The challenge of communicating advances in and applications of stochastic modeling in the natural sciences

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Banff, 14 July 2017

Joint with P Guttorp, K de Bruin, M Drews and P S Kaspersen

I don't know, are you sure you want to do this?

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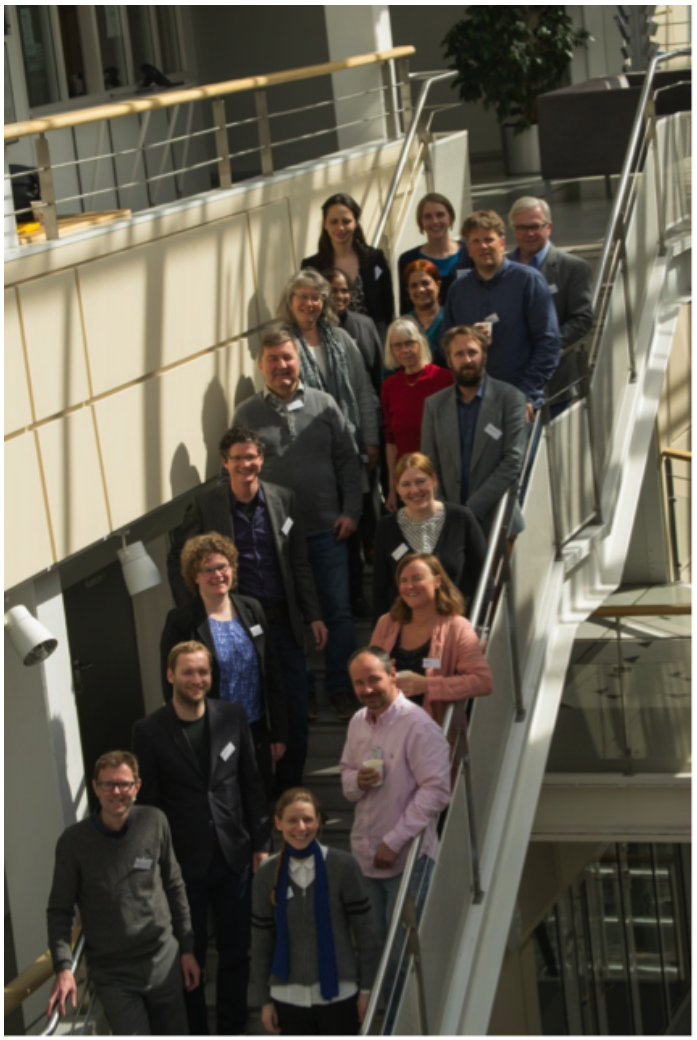
Project: "Statistical Analysis of Climate Projections" funded by NordForsk

Workshop in April 2016: Practical and methodological challenges of climate change adaptation

- Researchers
  - Statisticians
  - Climate scientists
  - Environmental economists
- Climate service providers
- Practitioners
  - Norwegian Environment Agency
  - Norwegian Natural Perils Pool
  - Finance Norway
  - City of Oslo



Identifying challenges

At the end of the two-day workshop, the participants were asked to (anonymously) identify **practical** and **methodological** challenges of

- **adaptation**
- **uncertainty**
- **visualization**

T & de Bruin (2016): Challenges of climate change adaptation, Eos, 97.
De Bruin & T (2016): Workshop report (NR report no. SAMBA/32/16).

