Supporting adaptive coastal planning under uncertain sea level rise using adaptation tipping points, pathways and detection of signals

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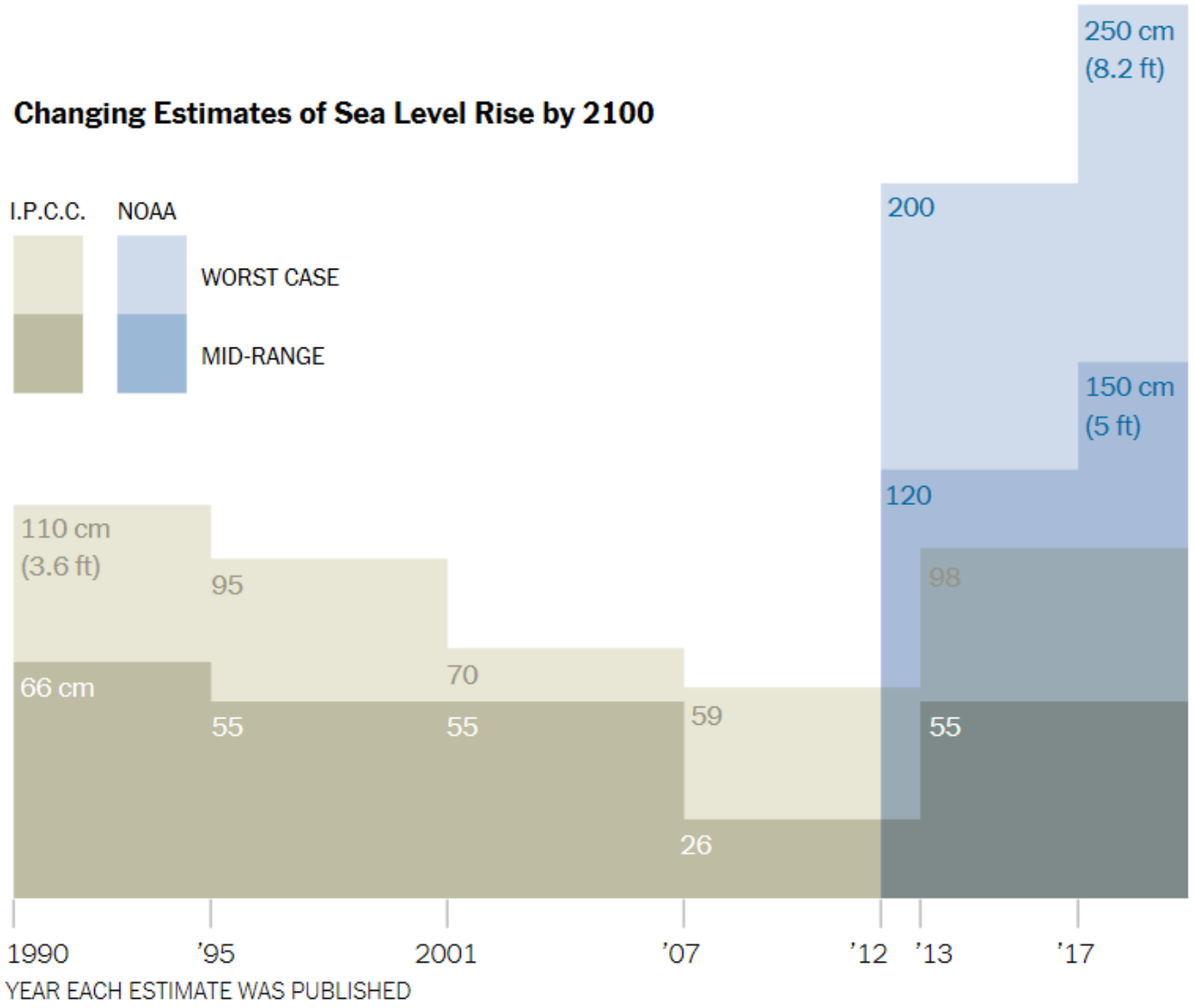
WCRP GRAND CHALLENGE AND CLIMATE SERVICES

Opinion

How Scientists Got Climate Change So Wrong

Few thought it would arrive so quickly. Now we're facing consequences once viewed as fringe scenarios.

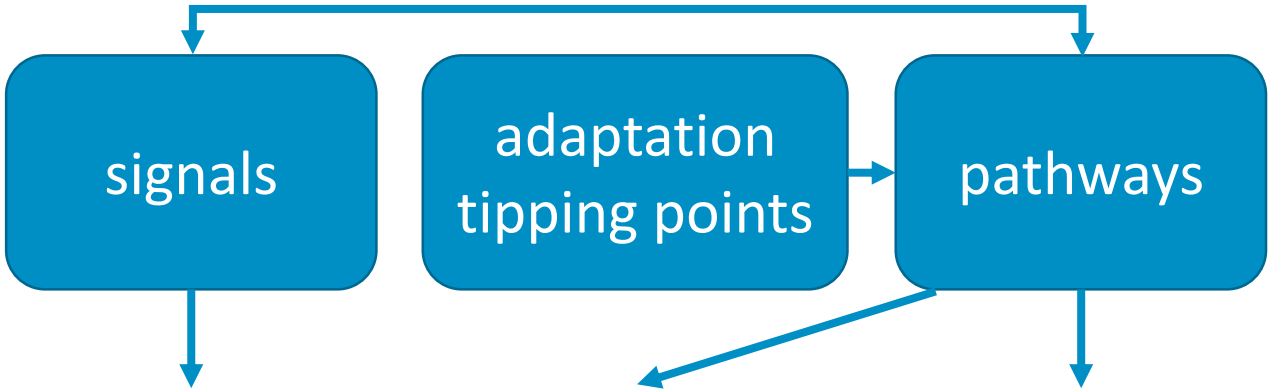
By Eugene Linden



Note: The I.P.C.C.'s 2007 estimate of future sea level rise did not include satellite data on the contribution of melt water from Greenland and Antarctica because of disagreements among scientists.

Larger bandwidth
Uncertainty increased
→ Deep uncertainty

Dynamic Adaptive Policy Pathways



When, how (much), how fast to adapt?

