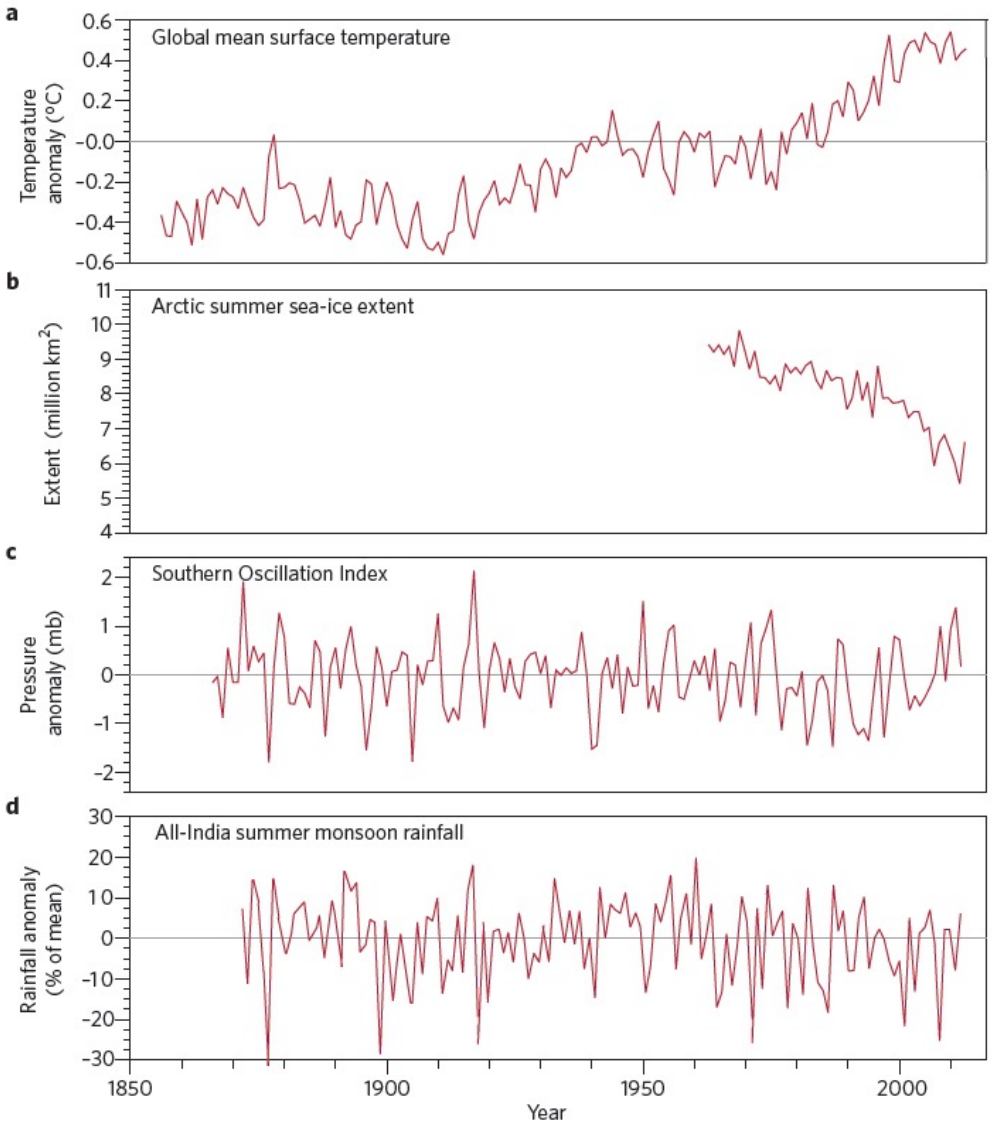
METEOROLOGY

University of Reading

NAVIGATING CLIMATE PROJECTIONS FOR DECISION MAKING AT REGIONAL AND LOCAL LEVEL

Ted Shepherd, Grantham Chair of Climate Science

Department of Meteorology, University of Reading



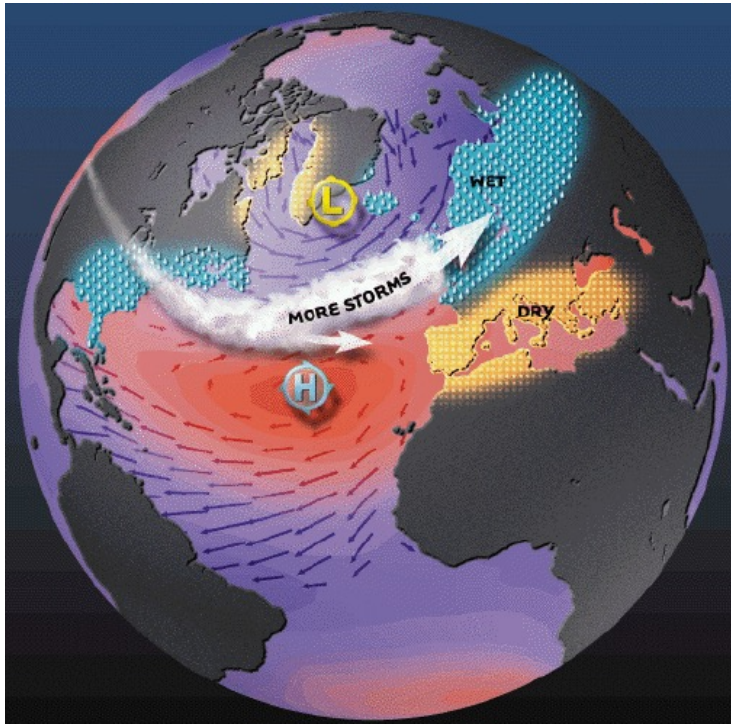
- Clear changes are evident in long-term observed records