Communication challenges

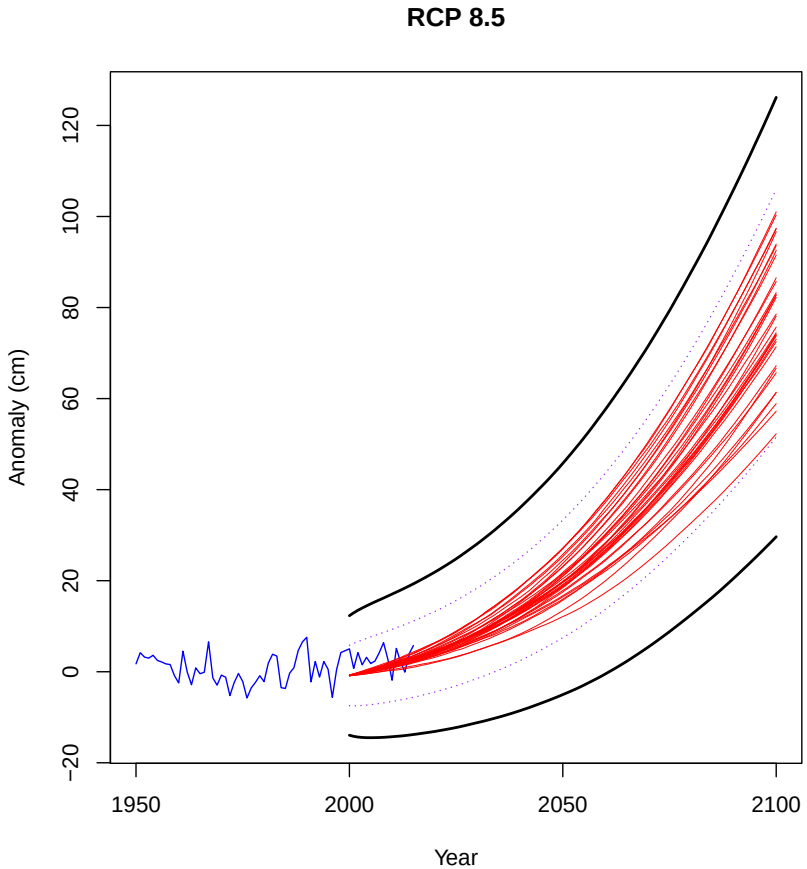
- Common understanding and language
- Transparency between scientists from different disciplines, decision makers, other practitioners, stakeholders and the general public
- Storytelling and narrative style

  Hillier, Kelly & Klinger (2016): Narrative Style Influences Citation Frequency in Climate Change Science. *PLoS ONE* 11(12): e0167983.
- Exposure and presentation of uncertainty; how to choose the correct/appropriate uncertainty information to present?

Other practical & methodological challenges

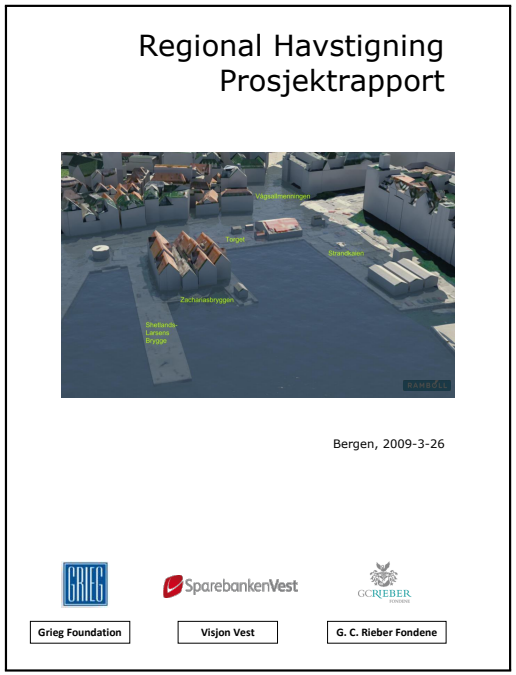
- Open access data that is easy to find, in particular, information on the costs and (co-)benefits of adaptation options
- "Light touch" decision tools
- Joint modeling of uncertainty arising from climate projections, impacts and benefits
- Visualization tools for decision making and adaptation options which are user-specific and simple without disguising uncertainty

Sea level will rise in Bergen on Norway's west coast



Previous project investigated the feasibility, consequences and costs of several adaptation options

1. **Outer barrier**
   - $>$ 30 billion NOK
   - Large environmental and economic consequences
2. **Inner barrier at Vågen**
   - 500 million NOK
   - Limited benefits
3. **Inner barrier at Damgårdssundet**
   - 500 million NOK
   - Limited benefits