How to enable socio-economic developments under climate change?

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1. Describe system, objectives, uncertainties

2. Assess vulnerability/opportunities : adaptation/opportunity tipping point (ATP/OTP)

3. Identify actions and assess ATP conditions and timing

4. Develop and evaluate adaptation pathways

5. Design adaptive plan: short-term actions, long-term options and adaptation signals

6. Implement the plan

7. Monitor: ATP approaching? Actions or reassessment?

Reassess

Actions

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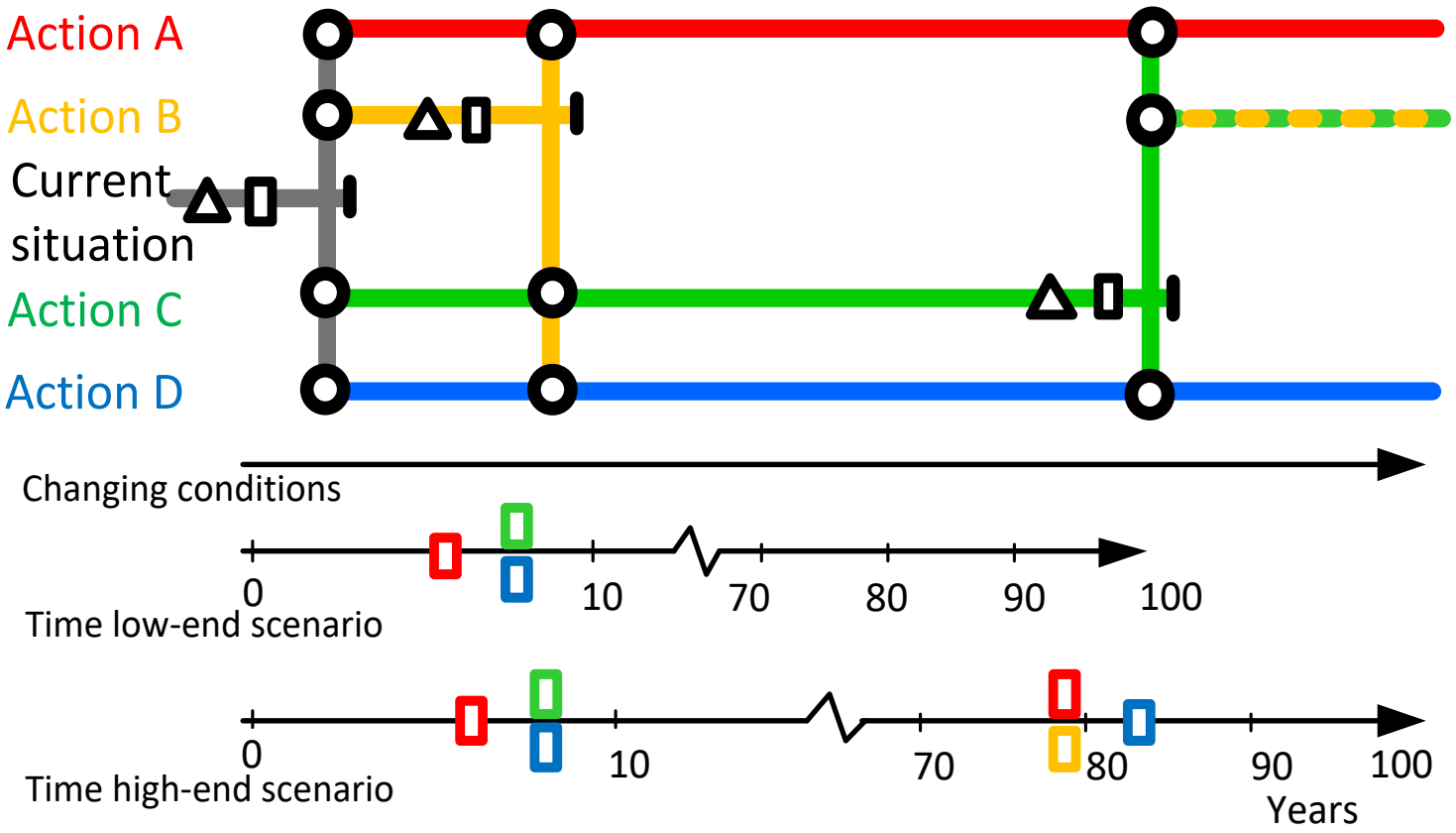
An adaptation pathways map shows different possible sequences of decisions to achieve objectives. A scorecard helps to evaluate the pathways and decisions.



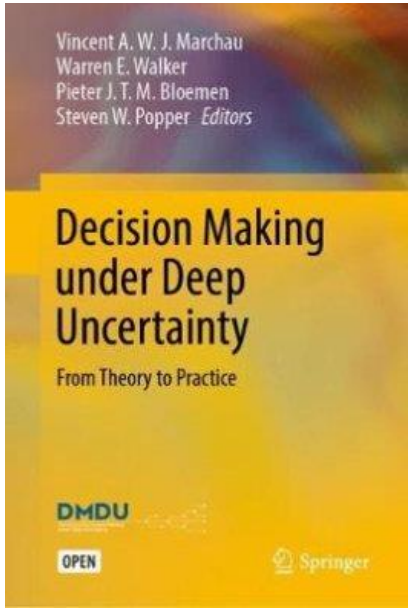
Transfer station to new policy action

Adaptation Tipping Point of a policy action (Terminal)

