Towards Adaptive Resilience

Managing uncertainties and exploiting predictability across timescales

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Conceptual Framing

Motivating example

How much to raise levees in the Netherlands (Eijgenraam et al., 2014; Oddo et al., 2017; van Dantzig, 1956)?

Figure 1: Construction workers raise a 12 km stretch of a sea dike by 2 m to meet new safety standards. Source: Teake Zuidema via PBS.

Tools for flood risk management

- Integrate financial, structural, operational instruments
- Permanent structures → debt → fragility
- Preserving future options increases adaptive capacity

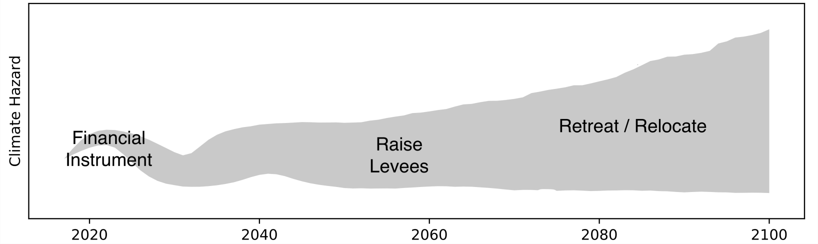


Figure 2: Adapted from Doss-Gollin et al. (2019, fig. 2)

Numerical Experiments

Deterministic DP $\Rightarrow$ optimal construction policy

State variables height of the levee

Decision variables how much to raise levee (A_t)

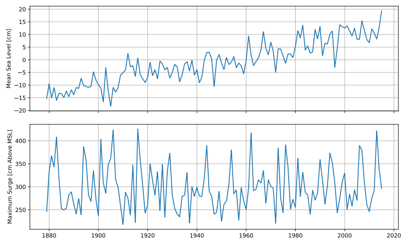
State transition let $p_f(S_t, t)$ be probability of flood; then

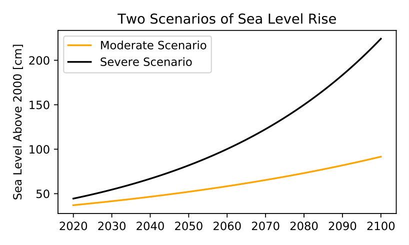
$$S_{t+1} = \begin{cases} S_t + A_t & \text{with probability} \quad 1 - p_f \\ 0 & \text{with probability} \quad p_f \end{cases}$$

Economics Capital costs of levee construction plus fair insurance premium for residual risk

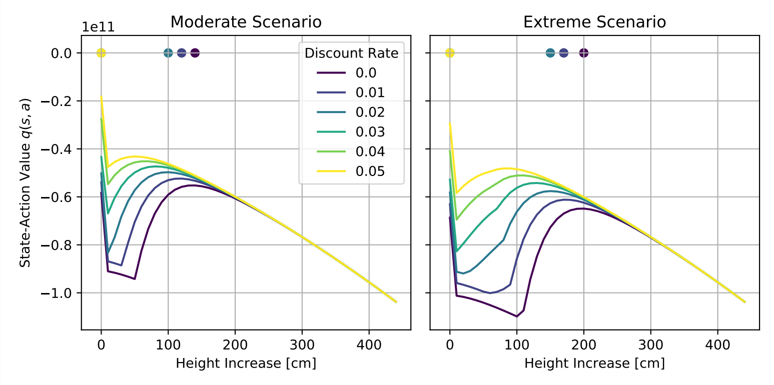
Objective minimize expected cost of decision pathway

Modeling flood risk



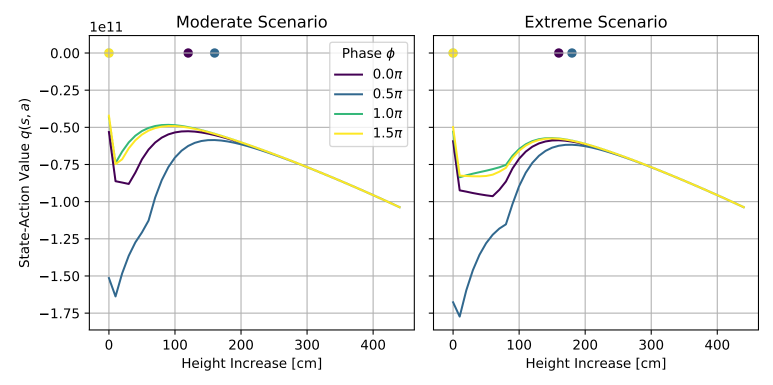


Does it matter which scenario we converge to?



What is sensitivity to decadal variability?

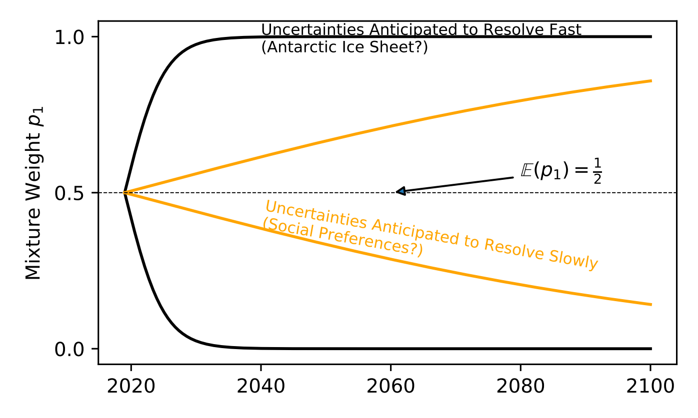
Model LFV as damped sine wave, vary phase ϕ:



Wrapup

Next steps

Decisions sensitive to rate at which uncertainties resolved



What have we learned?

