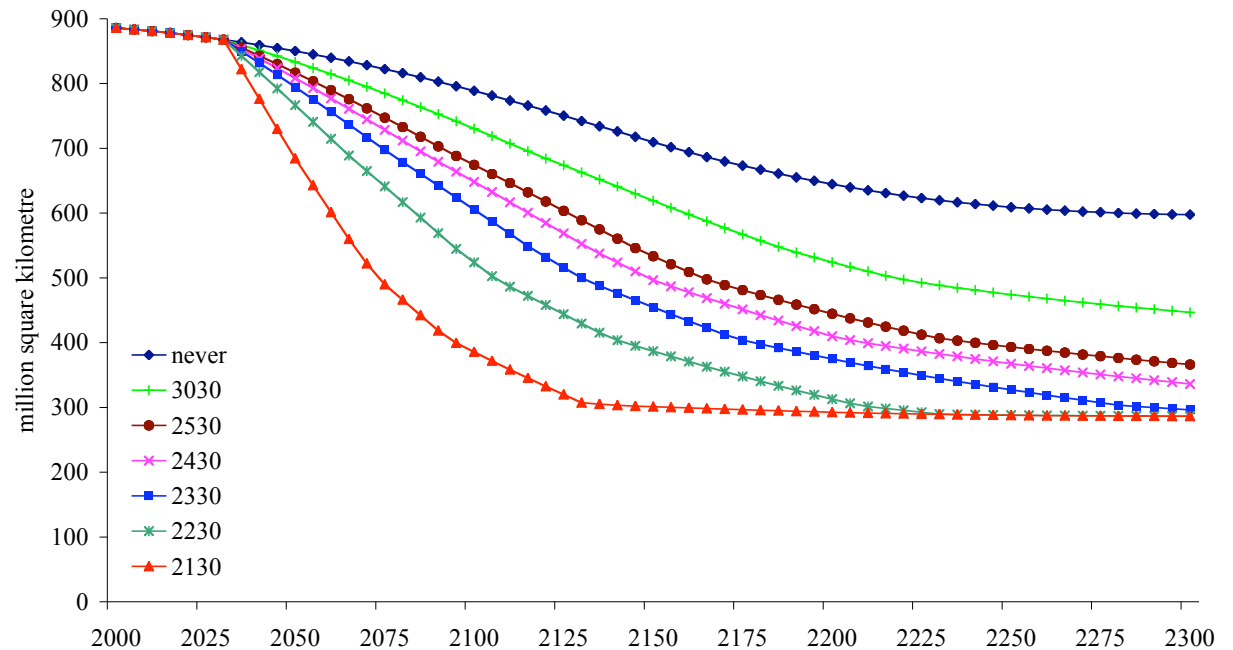
Less than linear, but only at the global level.