of temperature-related climate indices (high S/N ratio) ➔ Detection & Attribution

- Indices related to atmospheric circulation generally do not show clear long-term changes
- Climate models can give very different predictions
- There is no *accepted* theory of any such changes

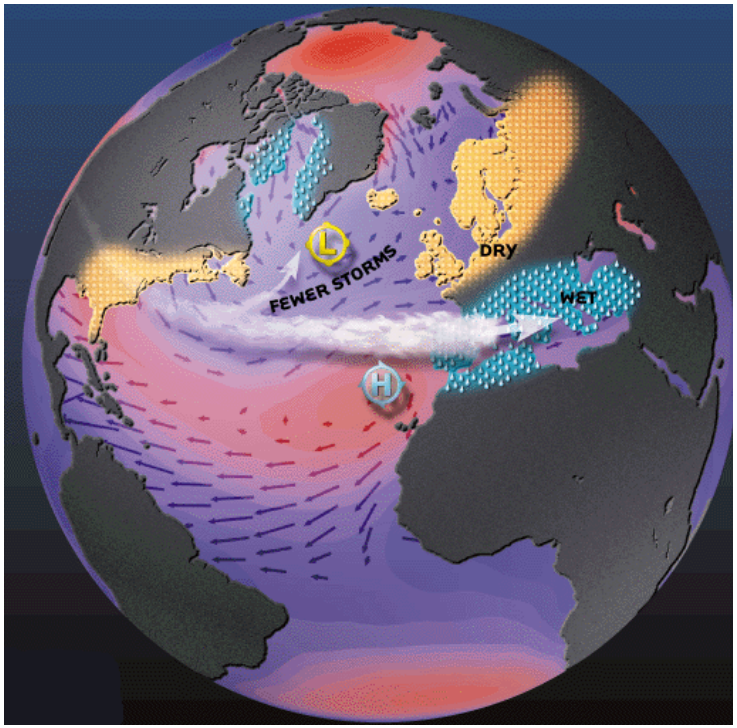
Shepherd (2014 Nature Geosci.)