Our questions

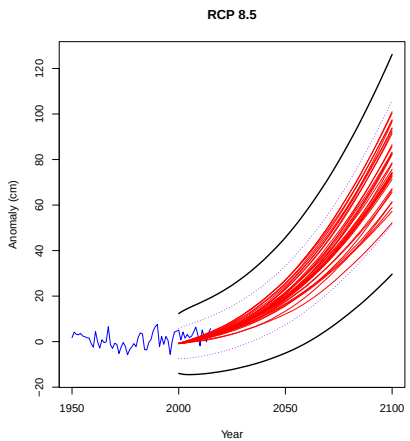
- Are these adaptation options appealing from a cost/benefit perspective?
- If we should adapt, when would be the best time?
- What are the effects of the associated uncertainties on the cost/benefit analysis?
  - Sea level rise is uncertain
  - Total yearly damage in each year is uncertain
  - Change in the total yearly damage due to sea level rise is uncertain

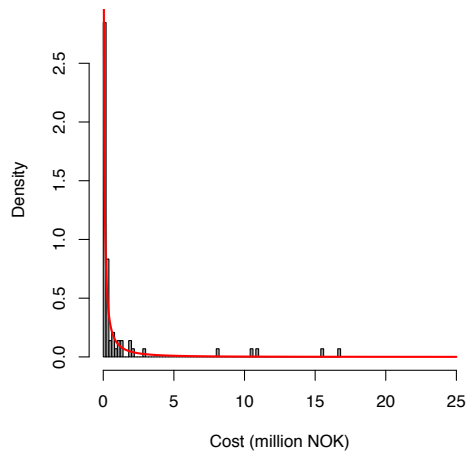
`https://github.com/eSACP/SeaLevelDecisions`