Policy action effective

Decision node

Adaptation signals based on signposts and trigger values



http://pathways.deltares.nl

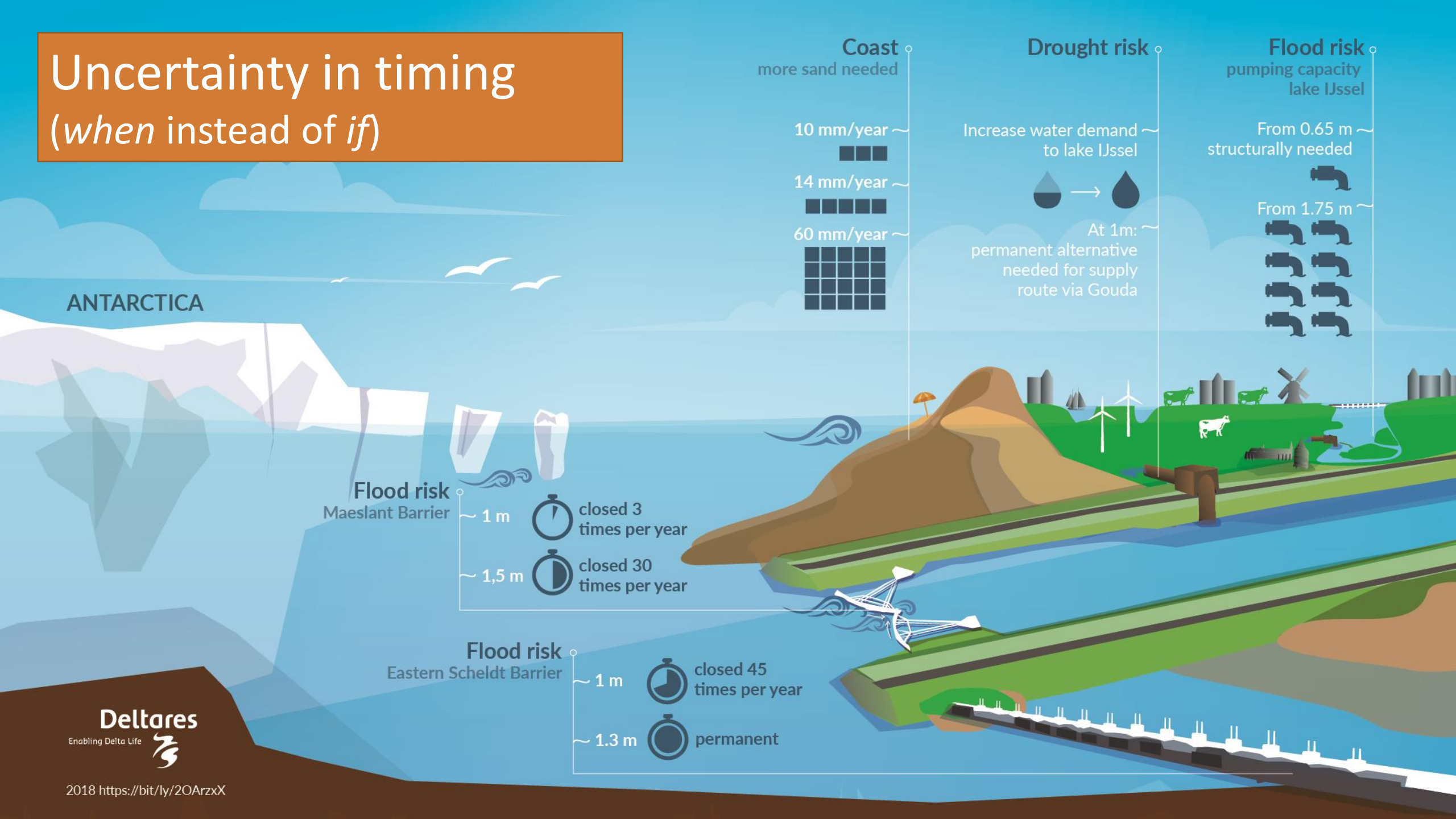
Haasnoot et al. 2013; Haasnoot et al. 2018 Glob. Env. Change, Haasnoot et al. 2019

Adaptation Tipping Points

How much change can a (portfolio) of measures address?

(thresholds, opportunities and limits)

Uncertainty in timing
(*when* instead of *if*)



Flood barriers will close more frequently and eventually overtop

- 1 m — closed 3 times per year
- 1.5 m — closed 30 times per year
- 1.2 m — design levels exceeded 1:10 years

- 1 m — closed 45 times per year
- 1.3 m — closed permanent
- 2.1 m — design levels exceeded 1:10 years

Haasnoot et al 2018 (in Dutch). Haasnoot et al (accepted) ERL

To what extent is sand nourishment flexible?

- 10 mm/year:

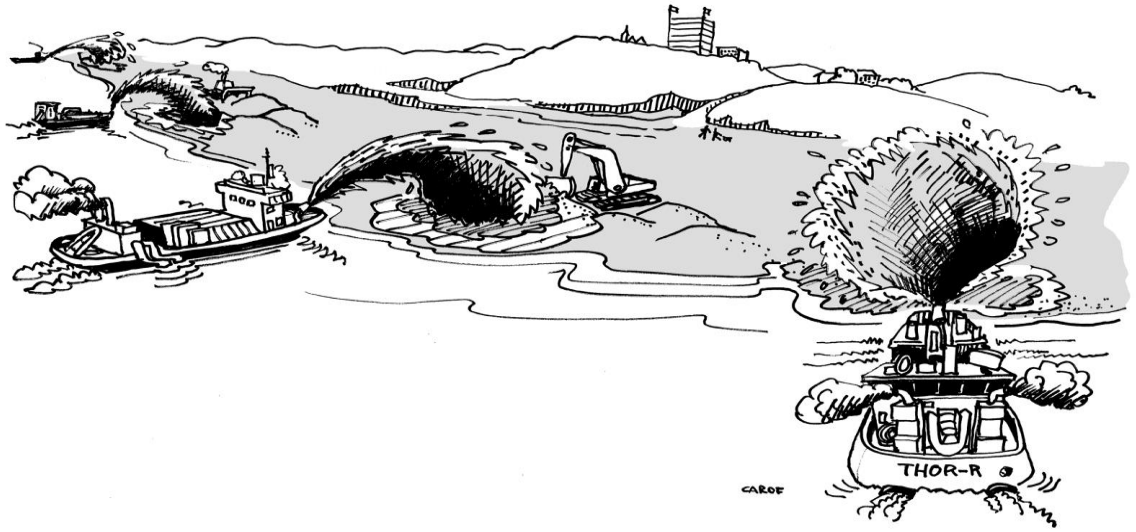
~2050

- 14 mm/year:

2070 - 2100

- 60 mm/year:

2100 ->



Haasnoot et al 2018 (in Dutch). Haasnoot et al (accepted) ERL

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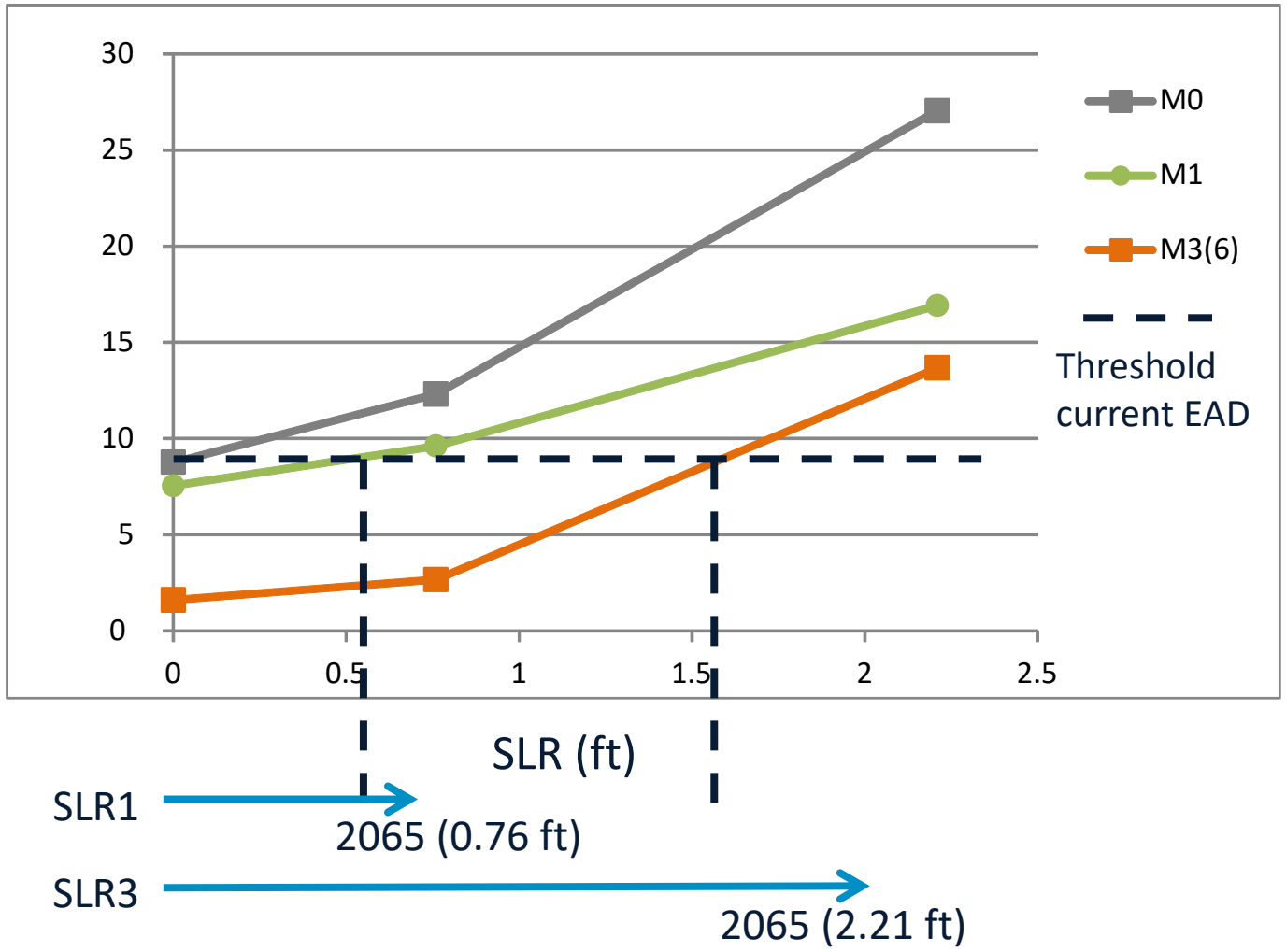
Adaptation pathways

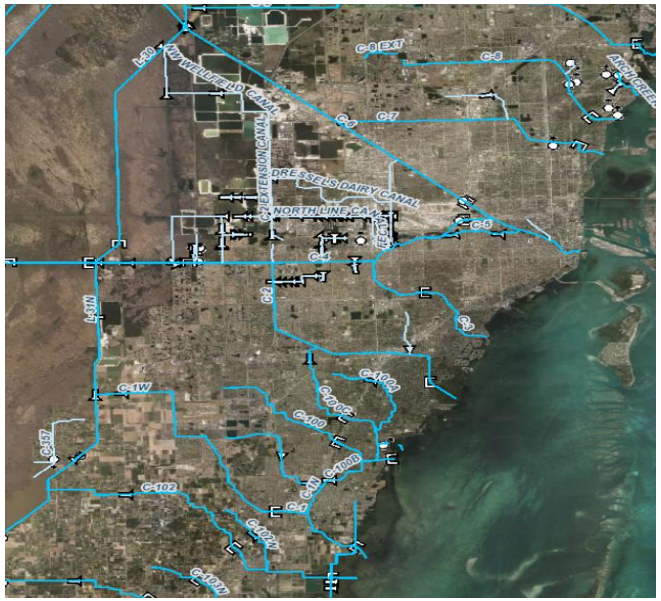
How (much) to adapt under uncertainty?