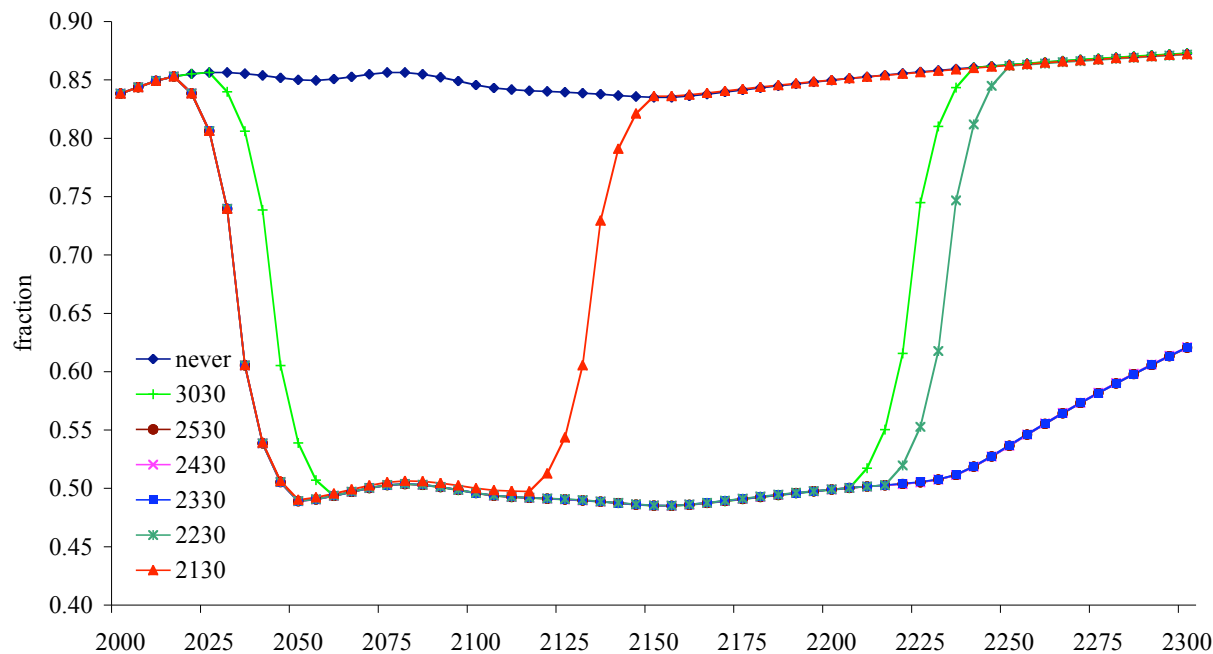




Hypothetical scenarios of sea level rise and WAIS collapse.

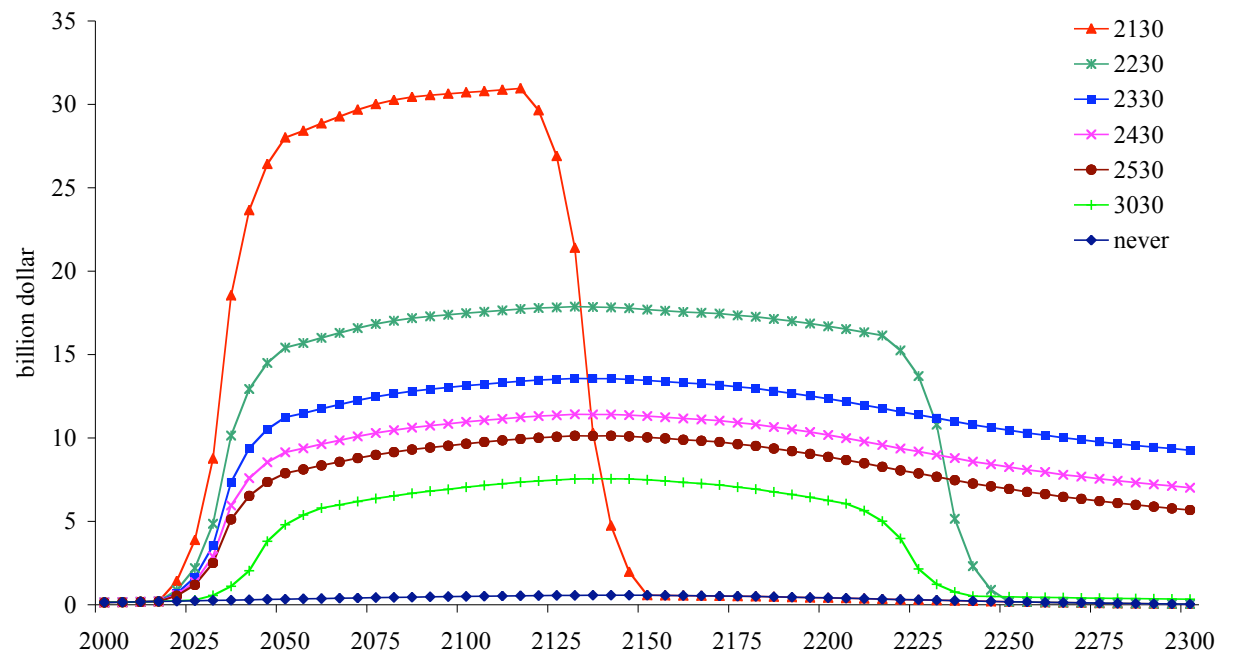
Standard sea level rise would destroy one-third of coastal wetlands, WAIS collapse would add another third.