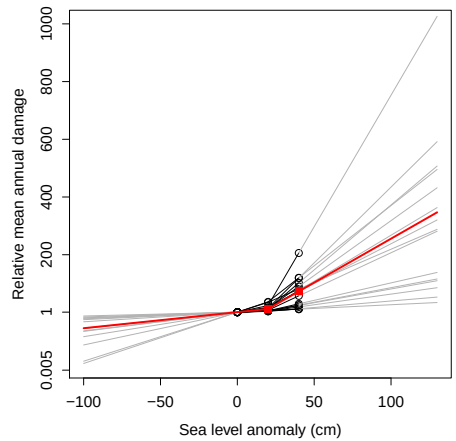
Light touch decision framework

We combine

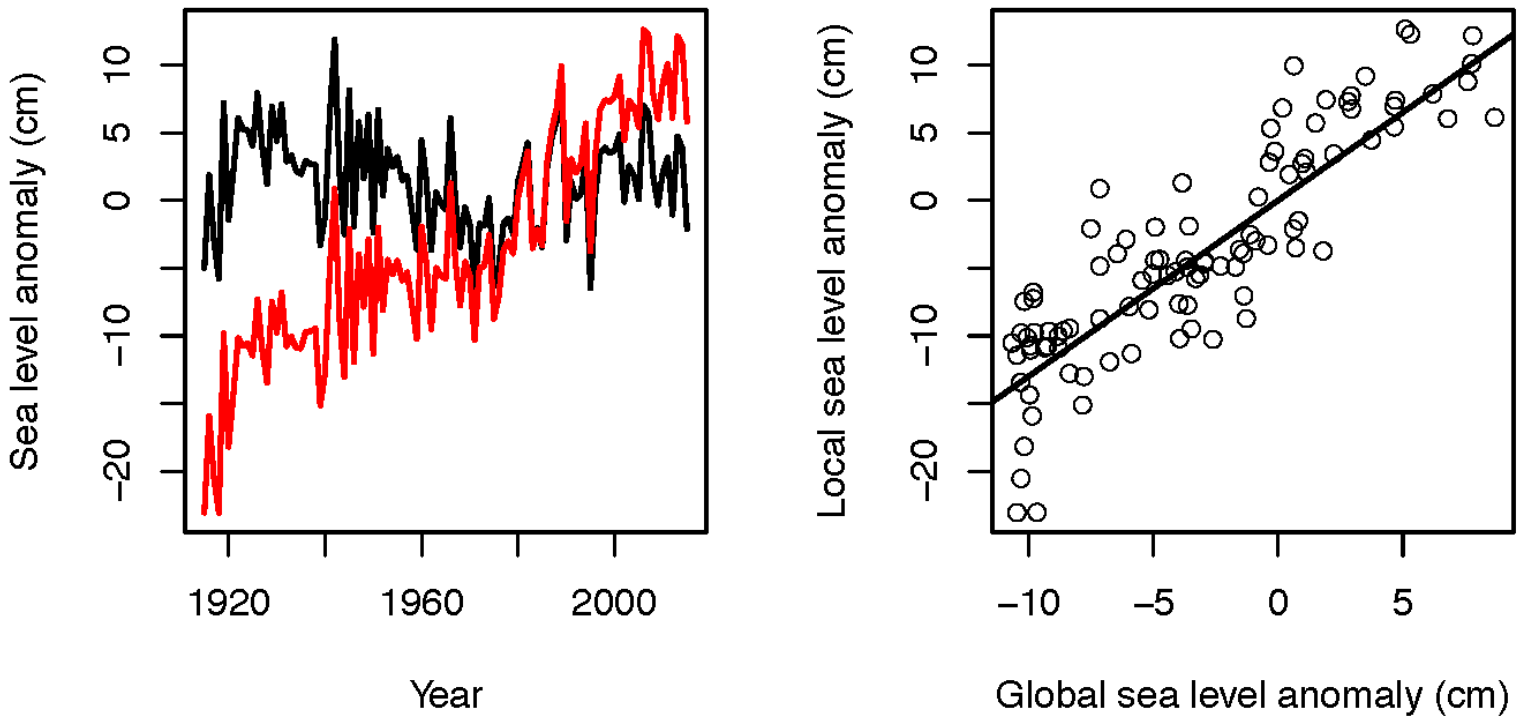
- Probabilistic local sea level projections
- Random damage costs drawn from a distribution estimated from historical data
- Probabilistic projections of change in damage costs due to sea level rise
- Adaptation in form of two inner barriers, or no adaptation





