Clarifying the impact of epistemic uncertainties on future marine flooding

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With : G. Le Cozannet[1], D. Lincke[2], J. Hinkel[2]

2: Global Climate Forum 1: Géosciences pour une Terre durable brgm

‘For every dollar that is spent trying to quantify uncertainty, we should spend 10 dollars collecting and analyzing data that would reduce uncertainty.’

Gail Atkinson (2004 World Conference on Earthquake Engineering)

Different categories of uncertainty

1. **Knowledge-based (epistemic uncertainty)**
   - from limited knowledge, measurement capability and modeling capability on the part of the analyst.
   - **Can be reduced.** Extreme case: **"***We expect that if we had infinite data it would be zero"*

[Abrahamson 00; Straub & Schubert 08; Marzocchi et al. 04; Deck & Verdel 12,…]

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2. **Randomness (aleatory uncertainty/variability)**
   - "real" variability intrinsic to the physical system under study (e.g., occurrence of storms);
   - **Irreductible;**

[Abrahamson 00; Straub & Schubert 08; Marzocchi et al. 04; Deck & Verdel 12,…]

- **What are the most important epistemic uncertainties to be reduced?**
  - Global test case

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- **Role of irreductible versus epistemic uncertainties?**
  - Local test case

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Coastal flood damage and adaptation costs under 21st century sea-level rise

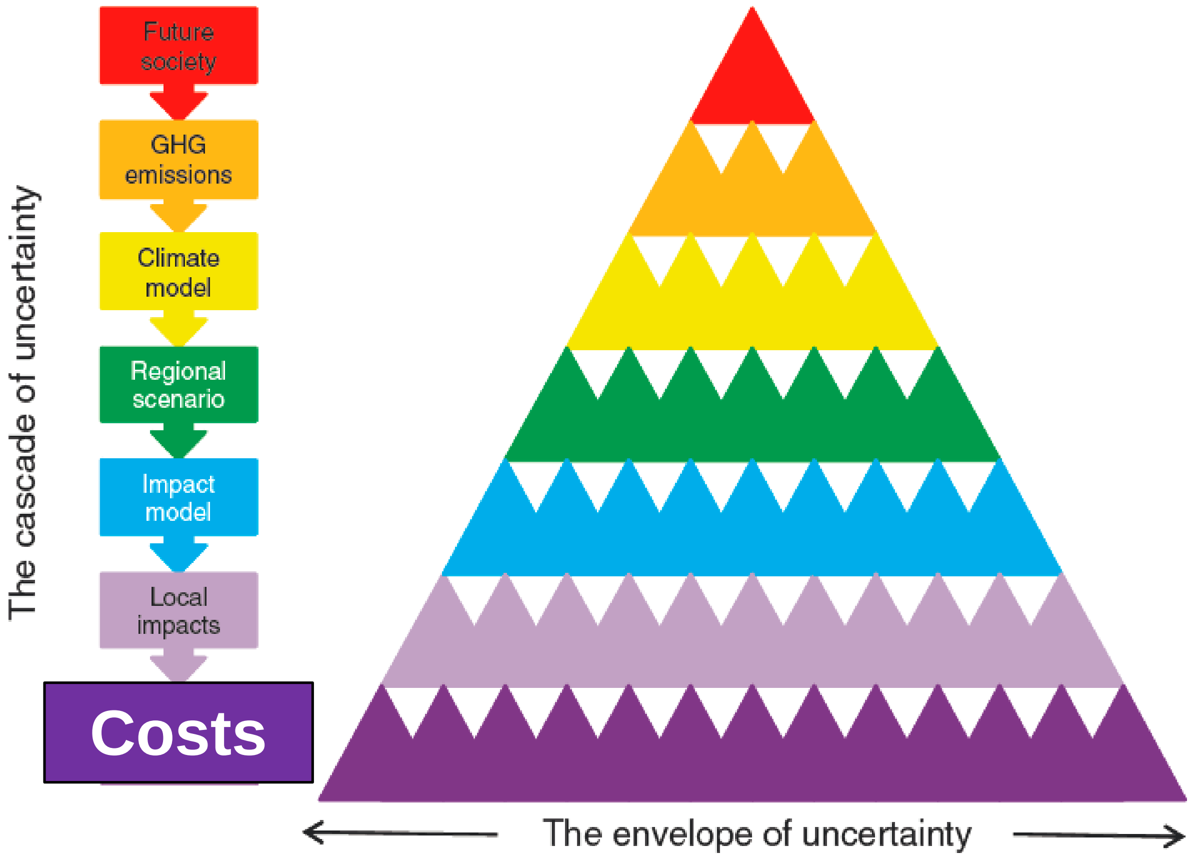
Jochen Hinkel[a,1], Daniel Lincke[a], Athanasios T. Vafeidis[b], Mahé Perrette[c], Robert James Nich
Ben Marzeion[g], Xavier Fettweis[h], Cezar Ionescu[c], and Anders Levermann[c,i]

PNAS

Hinkel et al. (2014)

Epistemic uncertainties in loss assessment

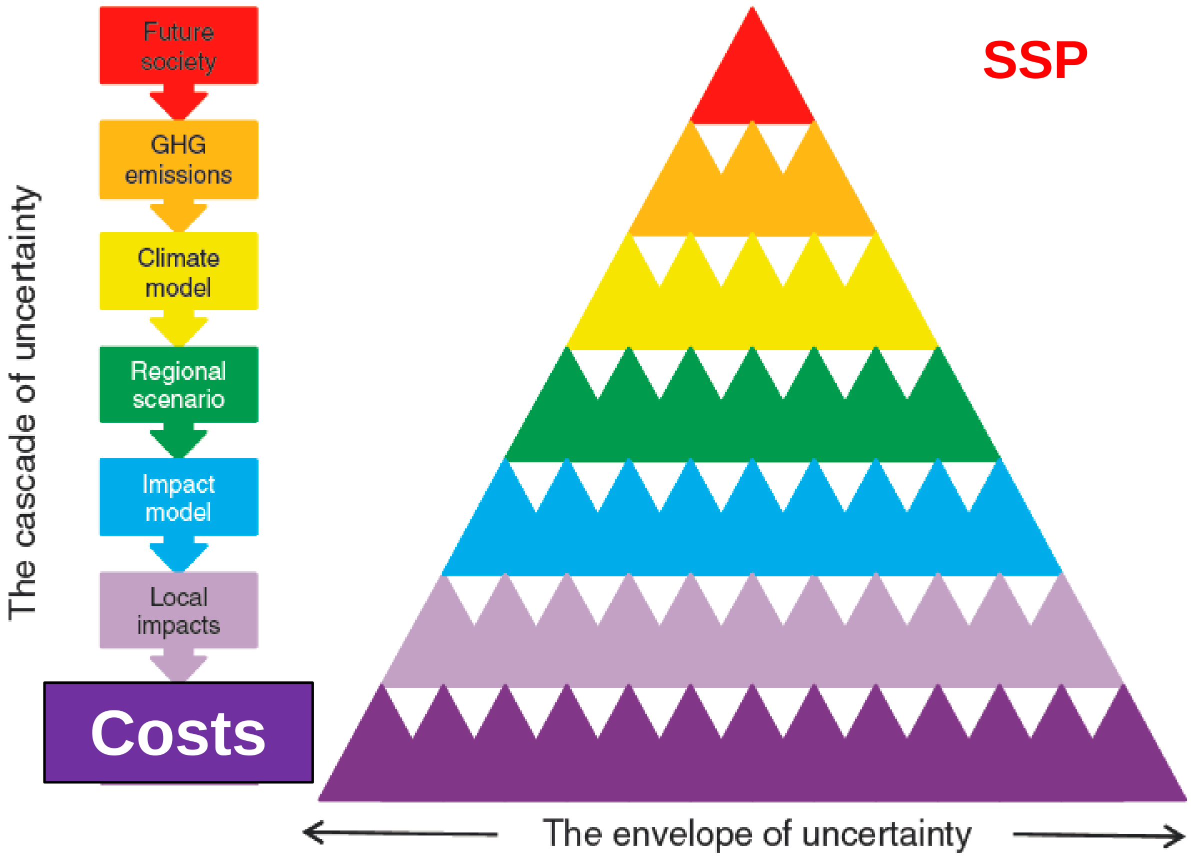
Hinkel et al. (2014)



Adapted from Wilby and Dessai (2010)

A scenario-based approach

Hinkel et al. (2014)