- **Yet atmospheric circulation patterns** exert a very strong control on climate and climate variability at the regional scale
  - For example, the “North Atlantic Oscillation” (NAO) affects weather and climate extremes over Europe through **shifts in the jet stream**

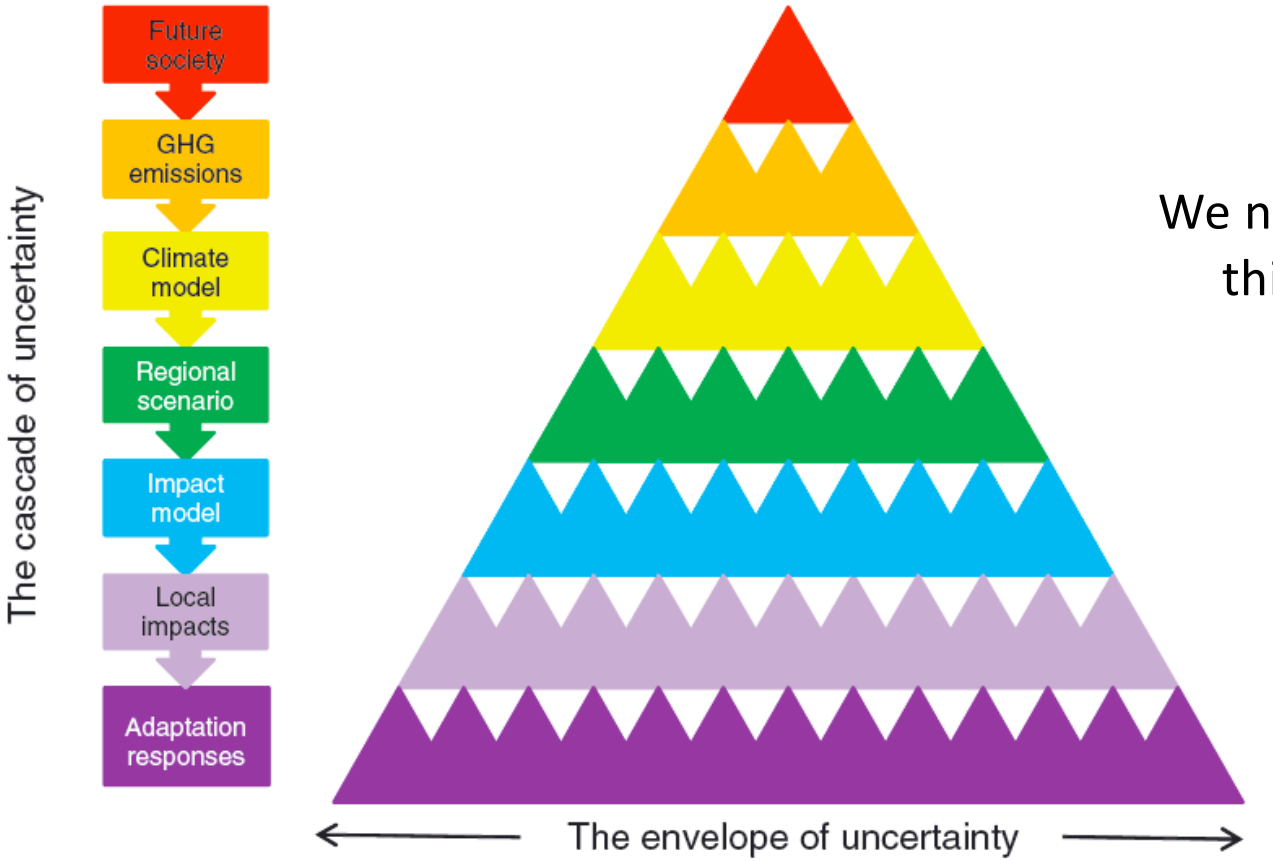
NAO positive phase



NAO negative phase



- Consideration of all the uncertainties in climate change in the traditional way leads to a "**cascade of uncertainty**" which obscures the climate information content