= limits, thresholds opportunities

Adaptation tipping points: scenario neutral assessment



Example adaptation to sea level rise Miami



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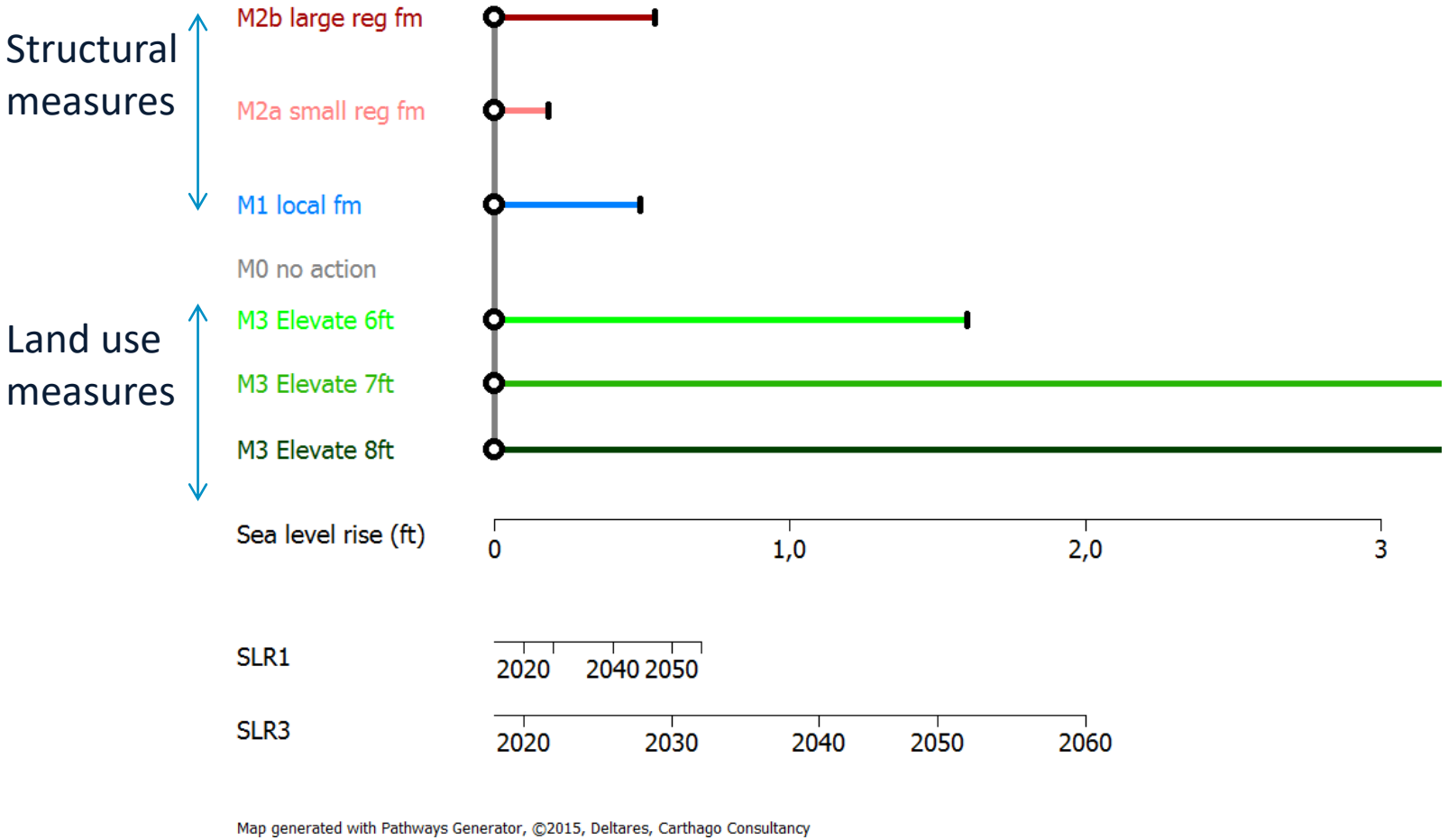
Adaptation tipping points: Kwadijk, J.C.J. et al 2010 WIRES Climate Change DOI: 10.1002/wcc.64 Miami: Bouwer et al 2018

Adaptive plan based on adaptation pathways



Map generated with Pathways Generator, ©2015, Deltares, Carthago Consultancy

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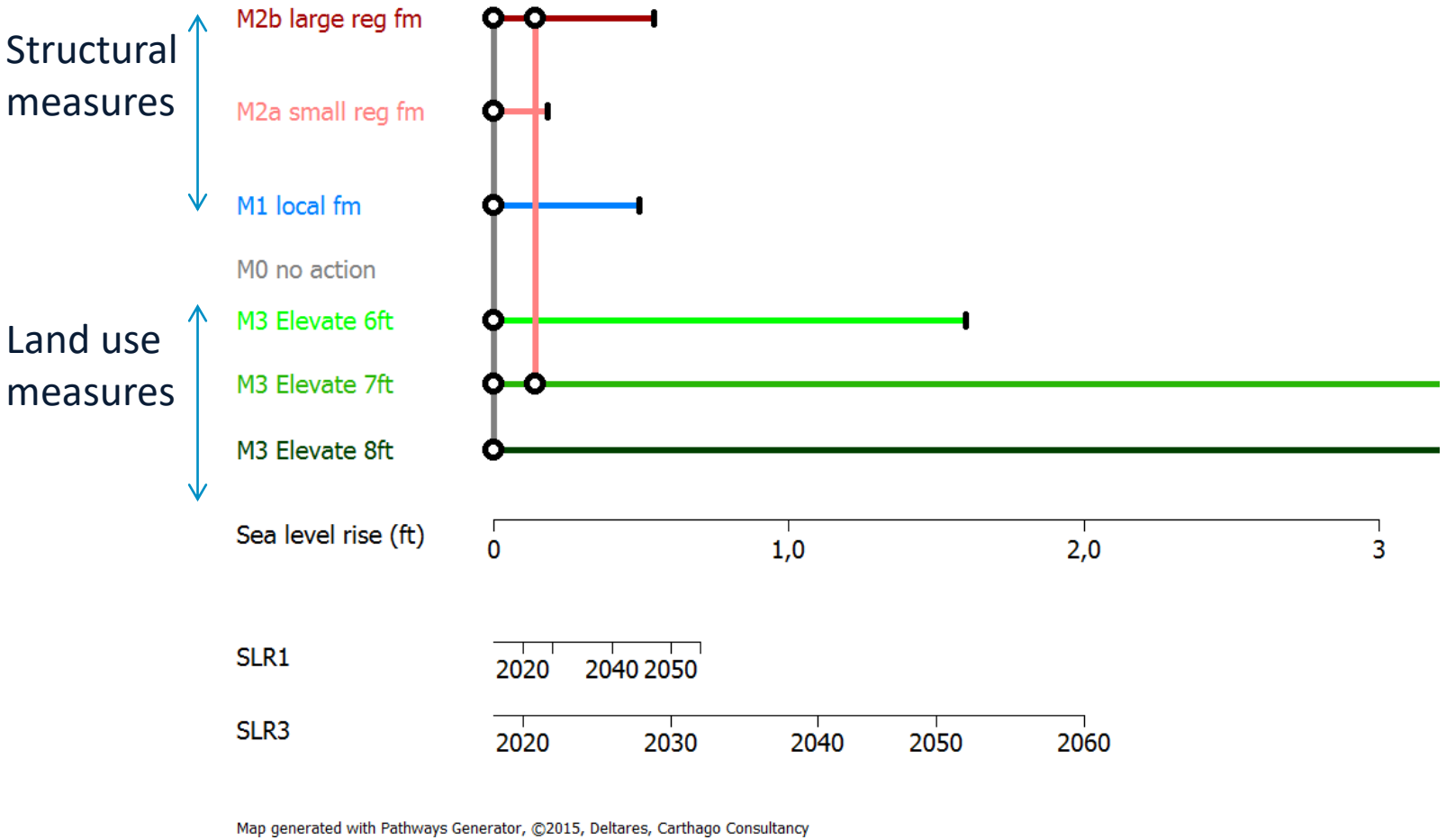
Adaptive plan based on adaptation pathways