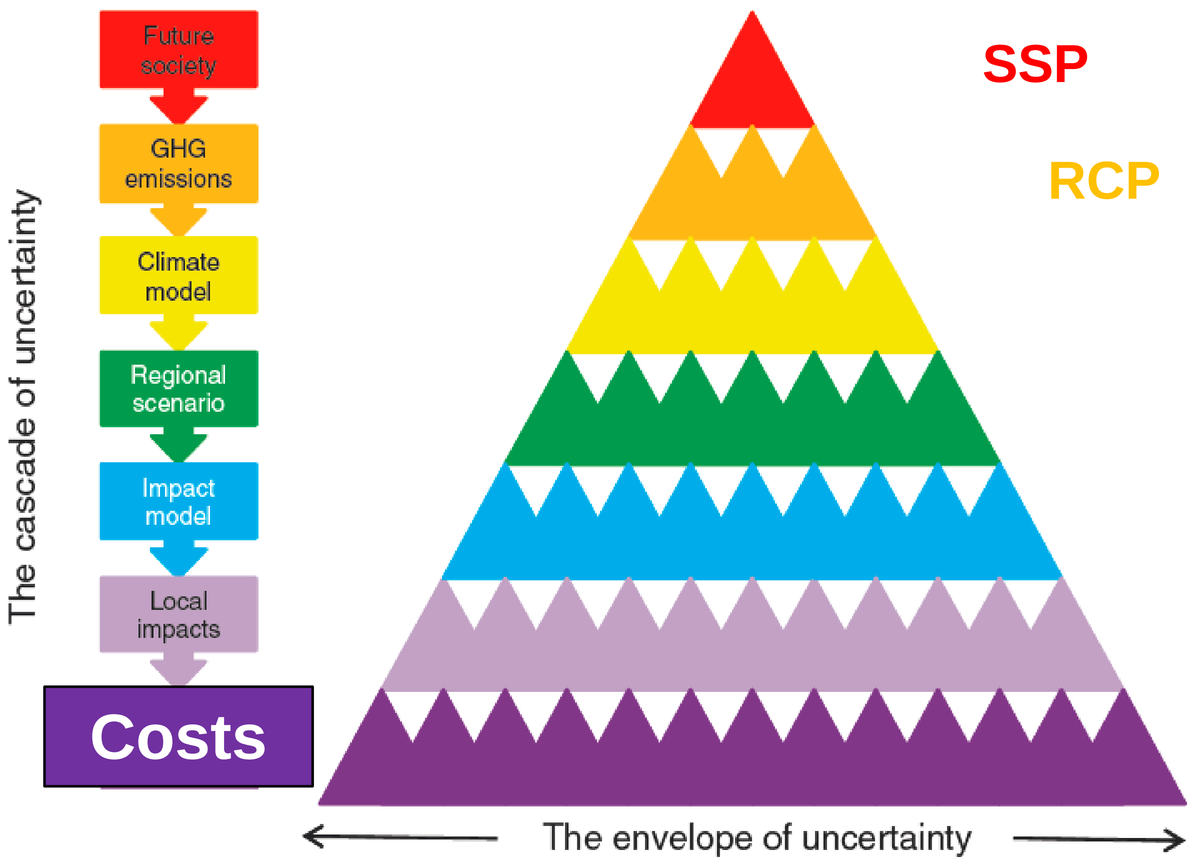


5 Shared Socio-Economic Pathways scenarios

Based on Hinkel et al. (2014)

A scenario-based approach

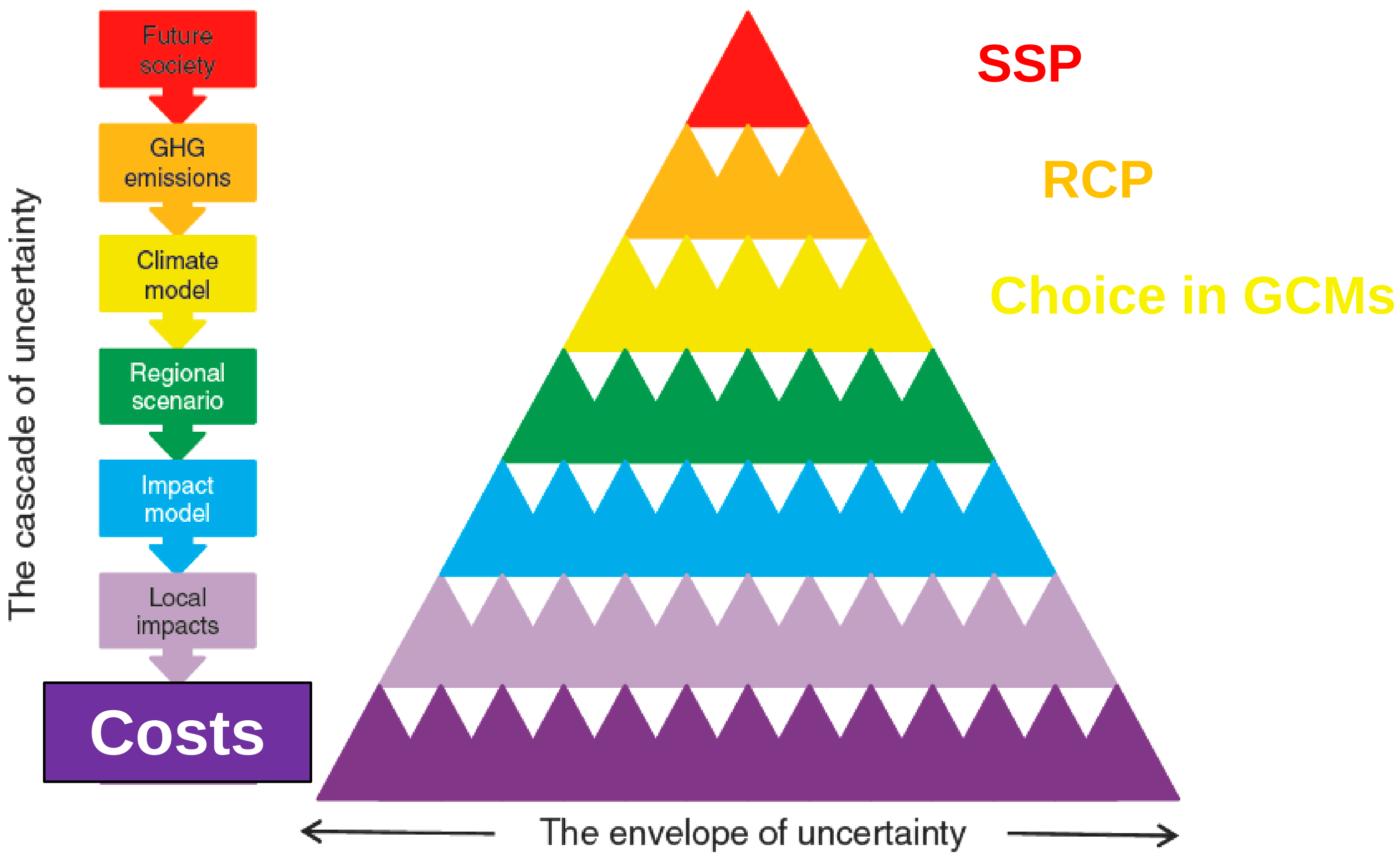
Hinkel et al. (2014)