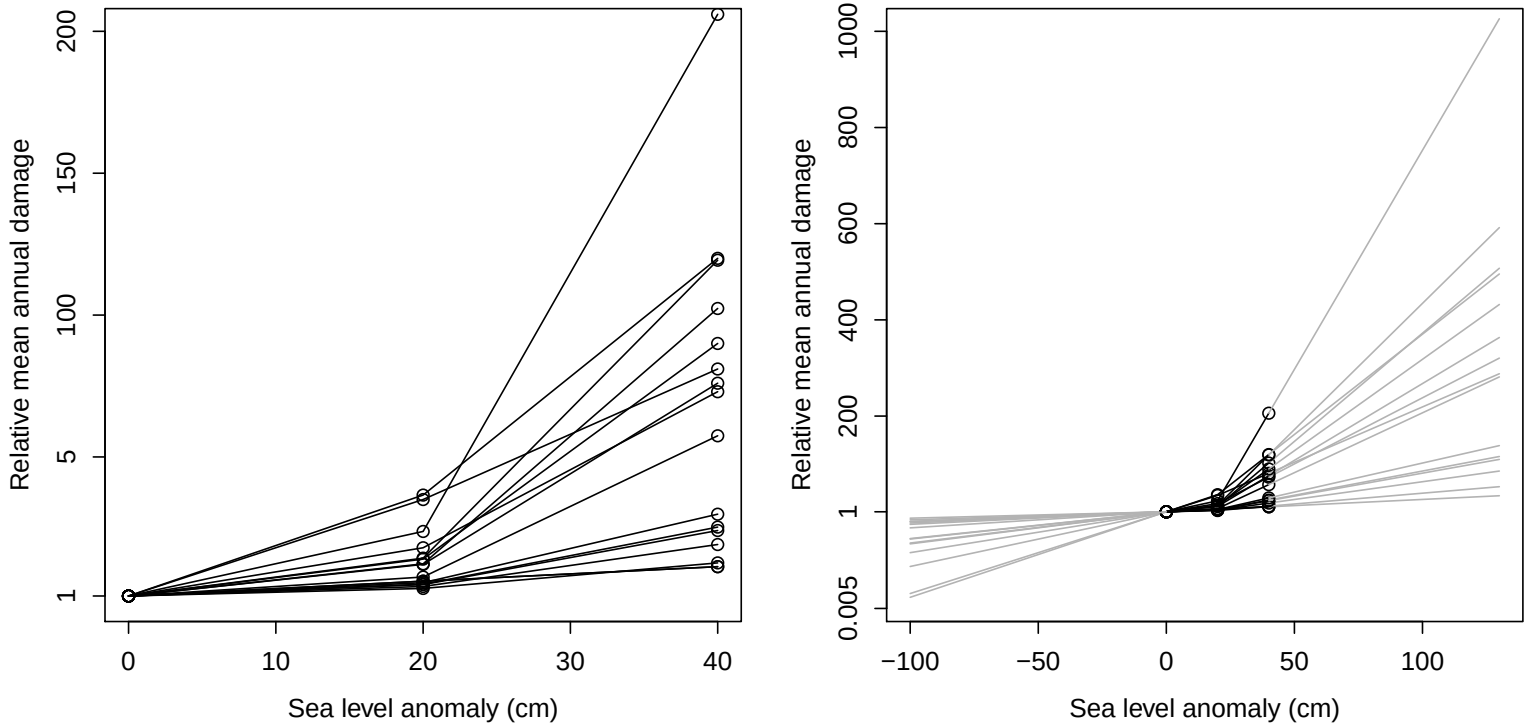


Local sea level projections



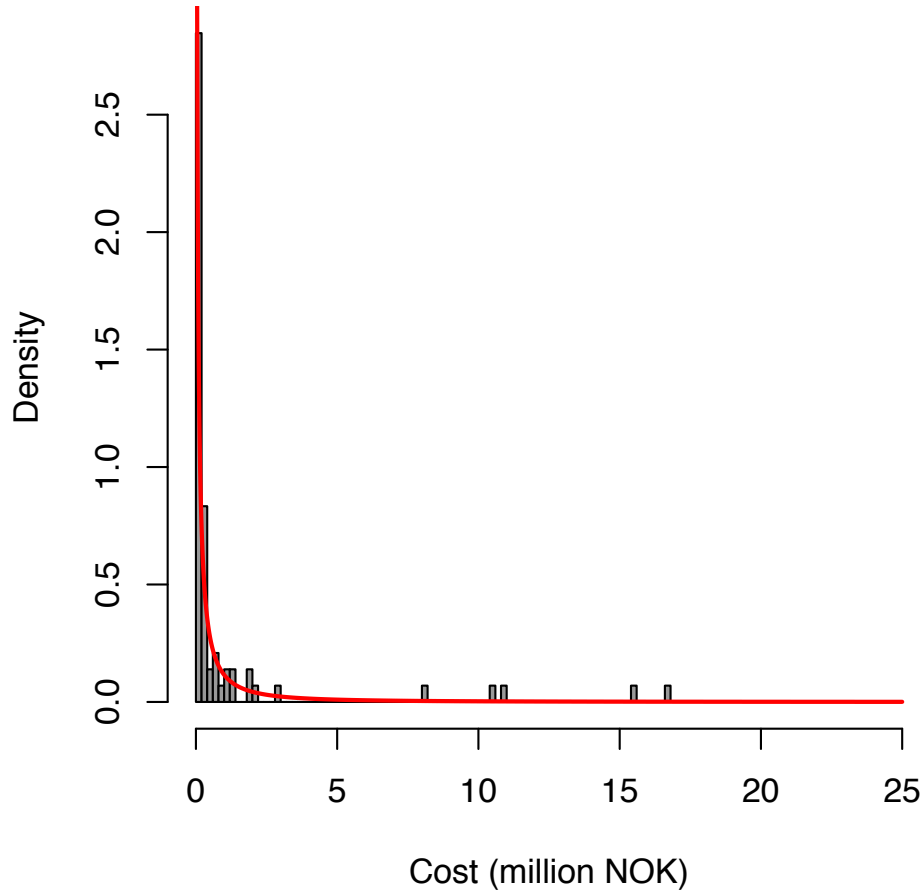
We relate **git-corrected Bergen sea level** to **global sea level** series of *Church and White (2011)*, then use the method of *Bolin et al. (2014)* to model the relationship between **global annual mean temperature** and global annual mean sea level rise.