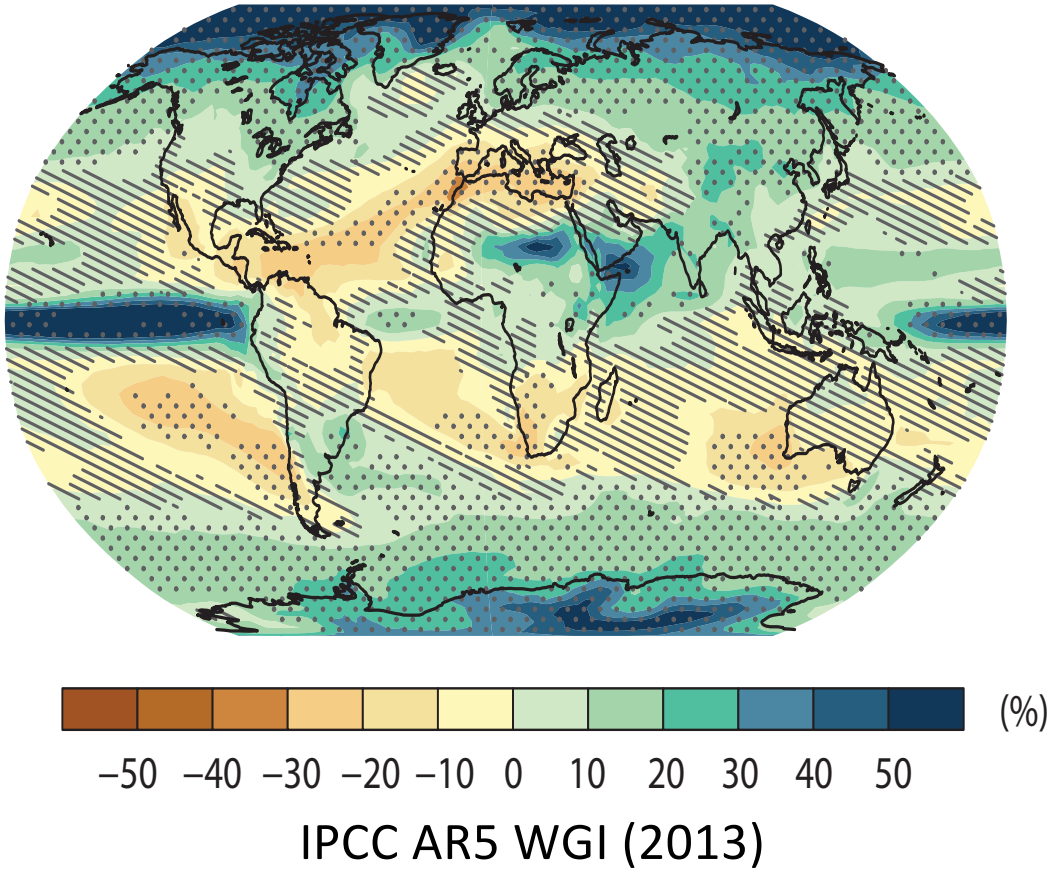


We need to navigate this somehow!

Wilby & Dessai (2010 Weather)

The IPCC AR5 narrative on the water cycle

Changes in the global water cycle in response to the warming over the 21st century will not be uniform. The contrast in precipitation between wet and dry regions and between wet and dry seasons will increase, although there may be regional exceptions (see Figure SPM.8).



IPCC AR5 WGI (2013)

- The statement achieves its reliability in the tropics by including the (very extensive) oceanic regions, but it is precipitation over land that matters
- The final caveat also increases reliability
- Together they make the statement completely **uninformative** for any particular region over land!

Reliability is achieved at the price of informativeness

See also Løhre et al. (2019 Wea. Clim. Soc.)

- The climate science community's consensus view on the North Atlantic **storm track response to climate change** (IPCC WGI AR5 Technical Summary):
  - The AR5 SPM was completely silent on circulation changes!