3 RCP scenarios (2.6, 4.5, 8.5)

A scenario-based approach

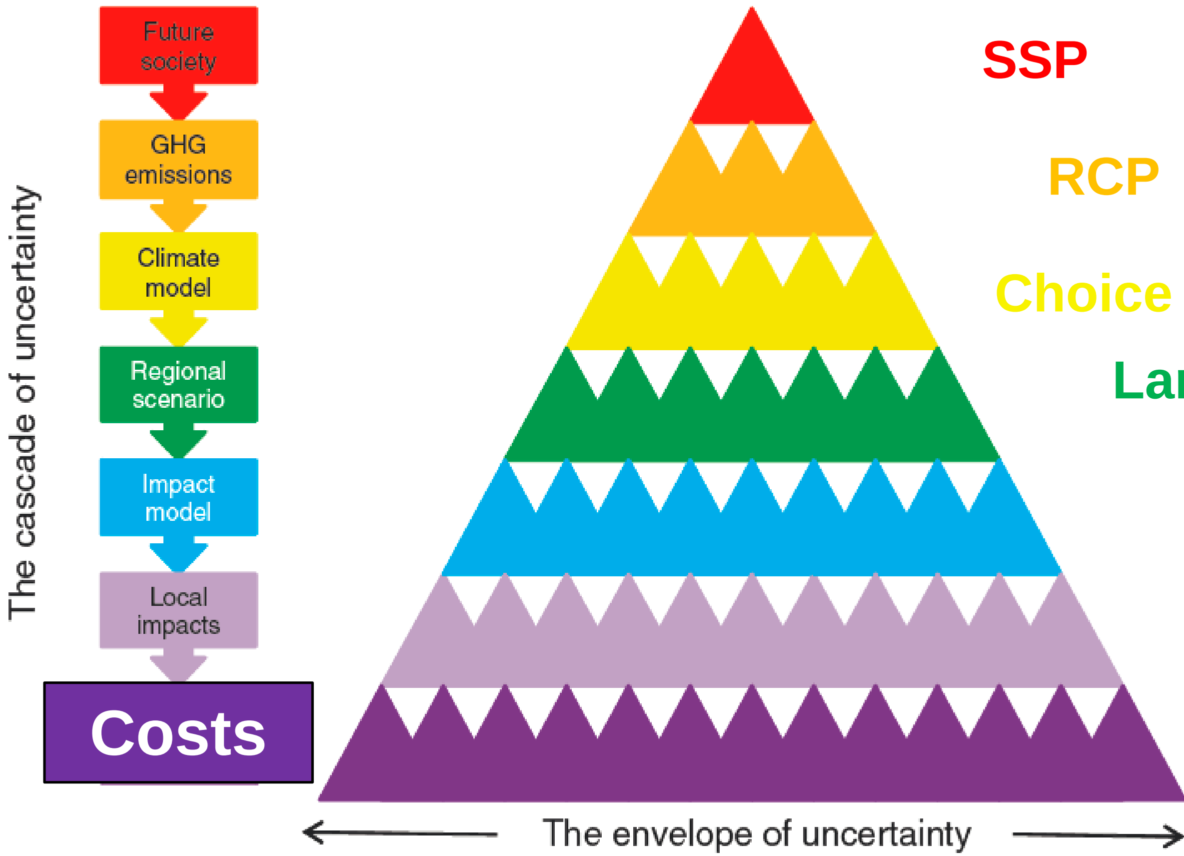
Hinkel et al. (2014)



HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM, NorESM1-M

A scenario-based approach

Hinkel et al. (2014)



SSP

RCP

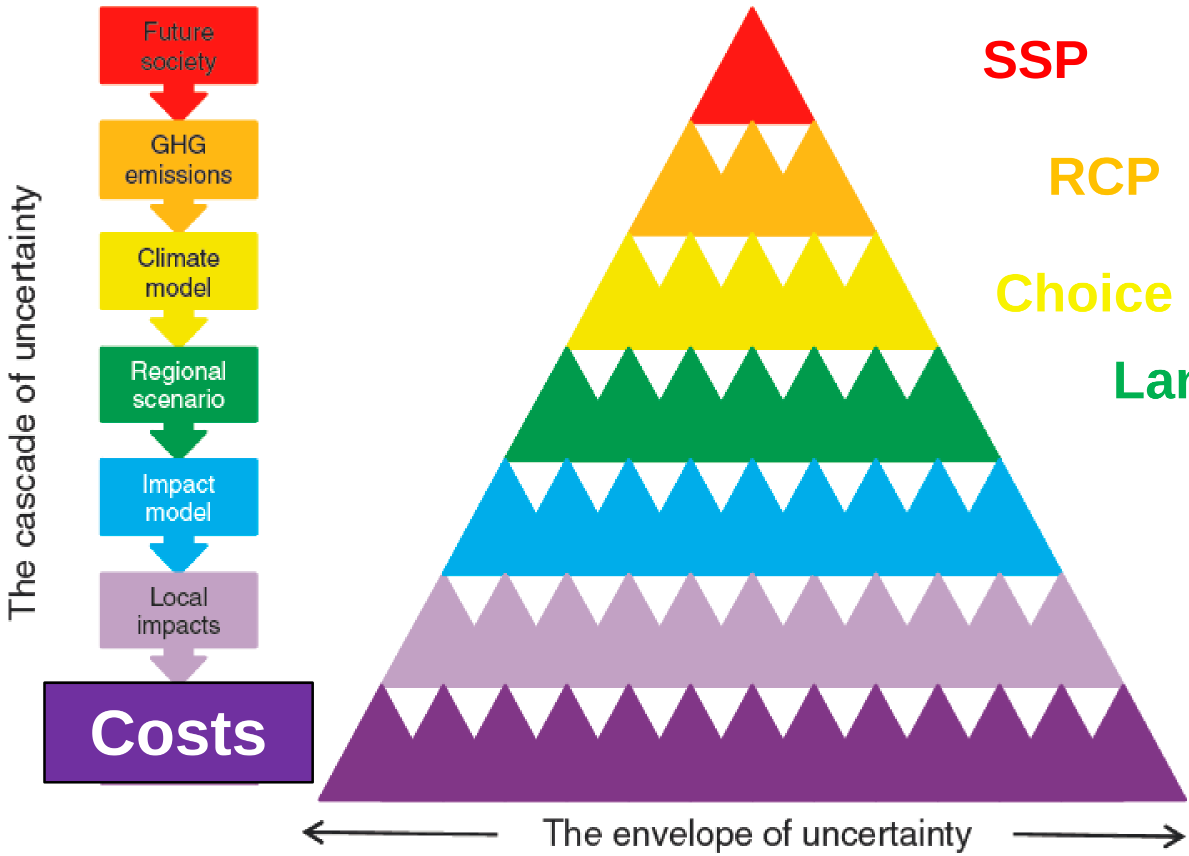
Choice in GCMs

Land-ice scenarios

3 scenarios of contributions from ice sheets and glaciers: low-med-high

A scenario-based approach

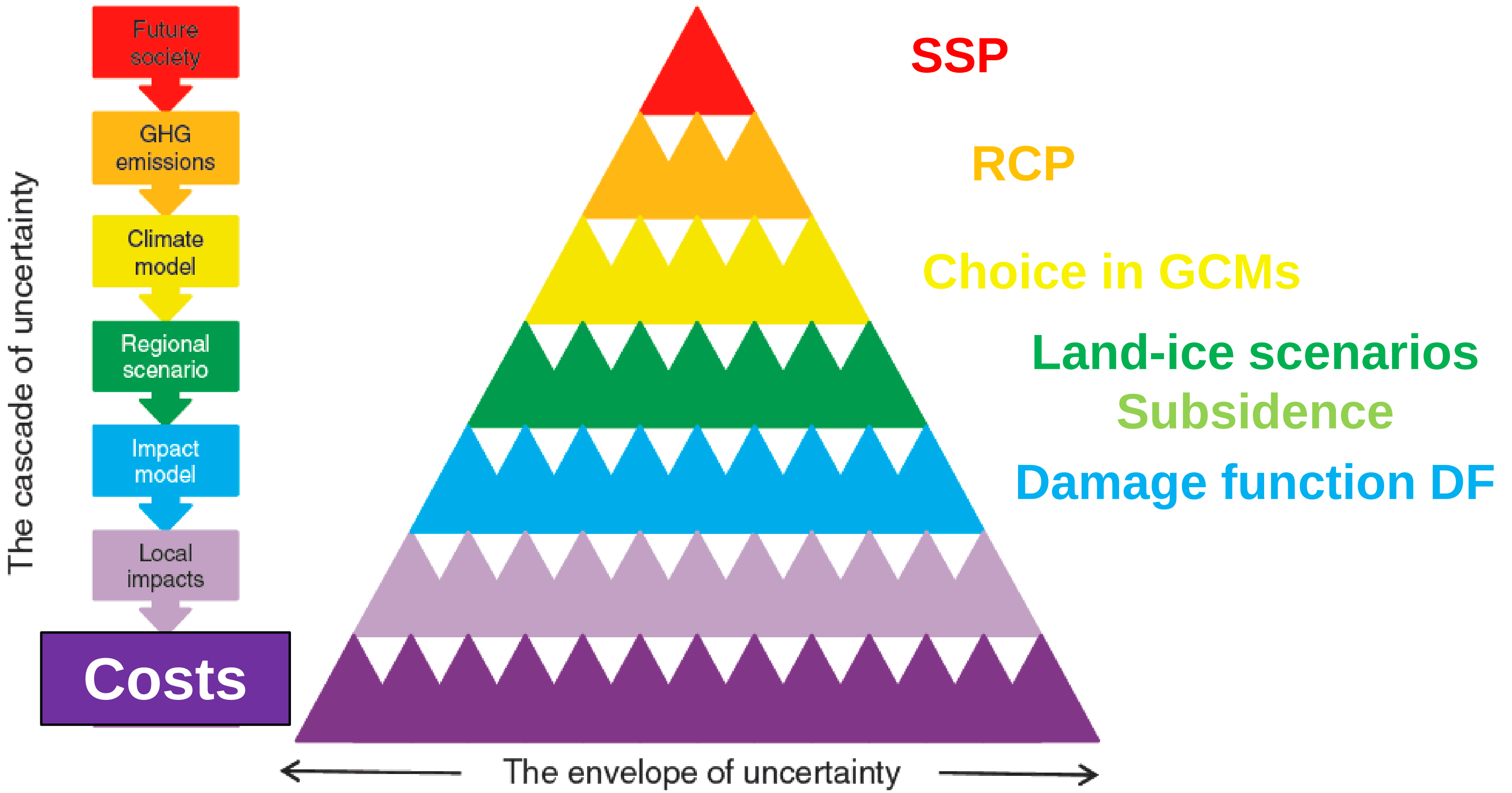
Hinkel et al. (2014)