- Premise: deferring capital costs can support flexibility.
- Magnitude of risk in the distant future matters a lot for our total costs, not much for optimal decision today
- If low-frequency variability dominates your near-term risk, adjust your decisions accordingly

Deferring investment $\neq$ be reactive

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Dowload annotated slides:

https://jamesdossgollin.me

References i

Cook, Edward R et al. (2010). “Megadroughts in North America: Placing IPCC Projections of Hydroclimatic Change in a Long-Term Palaeoclimate Context”. *Journal of Quaternary Science* 25.1. DOI: `10.1002/jqs.1303`.

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Supplemental Figures

LFV Matters I

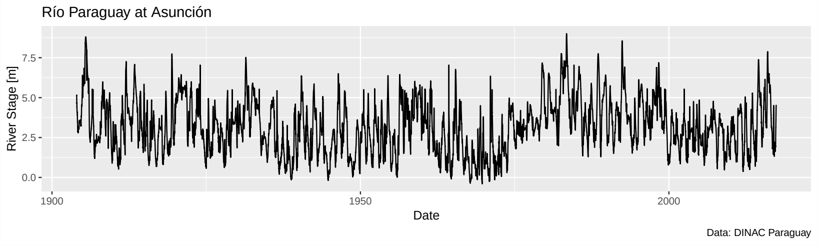

Figure A1: Río Paraguay at Asunción (Doss-Gollin et al., 2018)

LFV Matters II

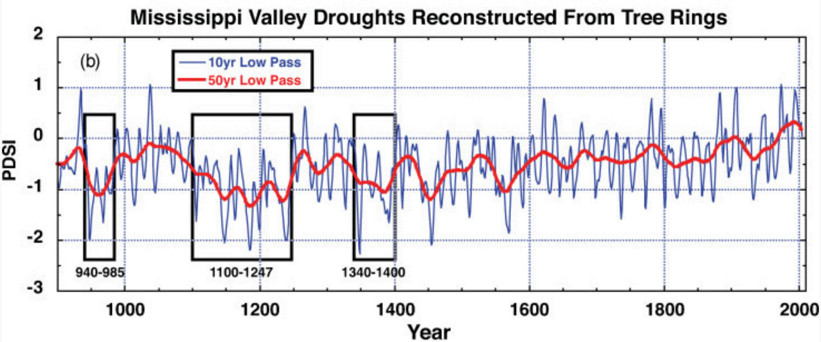

Figure A2: Fig. 8 of Cook et al. (2010)

LFV Matters III

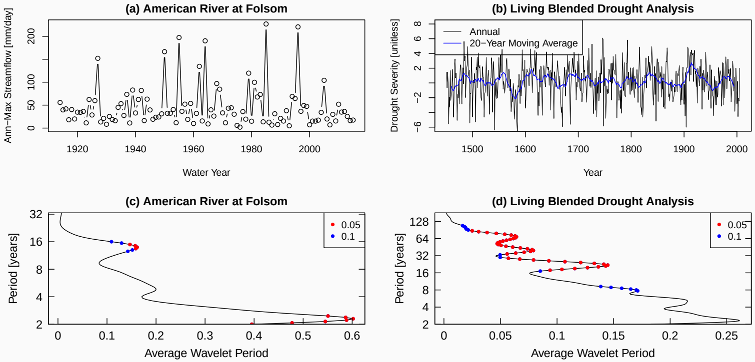

Figure A3: Fig. 1 of Doss-Gollin et al. (2019)

Case Study I

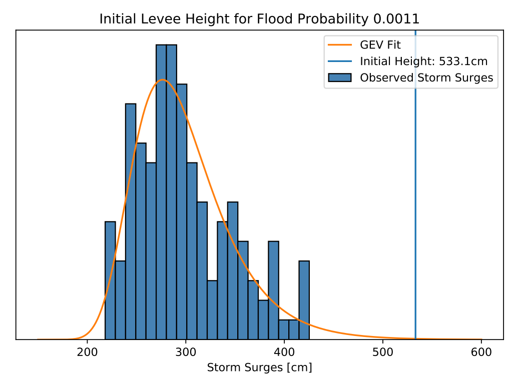

Figure A4: GEV Distribution of Storm Surges

Case Study Ii

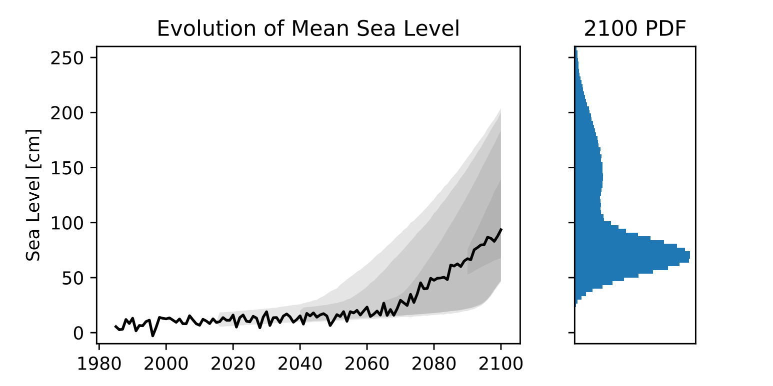

Figure A5: A more realistic parameterization of mean sea level Oddo et al. (based on 2017)