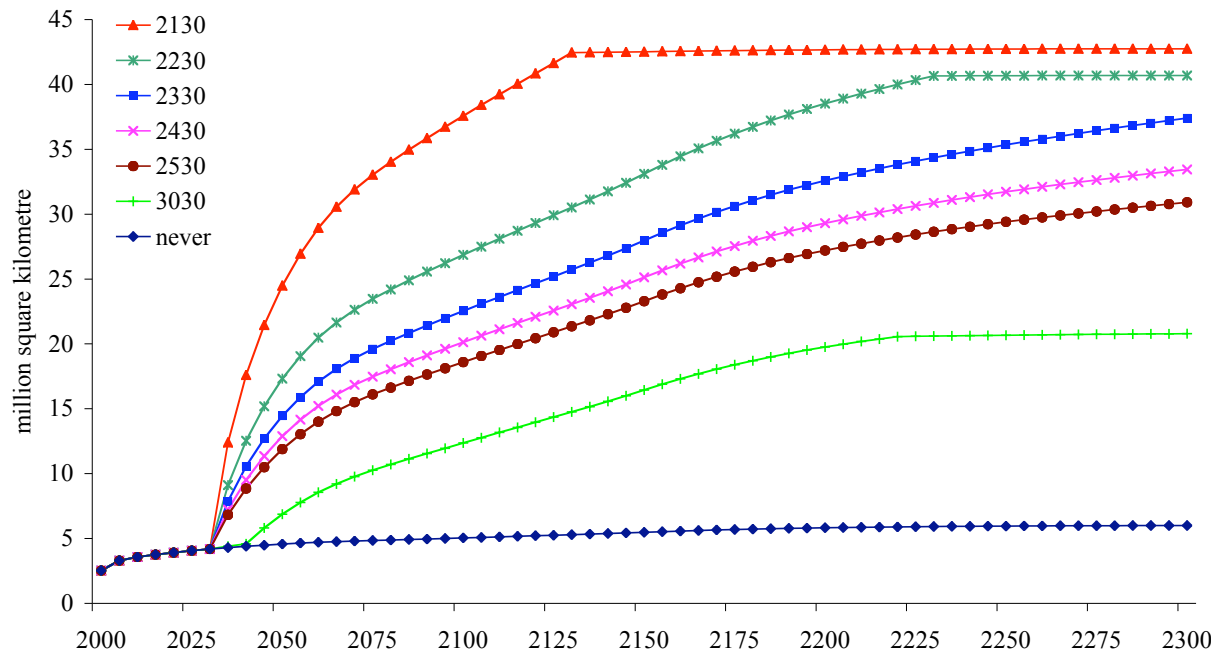




Extreme sea level rise would make coastal protection uneconomic in many places.

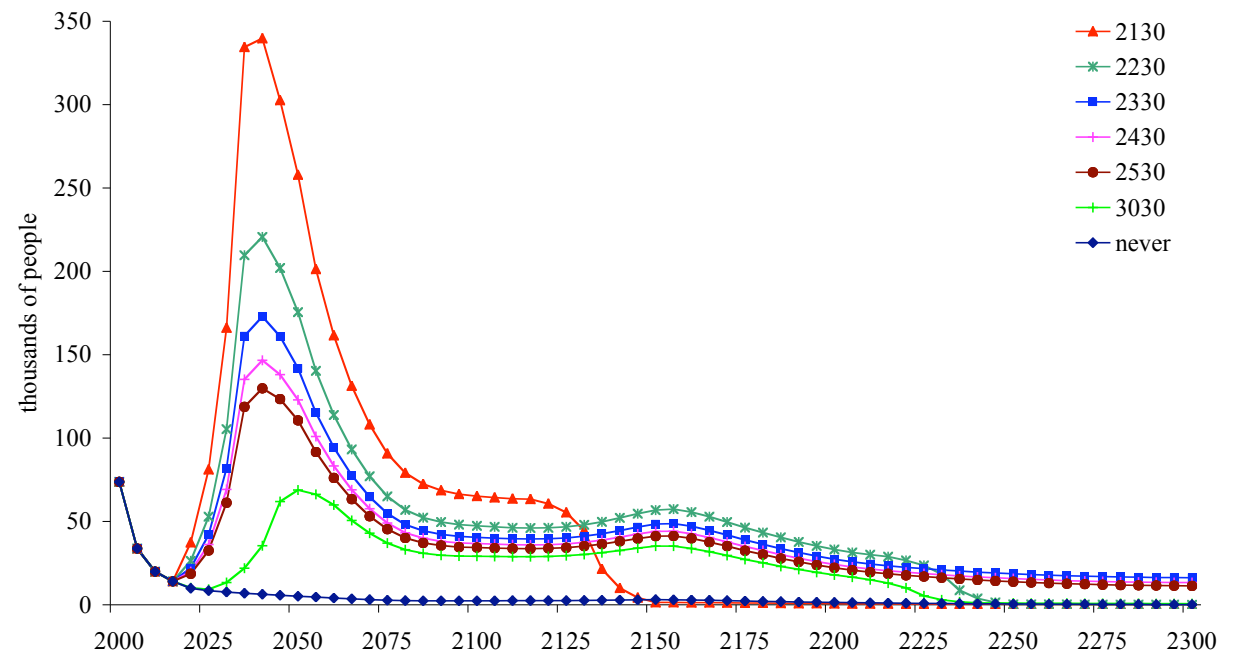
In other places, coastal protection costs would soar.