Subsidence in delta regions: Y/N

A scenario-based approach

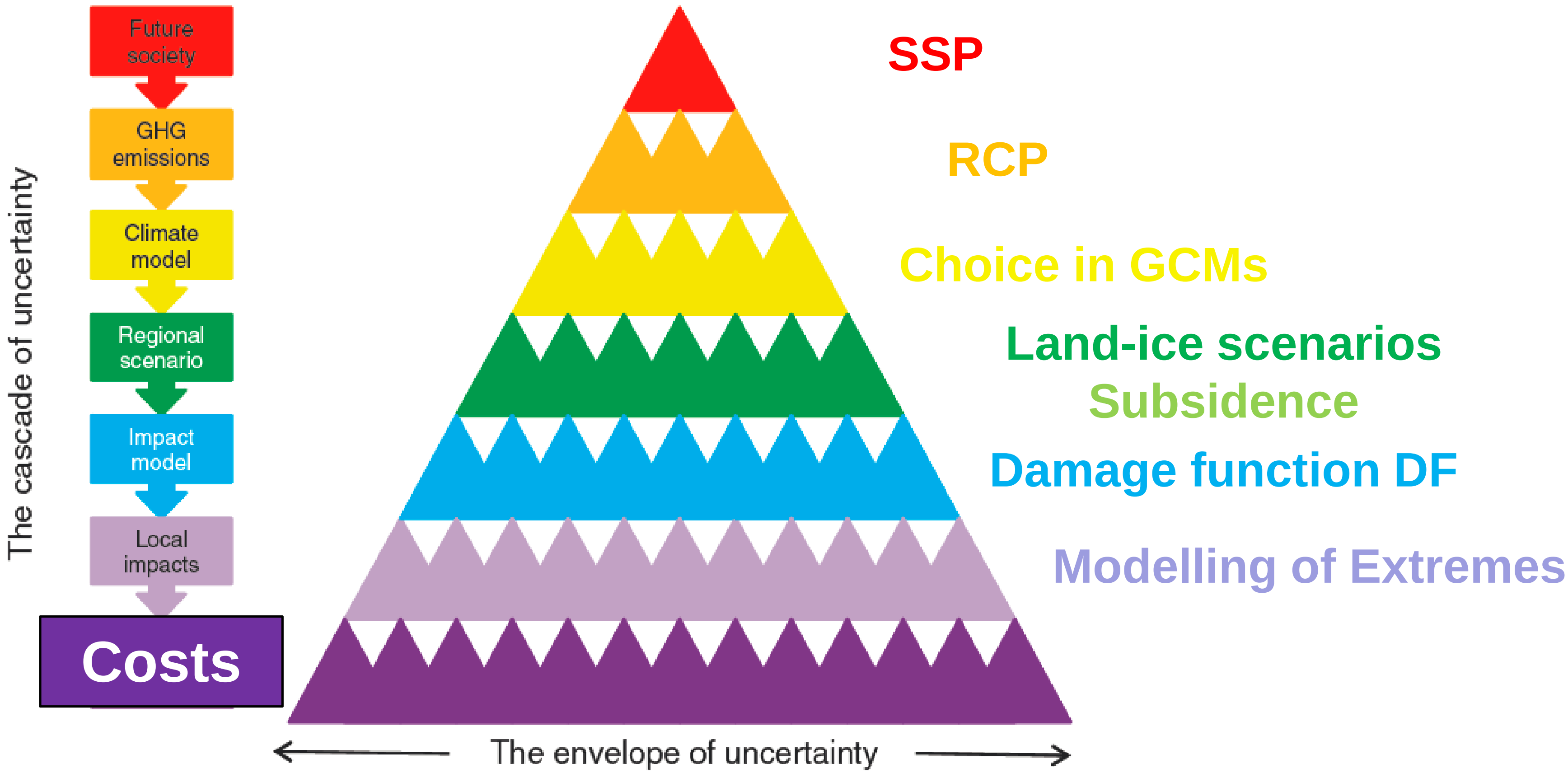
Hinkel et al. (2014)



2 configurations of the damage function

A scenario-based approach

Hinkel et al. (2014)

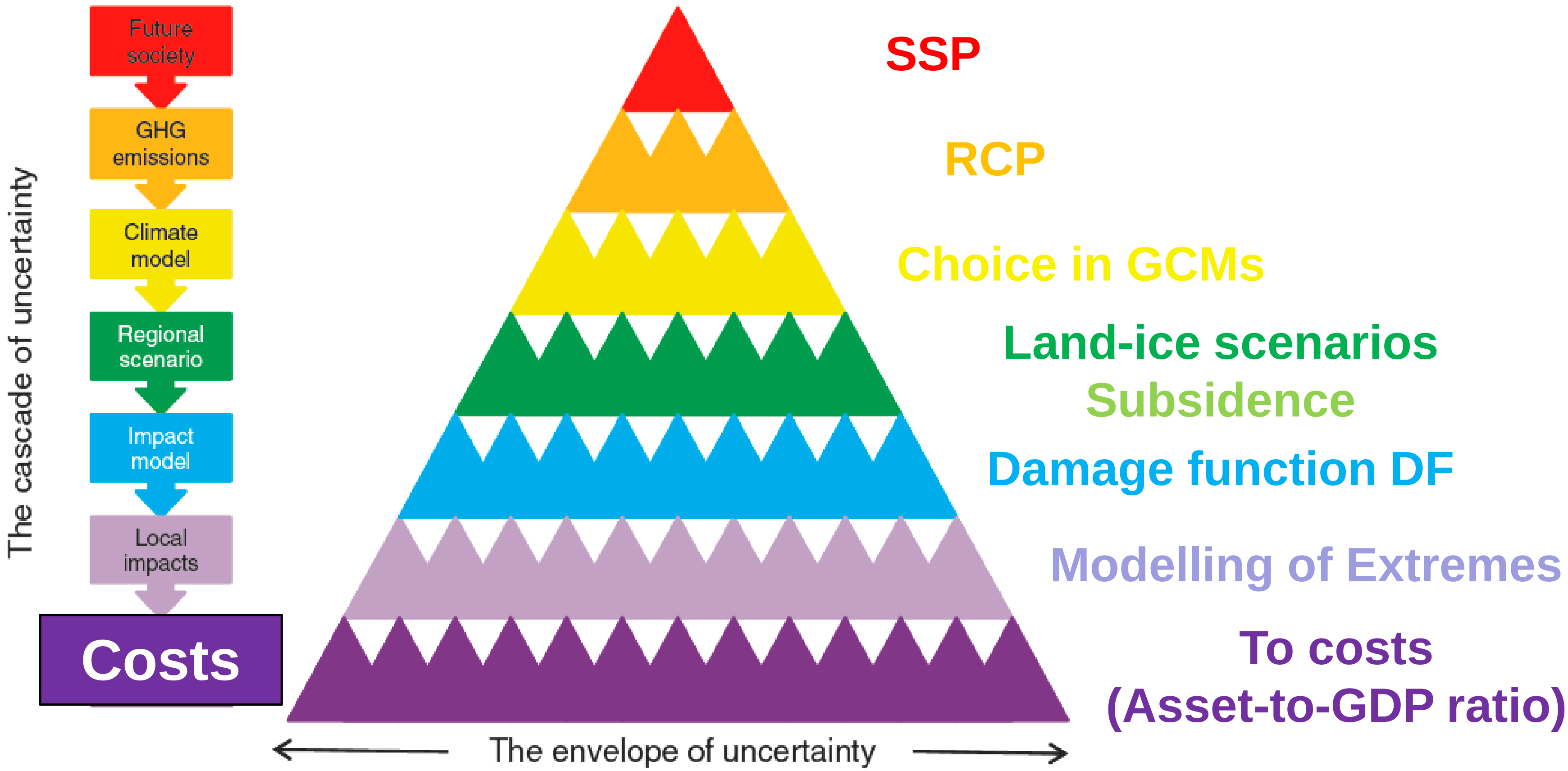


2 databases for estimating the extreme sea levels (DINA-COAST & GTSR)

Vafeidis et al., 2008 ; Muis et al. 2017

A scenario-based approach

Hinkel et al. (2014)