Changes in damage costs due to sea level rise



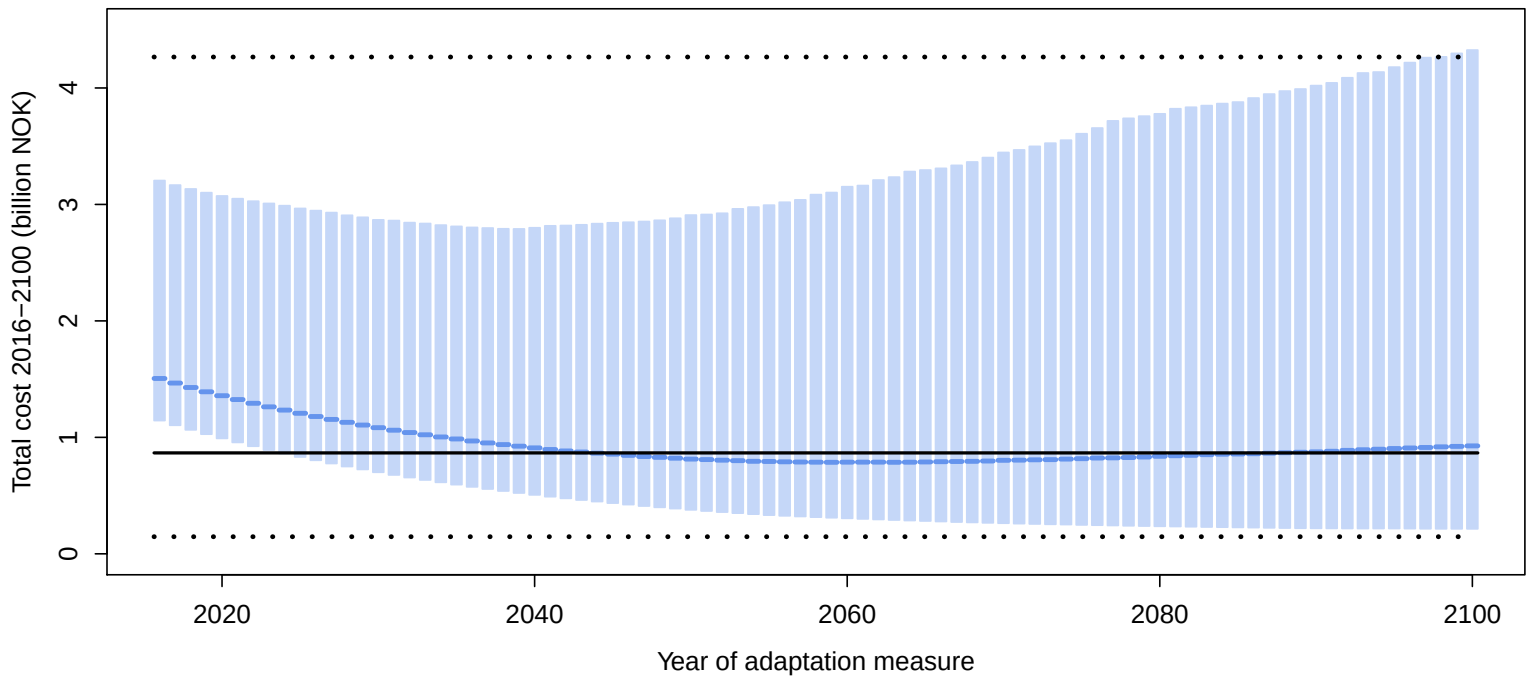
Hallegatte et al. (2013) investigate global **changes in damage costs under 20 and 40 cm sea level rise**. We extrapolate their results for 15 European cities and use the results as an ensemble prediction for the changes in damage costs in Bergen.