Extreme sea level rise and reduced protection would increase land loss by up to an order of magnitude.

Forced migration would be counted by the hundreds of thousands per year.

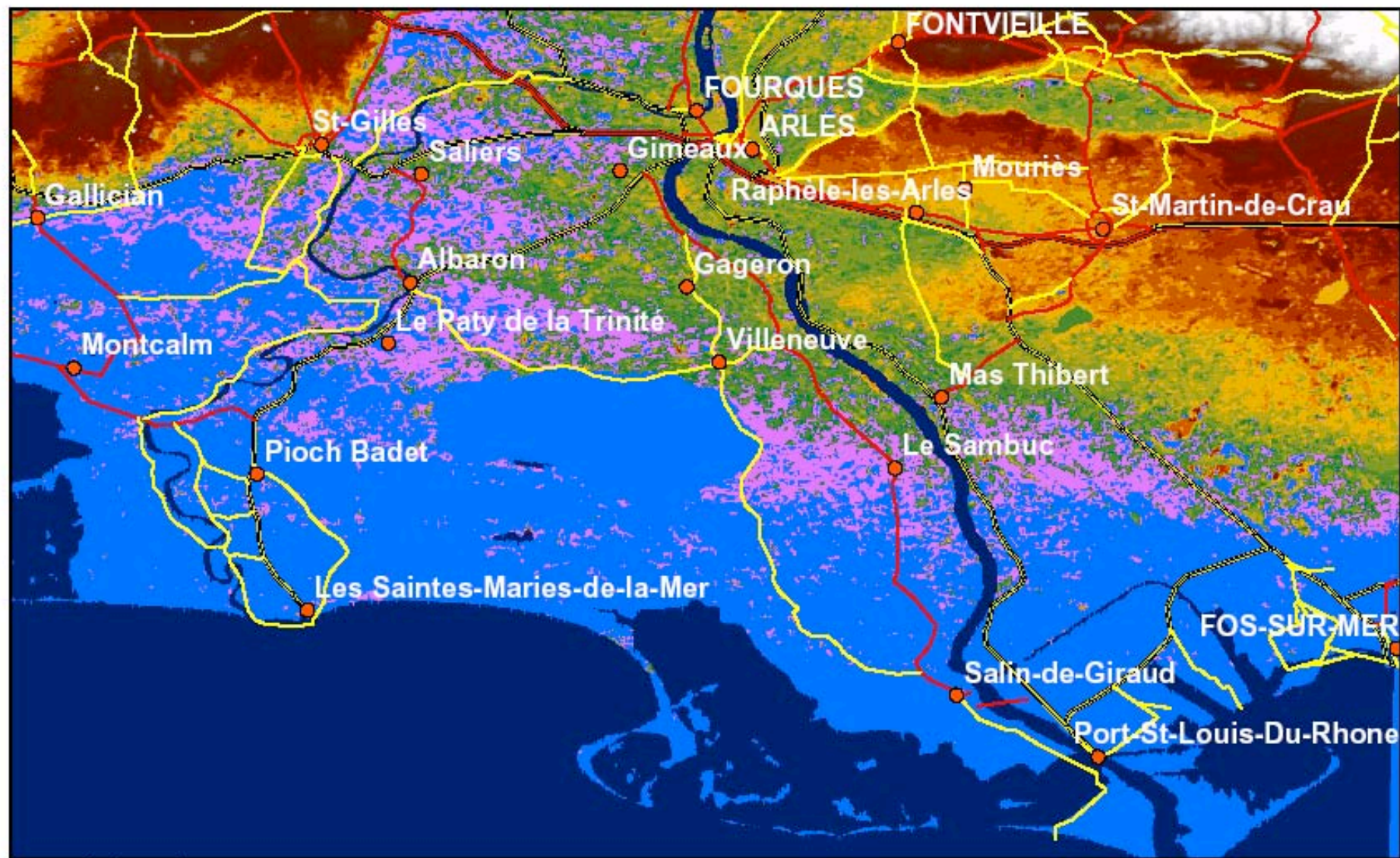




Adaptation

- In the model study, coastal protection fell, but not below 50% (if we push the parameters, this can be 30%)
- Coastal protection in the model is based on a cost-benefit analysis; not so in reality