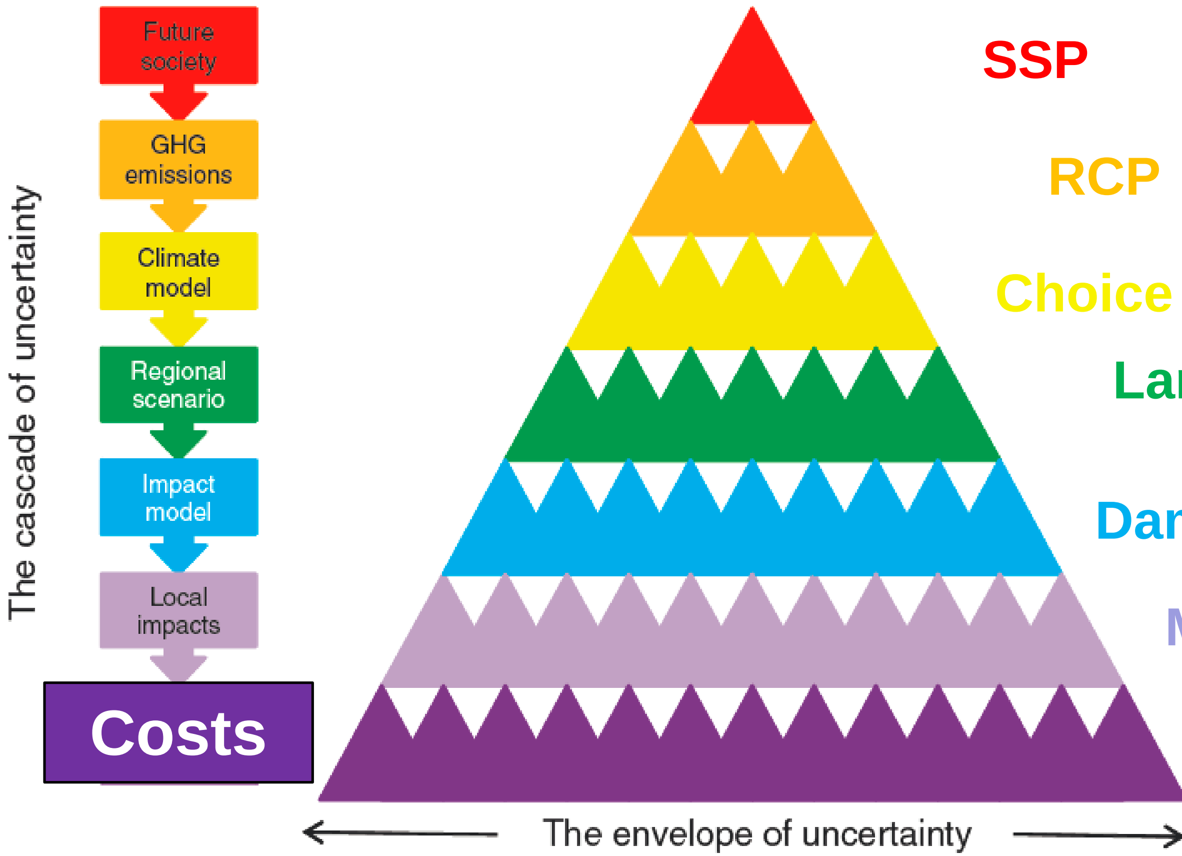


2 Asset-to-GDP ratios: 2.8* ; 3.8

*Hallegate et al., 2013

A scenario-based approach

Hinkel et al. (2014)