Annual damage costs



The Norwegian Natural Perils Pool publishes annual damage costs due to storm surges on county level. We fit a **Burr distribution** to the 1980-2015 data from Hordaland and Rogaland counties.

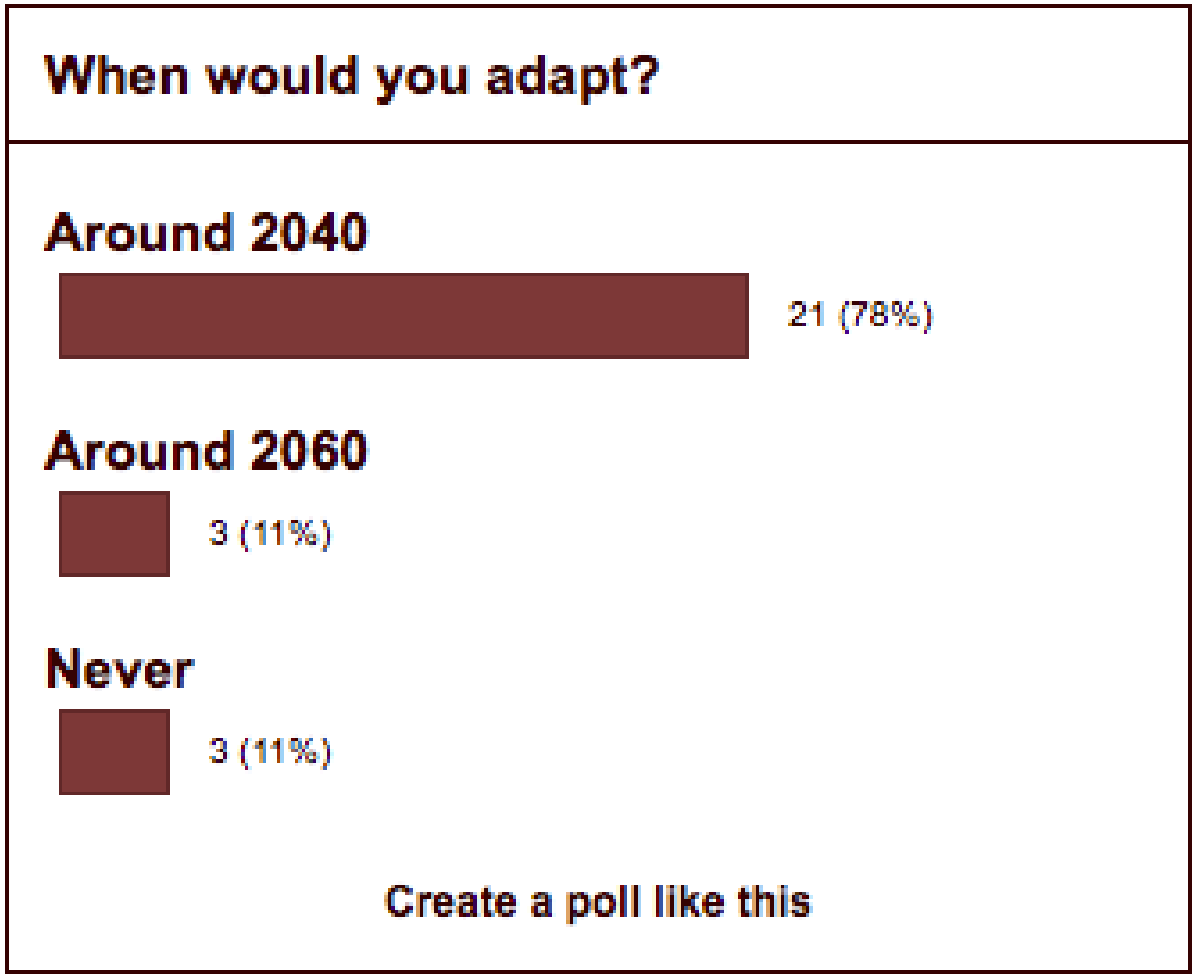
Optimal adaptation timing depends on the decision-maker's loss function/risk aversion



When would you adapt?

1. Around 2040
2. Around 2060
3. Never

When would you adapt?