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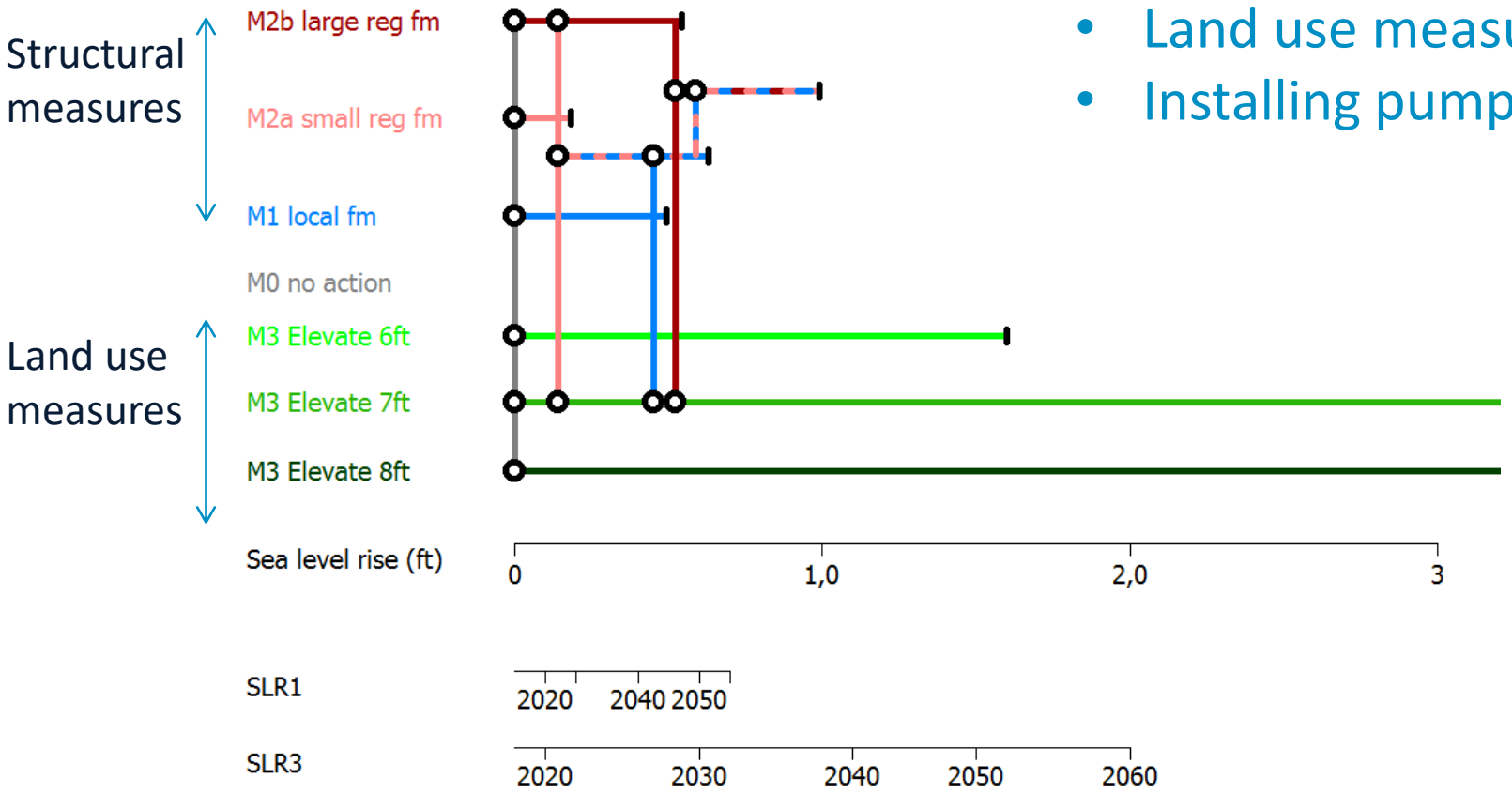
Adaptive plan based on adaptation pathways



- Land use measures are needed in the end
- Installing pumps can buy some time.