SSP

RCP

Choice in GCMs

Land-ice scenarios

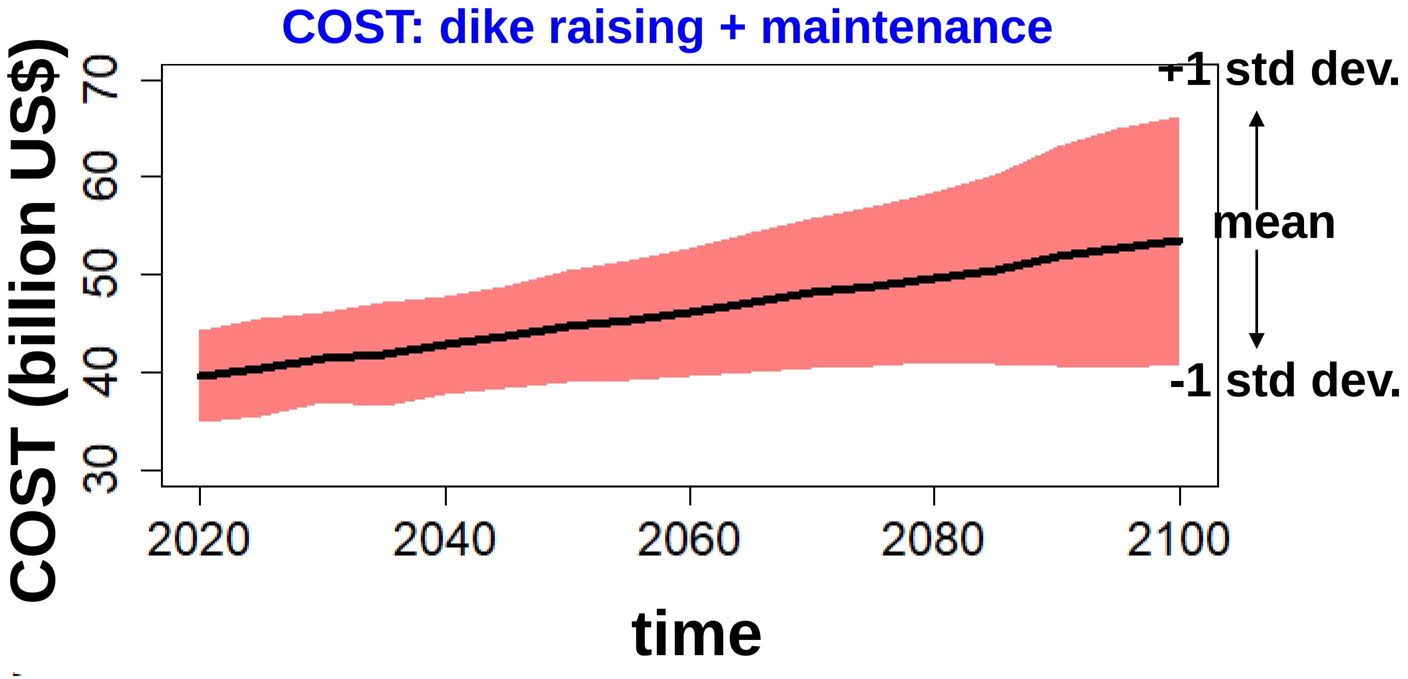
Subsidence

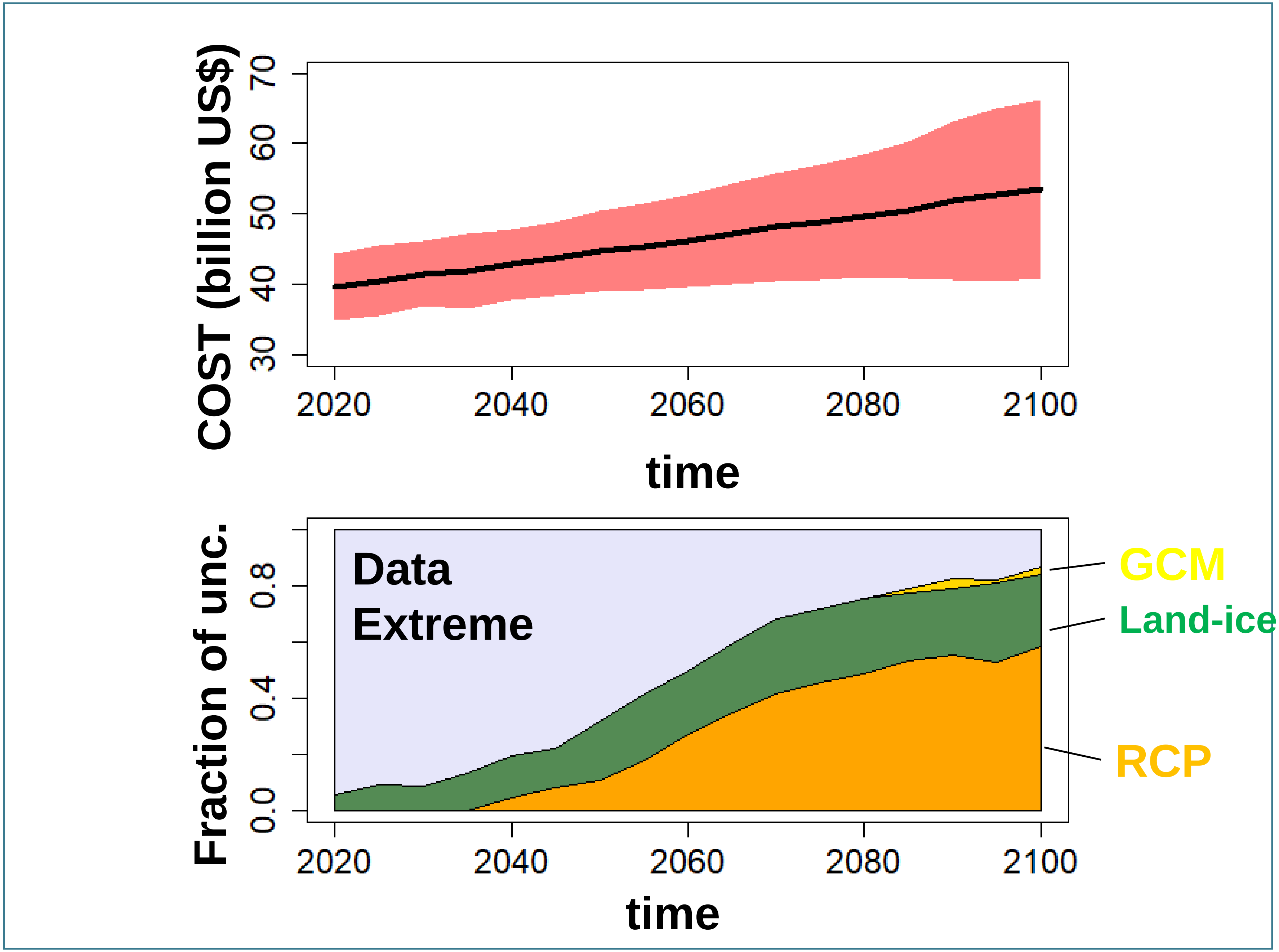
Damage function DF

Modelling of Extremes

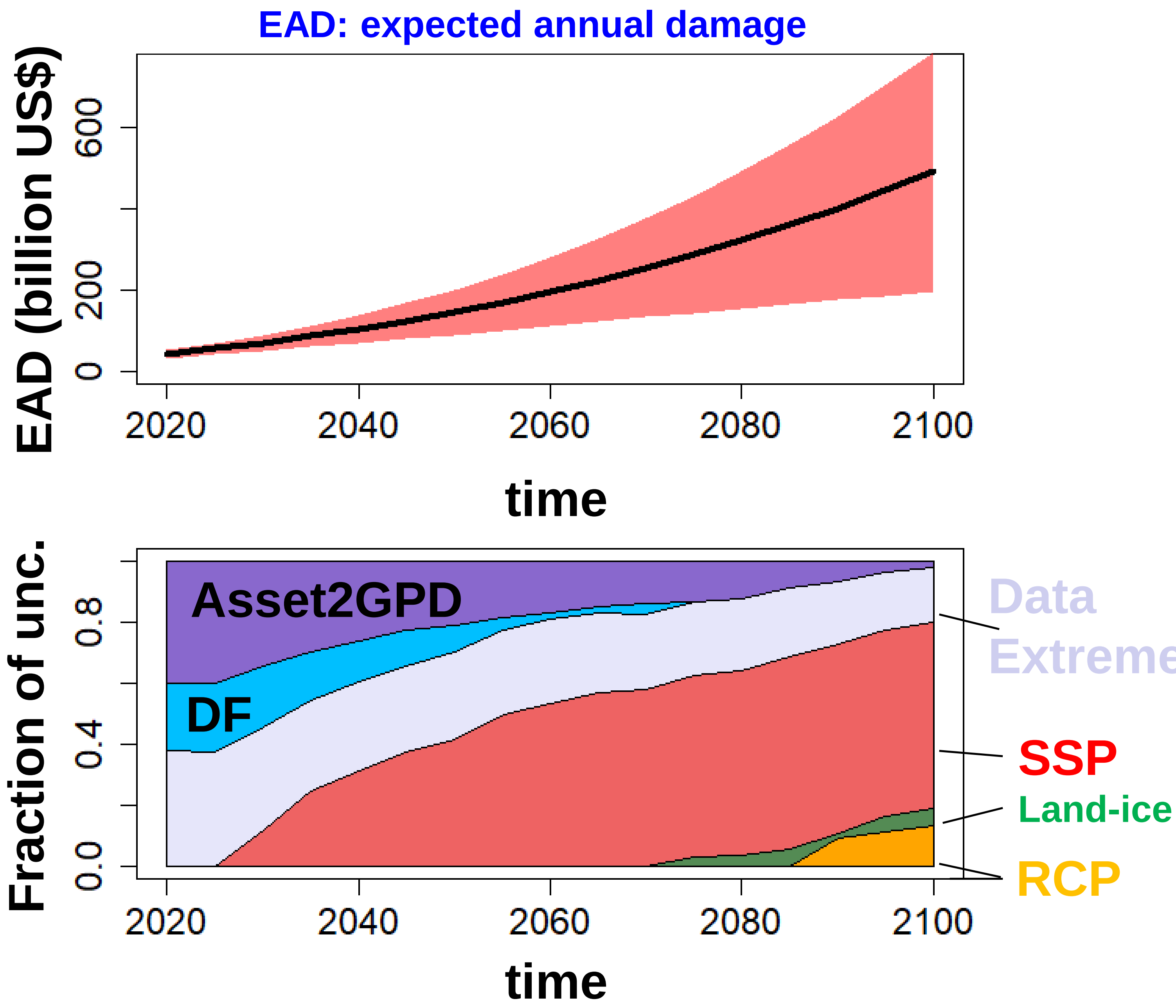
To costs (Asset-to-GDP ratio)

2 880 combinations!


COST: dike raising + maintenance
COST (billion US$)
30
40
50
60
70
2020
2040
2060
2080
2100
time
+1 std dev.
mean
-1 std dev.



Using a tree-based Machine Learning approach



Using tree-based Machine Learning approach

- **What are the most important epistemic uncertainties to be reduced?**
  - Global test case

- **Role of irreductible versus epistemic uncertainties?**
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nature climate change

ARTICLES

https://doi.org/10.1038/s41558-019-0587-5

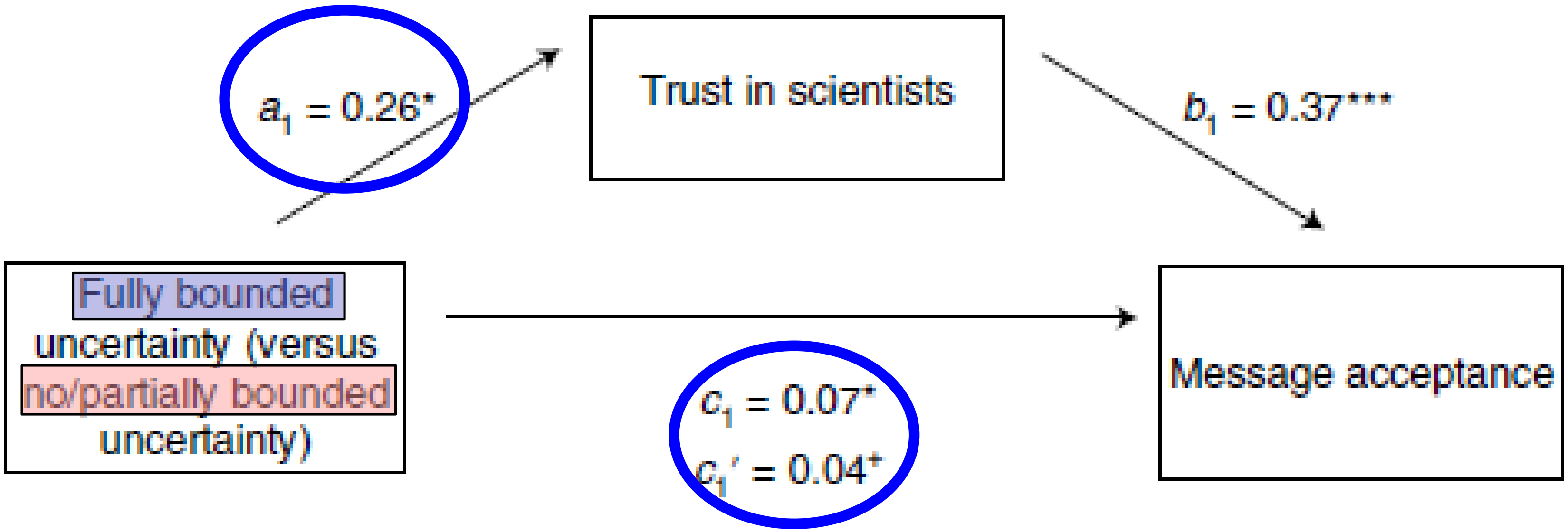
Acknowledging uncertainty impacts public acceptance of climate scientists' predictions