- Three case studies looked at adaptation in more detail, on the basis of interviews and policy exercises with stakeholders and experts - in an attempt to write "future histories" of a WAIS collapse





Légende

- Mer
- Zones submergées à +1m
- Zones submergées à +5 m
- Autoroutier
- Liaisons principales
- Liaisons régionales
- Liaisons locales

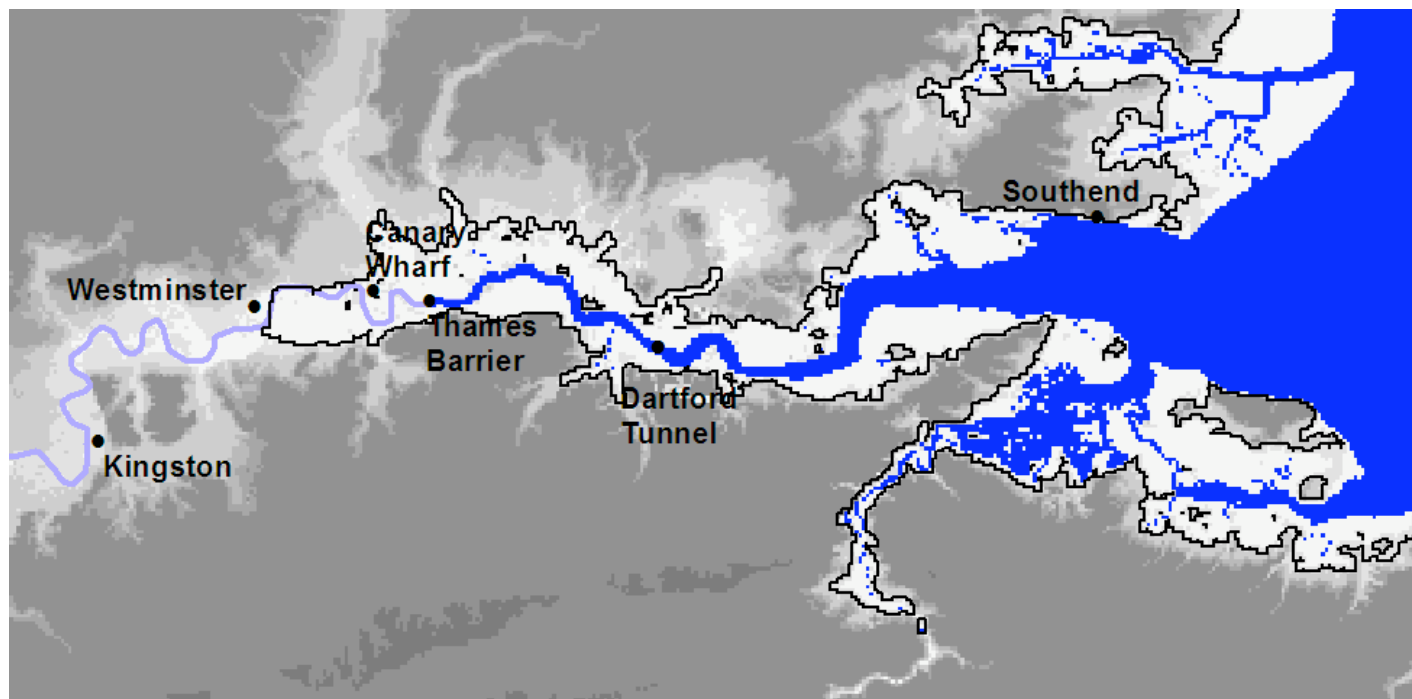
Camargue, 2130: Submersion après une élévation de 5 m du niveau de la mer