Which uncertainty component has the largest effect on the results?

1. Sea level rise
2. Damage costs
3. Effect of sea level rise on damage costs

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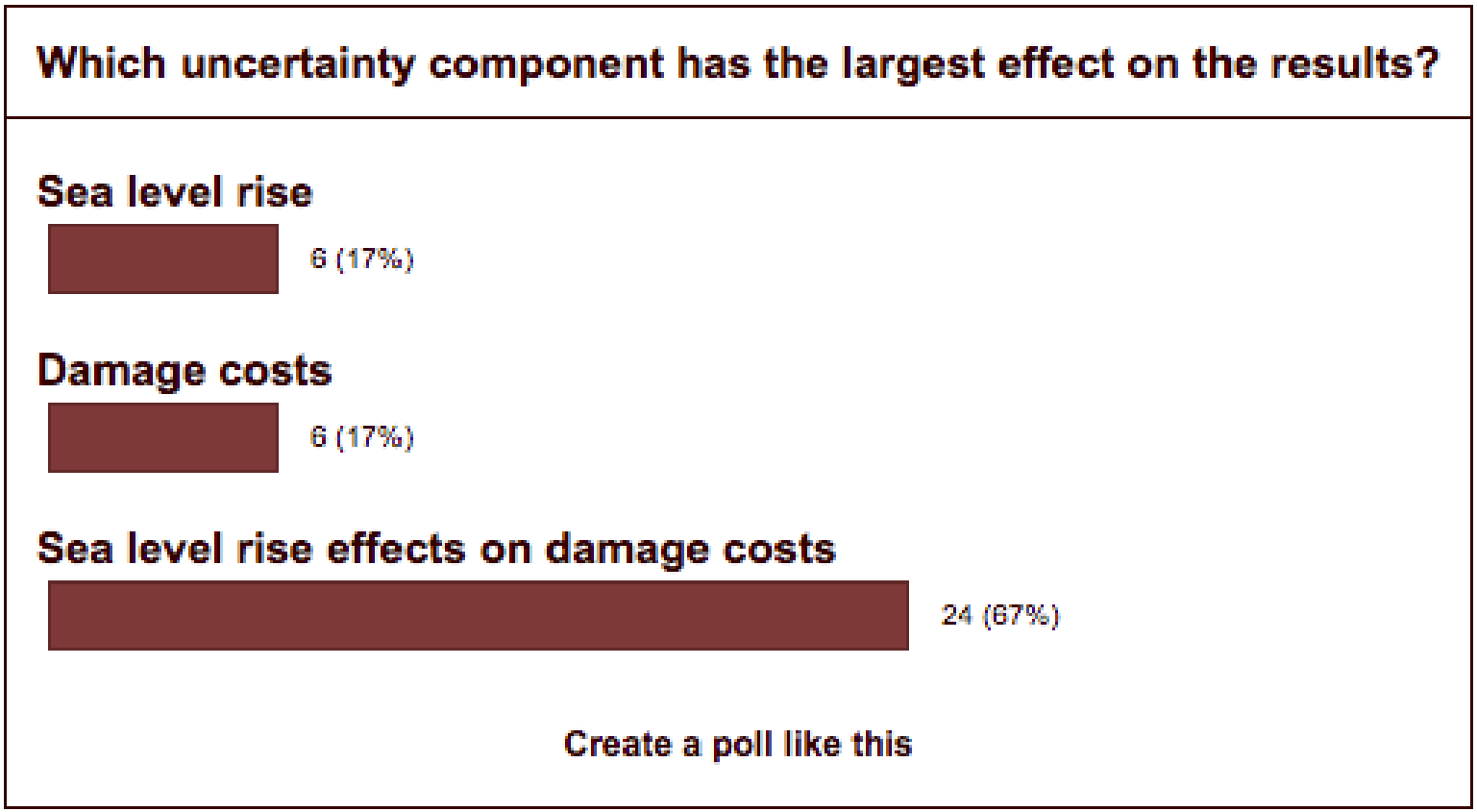

Including the uncertainty is vital; uncertainty in the damage costs has the largest effect