Map generated with Pathways Generator, ©2015, Deltares, Carthago Consultancy

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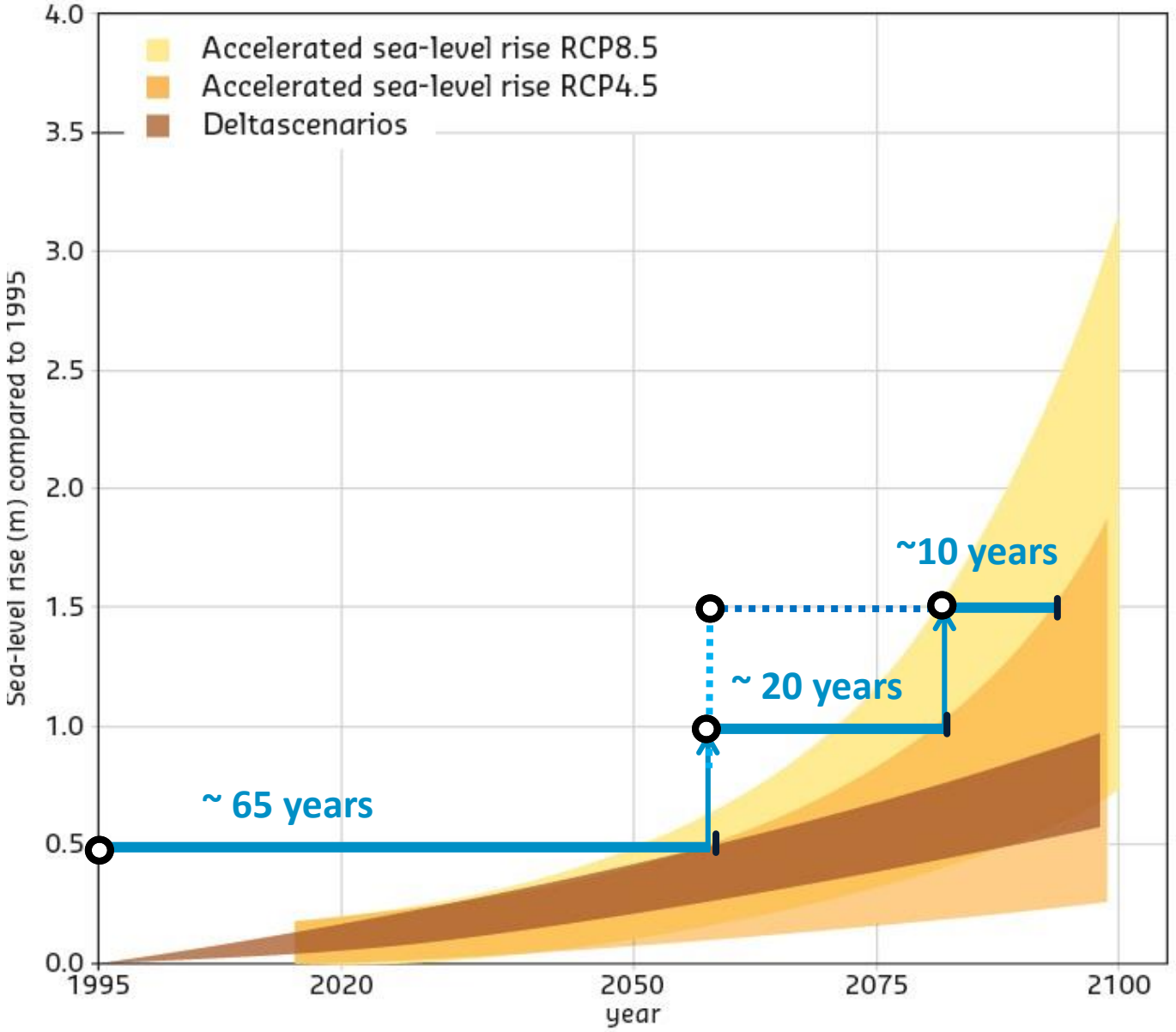

Limits due to rate of change?

Functional life time of investments decreases:

adapt faster or larger

Haasnoot et al. 2018 https://bit.ly/2OArzxX (in dutch). Haasnoot et al. (accepted) ERL
Source SLR data: Le Bars et al 2017 ERL

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Signals

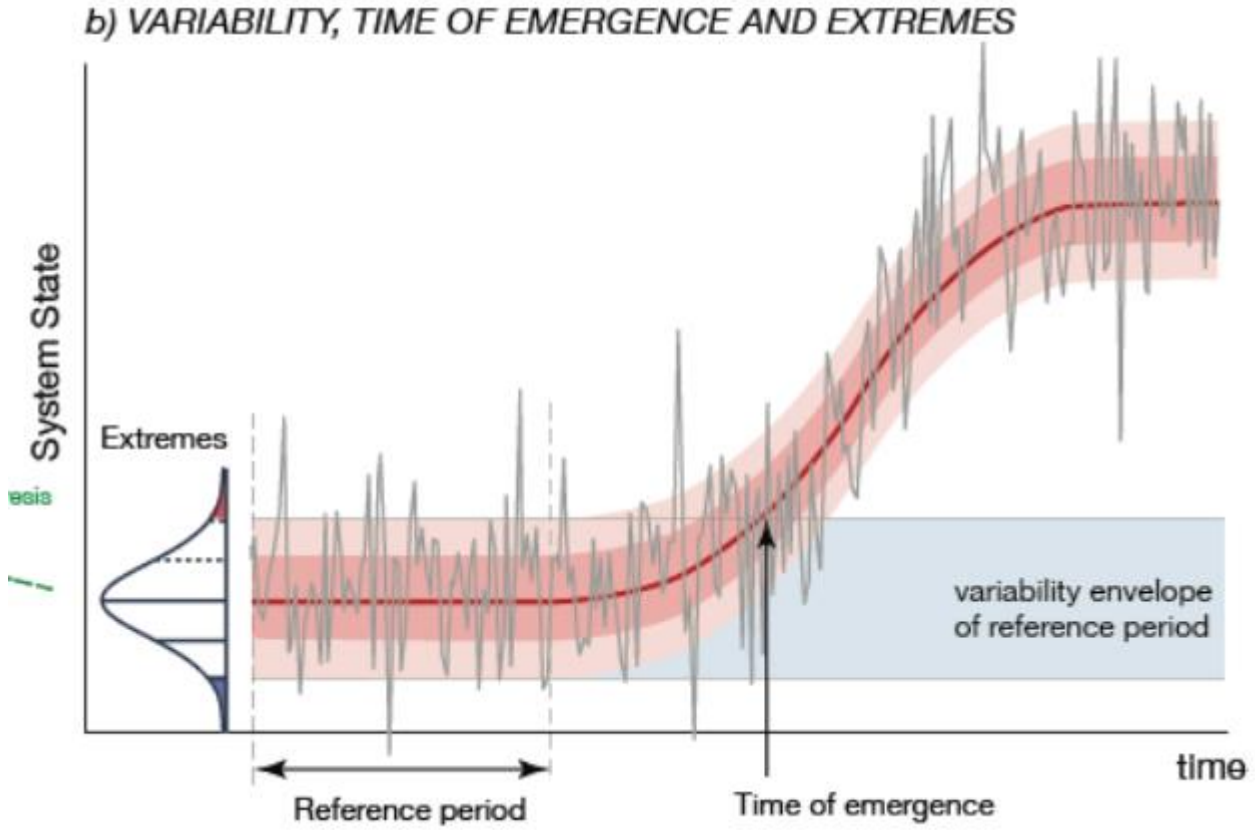
When to implement or reassess the adaptive plan?