> *"Substantial uncertainty and thus low confidence remains in projecting changes in NH storm tracks, especially for the North Atlantic basin."*
>
> *"…it is unlikely that the response of the North Atlantic storm track is a simple poleward shift"*

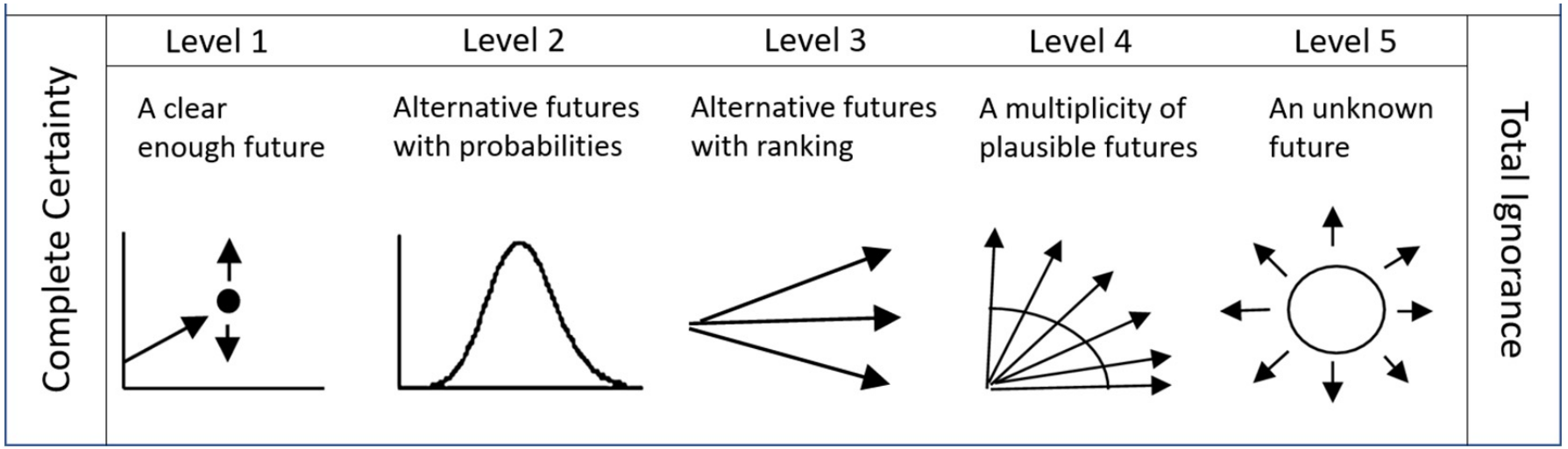
- Note that in IPCC WGI, the word "unlikely" is generally used to *dismiss* possibilities
  - Tends to de-emphasize risk (Juanchich, Shepherd & Sirota 2020 Clim. Change)

Term*	Likelihood of the outcome
Virtually certain	99–100% probability
Very likely	90–100% probability
Likely	66–100% probability
About as likely as not	33–66% probability
Unlikely	0–33% probability
Very unlikely	0–10% probability
Exceptionally unlikely	0–1% probability

The IPCC calibrated uncertainty language does not seem to correspond to common usage!