Lauren C. Howe[1*], Bo MacInnis[2], Jon A. Krosnick[2,3], Ezra M. Markowitz[4] and Robert Socolow[5]

Framed using predictable bounds

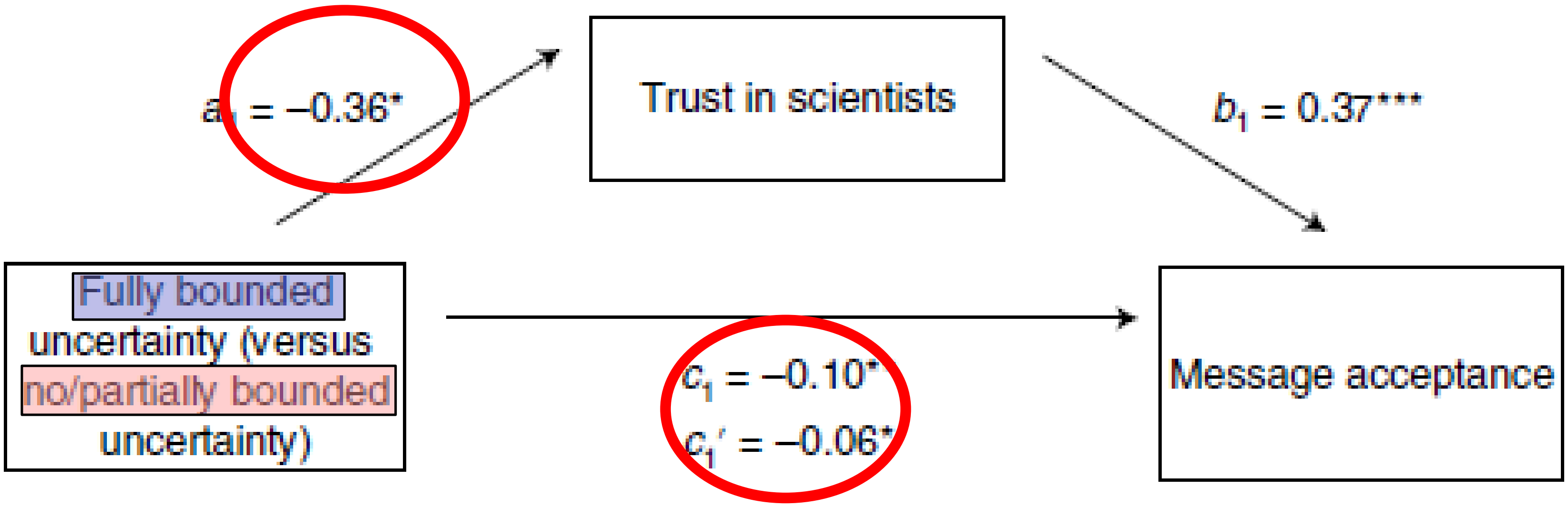
Fully bounded uncertainty (versus no/partially bounded uncertainty)

Framed using worse case sc.

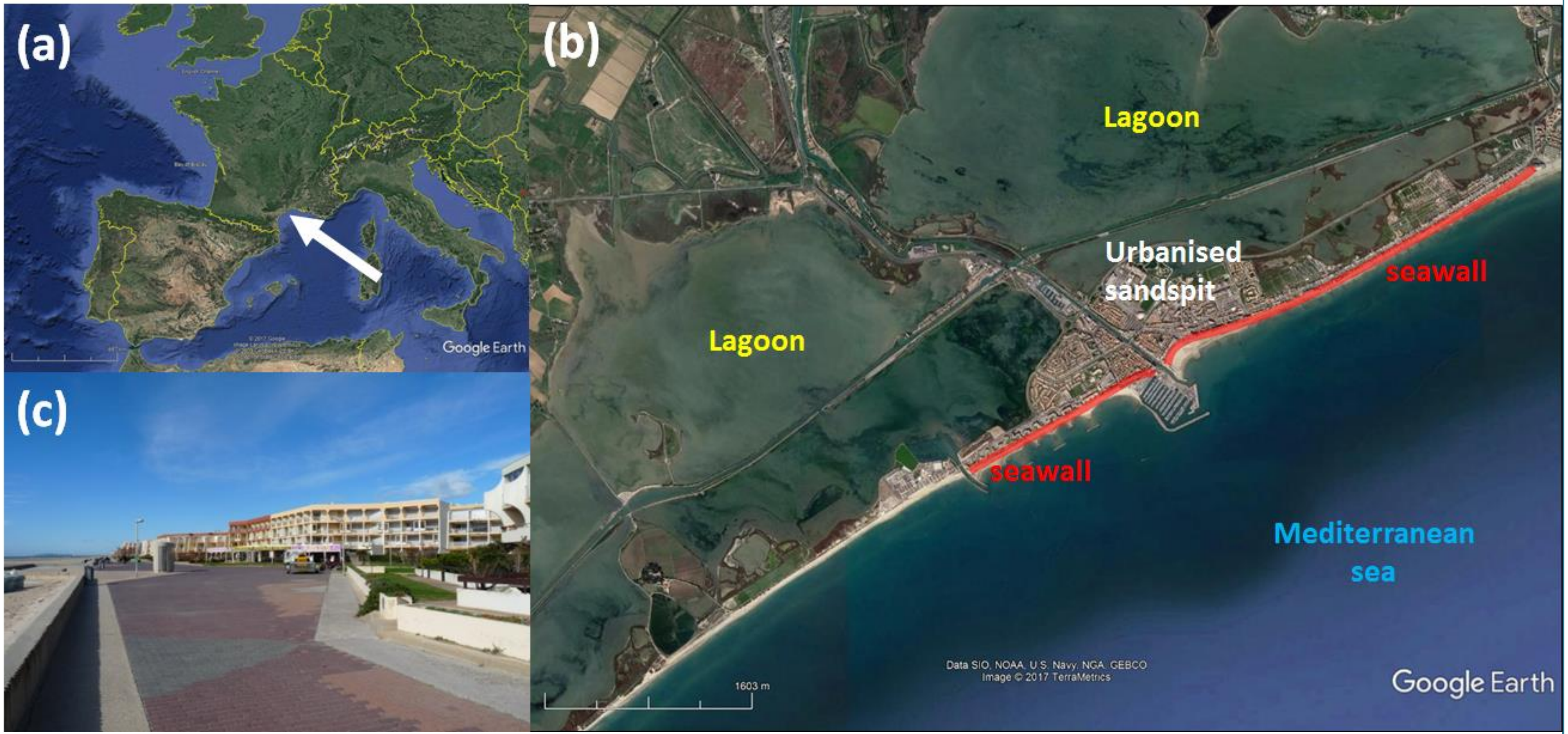


Trust in scientists
$a_1 = 0.26^*$
$b_1 = 0.37^{***}$
Fully bounded uncertainty (versus no/partially bounded uncertainty)
$c_1 = 0.07^*$
$c_1' = 0.04^+$
Message acceptance