Monitoring, analysis and evaluation of early warning indicators

Monitoring to detect signals for implementation or adjustment

- Timely, reliable, convincing to act

- Trend, Rate, Time of emergence
- Observations and projections



Hawkins and Sutton, 2012

Haasnoot, M. et al. (2018). Designing a monitoring system.. GEC 10.1016/j.gloenvcha.2018.08.003

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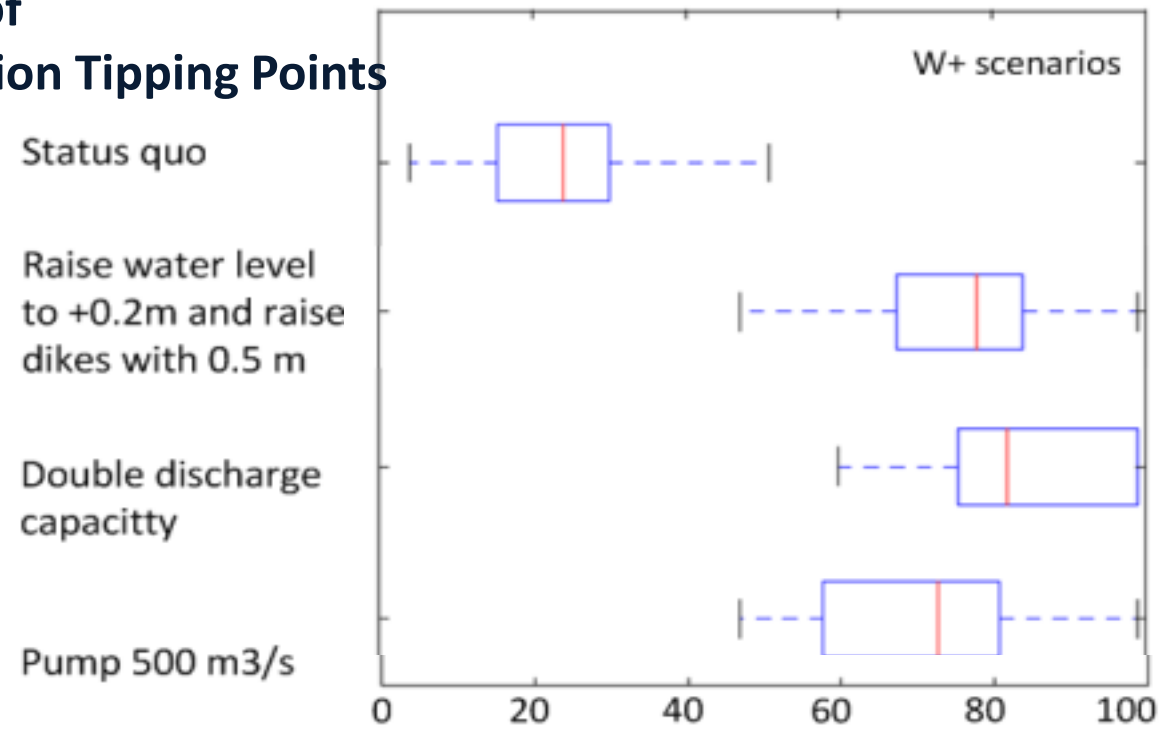
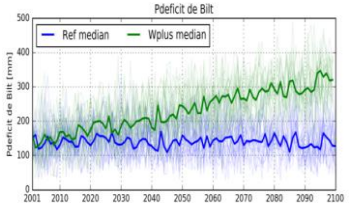
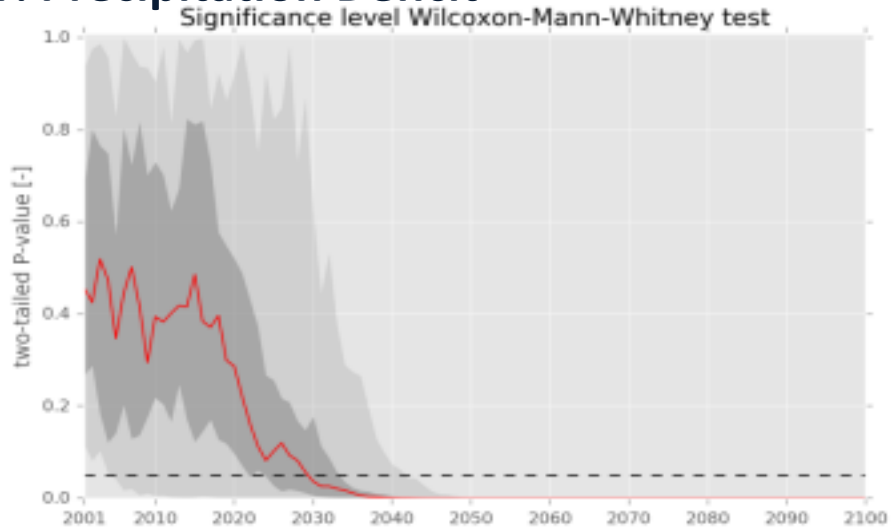
Timing of Adaptation Tipping Points



Early warning inidicator: Precipitation Deficit





Significance (p-value) could be used to categorise the signal:

- <5% strong signal,
- 5-15% moderate signal,
- <25% weak signal

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Summary

Decision services

Climate services

- Adaptation tipping points to assess *if* and use scenarios to assess *when* limits, thresholds, opportunities may occur. Use amount and rate of change to assess them
- Explore adaptation pathways → adaptive plan
- Beyond 2100 for investments with long life time
- Low to high-end scenarios to assess incremental and transformative decisions, and consider lead time
- Signal Monitoring System: timely, reliable, convincing. Not only about what to measure but also how to analyse

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