0 2 4 8 12 16 Km

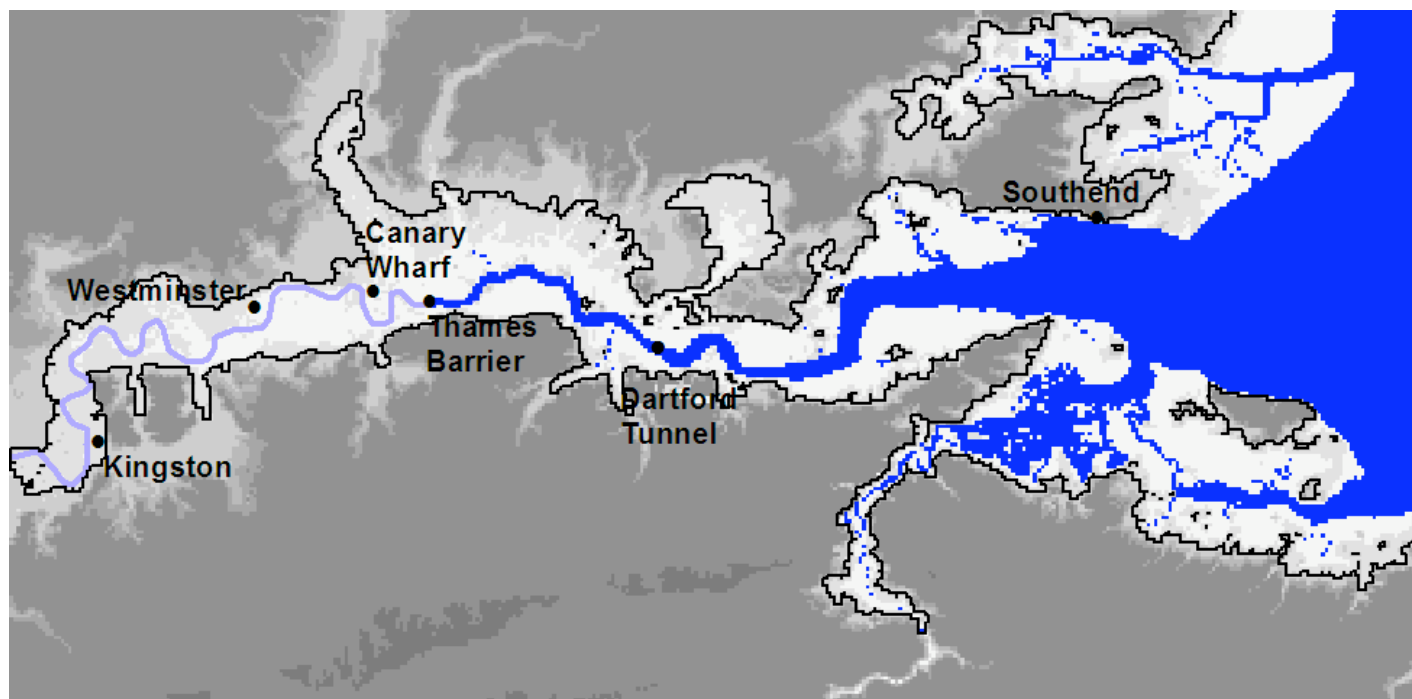


fhr
FLOODING HAZARD RISK

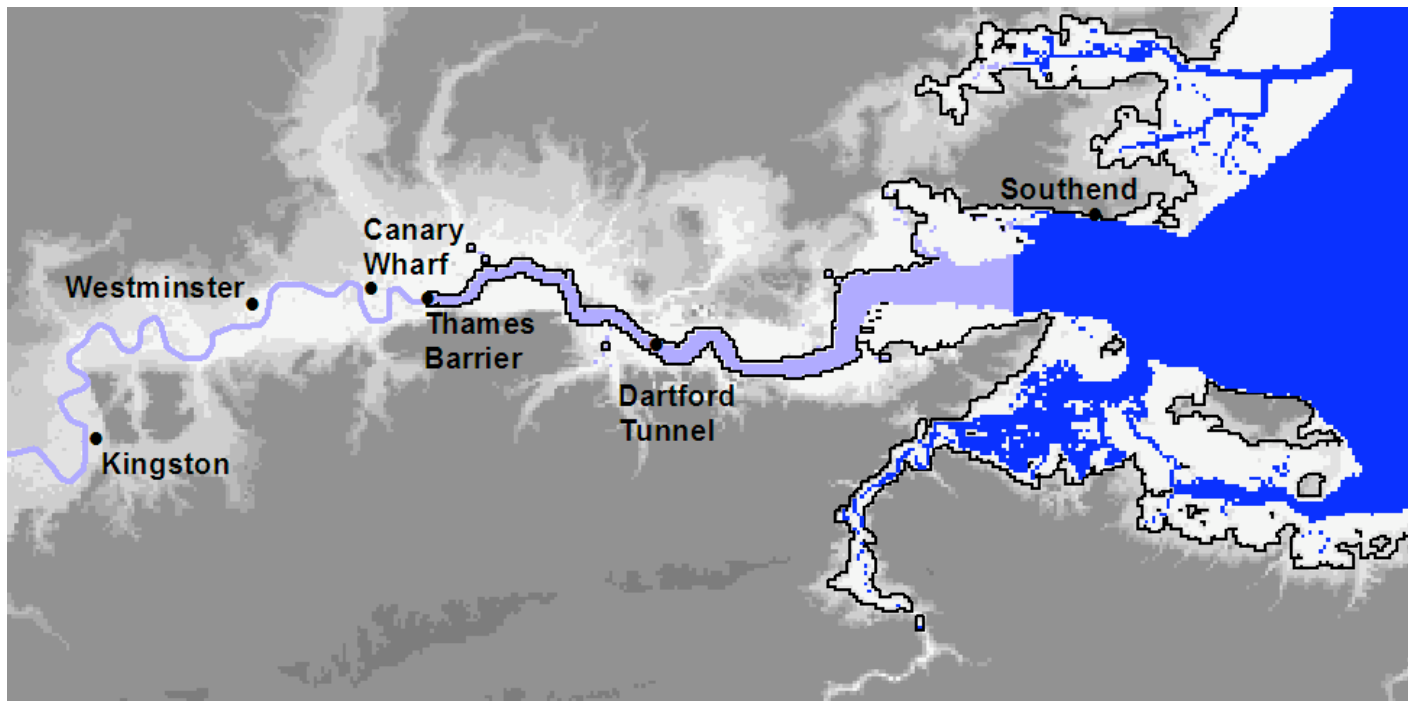




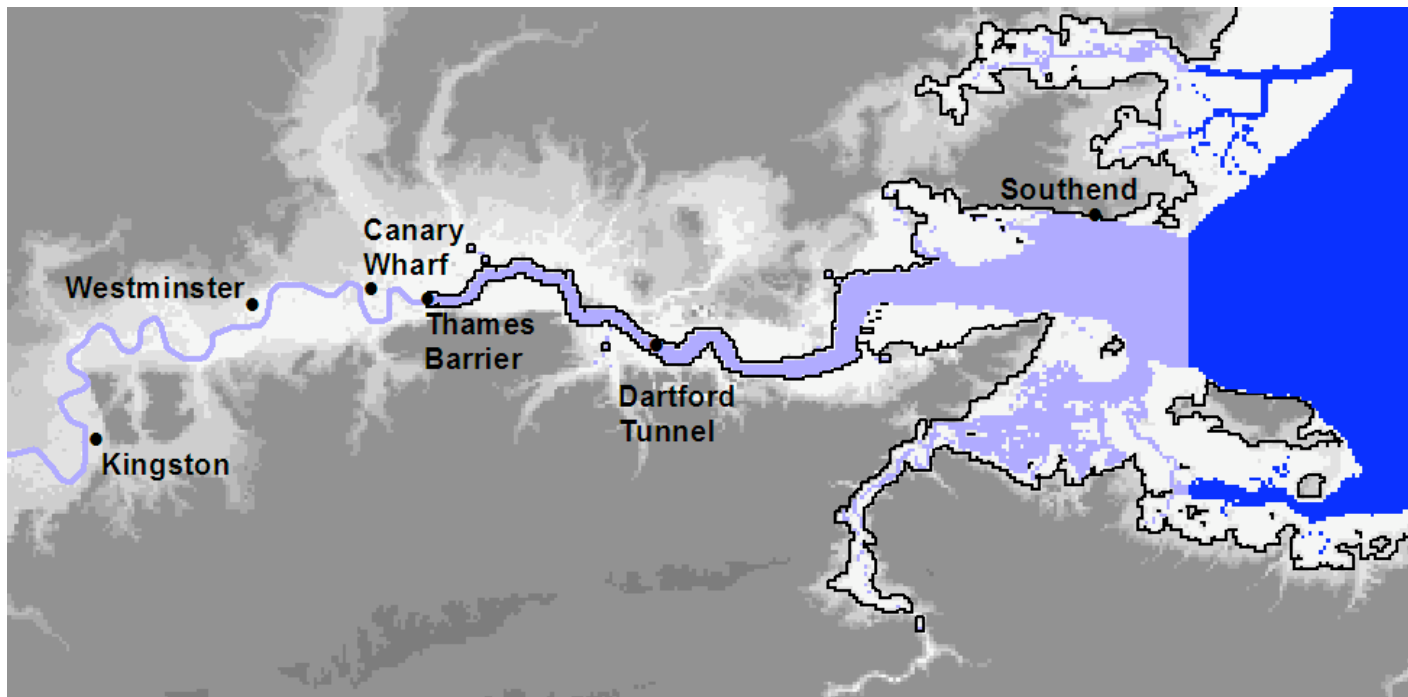
1/1000 flood,
1 m SLR



1/1000 flood,
5 m SLR



1/1000 flood,
Canvey Island
Barrier,
1 m SLR



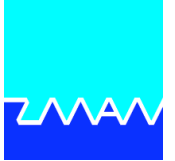
1/1000 flood,
Sheppey
Barrier
1 m SLR



The Netherlands

- In Europe, the Netherlands is most vulnerable to sea level rise
- Technically, it is possible to protect against a 5-6 m sea level rise
- It would be costly; if this were to happen in a century, annual costs would amount to 3-4% of GDP (assuming no economic growth), more than an order of magnitude higher than today
- The real issue is politics, however

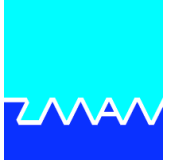




The Netherlands -2

- Major, expensive infrastructure is likely to lead to endless bickering - between political parties, high and low, north and west ...
- This would delay dike building, until the first dike is breached
- By then, time has shortened and costs gone up; people and companies will have lost faith in flood safety and move elsewhere
- It less worthwhile yet more costly to protect





Methodology

- This conclusion was drawn by a group of experts and stakeholders, in two rounds of individual interviews and a policy exercise
- At first, protection and retreat were about equally represented, but at the end retreat was the unanimous best guess
- This is independent of the background scenario
- The same conclusion (substance, shift in opinion) was found in London, Camargue Soft, yes, but can you do it harder?





Conclusions

- A thermohaline circulation collapse may not be that bad
- In a model study, a WAIS collapse had pretty serious impacts
- One can question models as to their validity for non-marginal change; and their assumptions on adaptation
- In three case studies, a WAIS collapse had dramatic impacts in Europe; extrapolation suggests worse elsewhere



We'd better look at this issue in more detail, and try to avoid it while so uncertain