With information on irreductible uncertainty



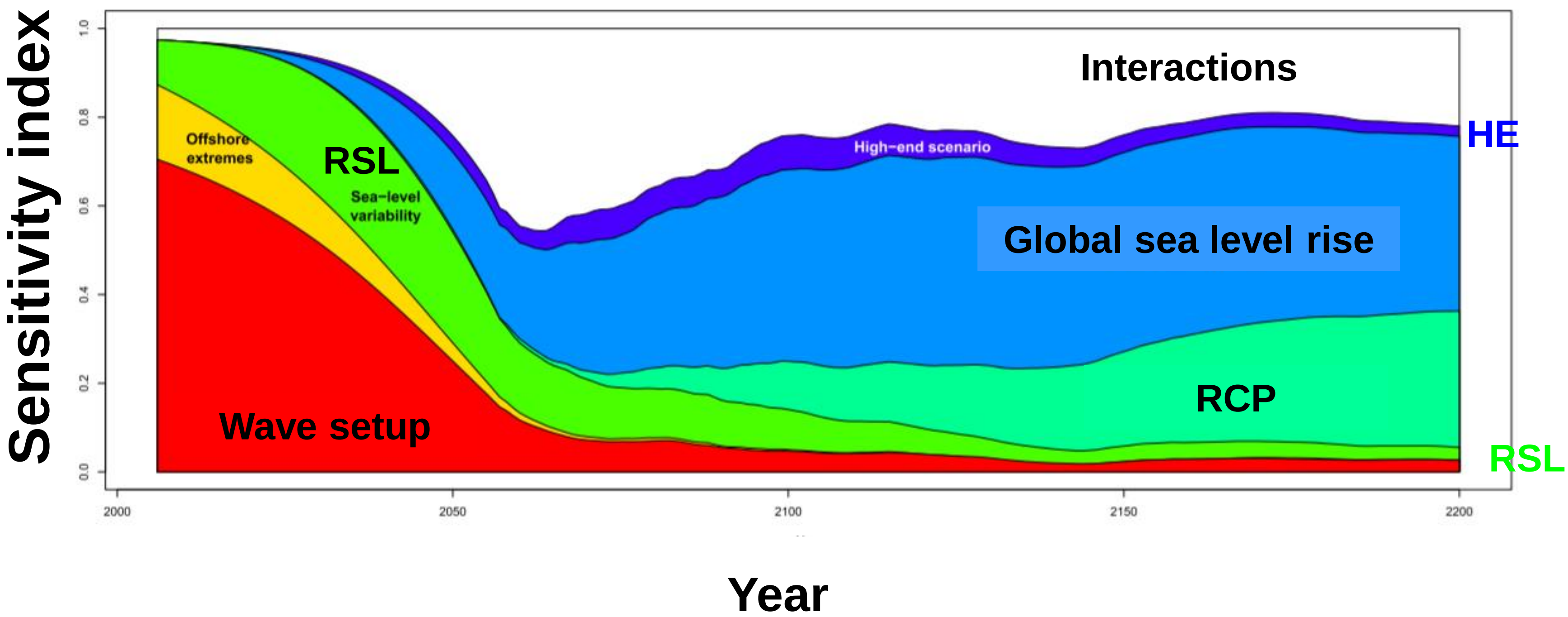
Yearly probability of flooding over time?



Le Cozannet et al., 2015

Global sensitivity analysis at Palavas

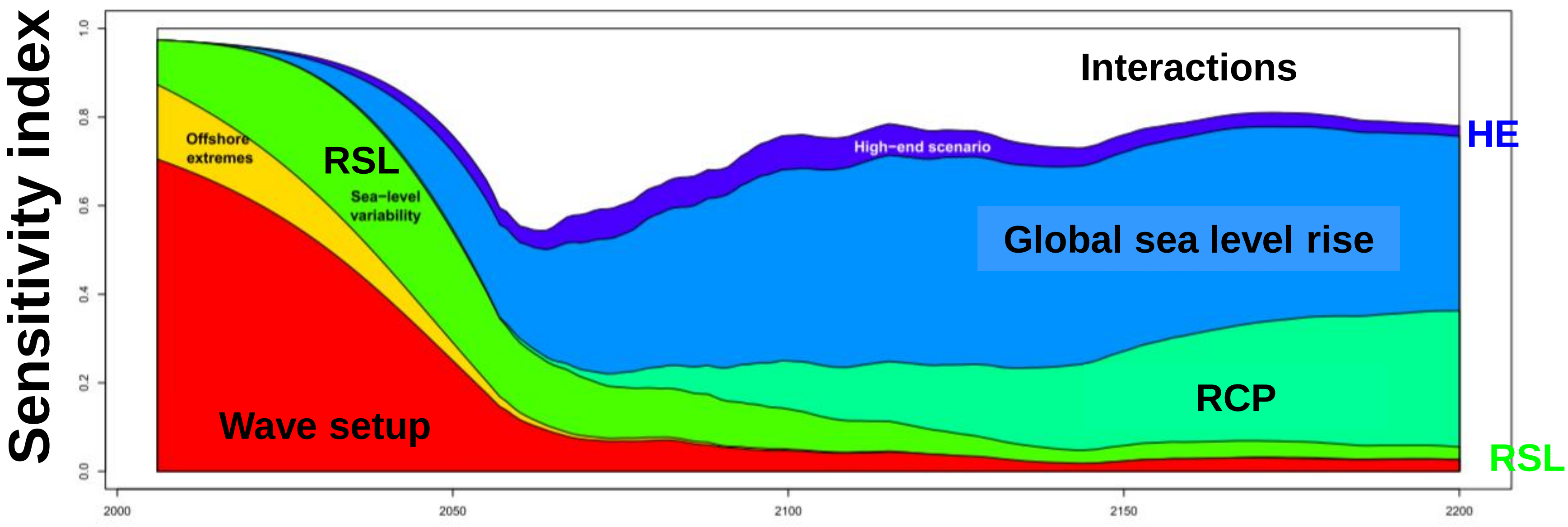
Uncertainty on: yearly probability of exceeding the seawall height

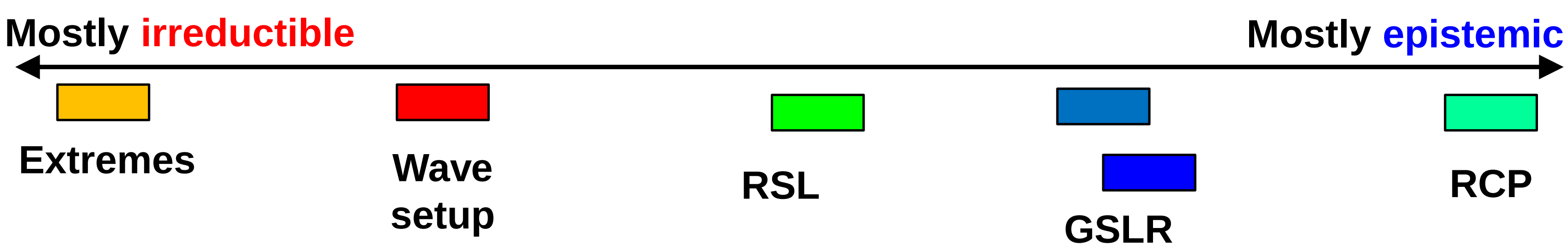


Le Cozannet et al., 2015

Epistemic versus Irreductible

Classification Attempt!





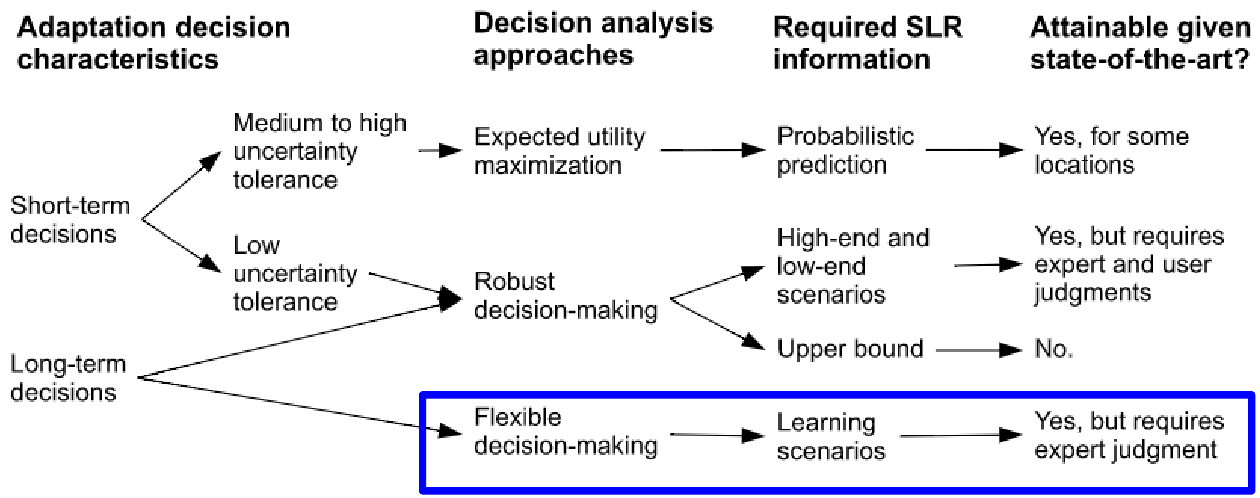
Epistemic versus Irreductible

Classification Attempt!

- **Classification not straightforward**
- **Most uncertainties both contain irreductible and epistemic part**
- **Time evolution of the irreductible/epistemic part?**

Summary

- **Global sensitivity analysis:**
  - Defines research priorities
  - Identifies most appropriate time-frame
  - Contributes to the definition of learning scenarios (Hinkel et al. 2019)



Summary

- **Global sensitivity analysis:**
  - Defines research priorities
  - Identifies most appropriate time-frame
  - Contributes to the definition of learning scenarios (Hinkel et al. 2019)

- **Classification irreductible/epistemic**
  - Potentially alleviates the negative effect on message acceptance (Howe et al., 2019)
  - Raises practical difficulties

Thank you for your attention!