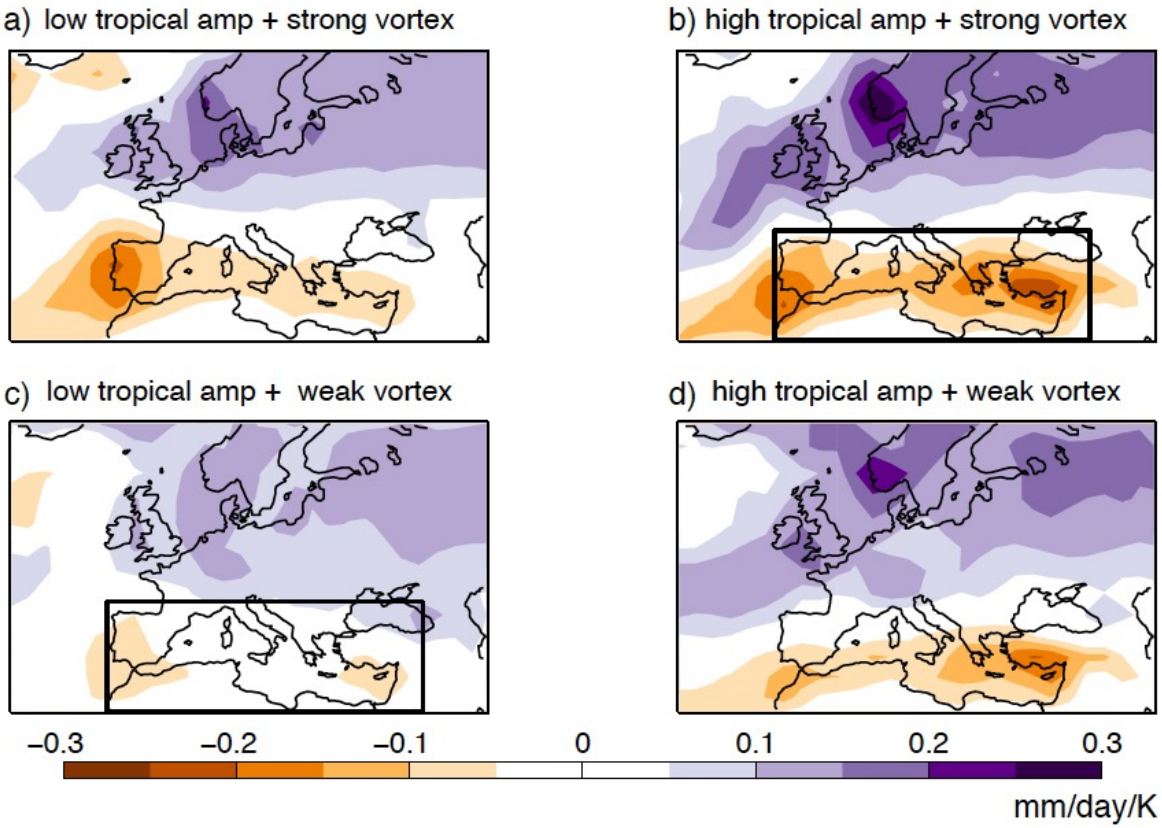
- Scientists are pressured to issue ‘single, definitive’ statements (Stirling 2010 Nature)
- We need a language for expressing a **‘plural, conditional’ state of knowledge**
    - There are many decision-making methods that deal with deep uncertainty (Weaver et al. 2013 WIREs Clim Change; Rosner et al. 2014 Water Resources Res)

Levels of uncertainty



Adapted from Marchau et al. (2019)

- Even where precipitation projections are reasonably robust in sign, there can be significant quantitative uncertainty even for specified global warming levels
  - Four **storylines of future cold-season Mediterranean drying**
    - So far as we know, any one of these could be true

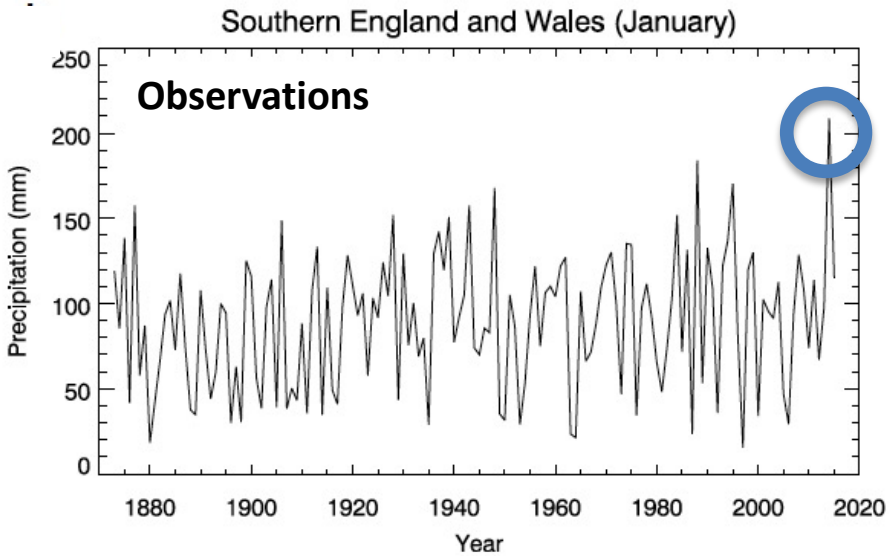


Physical climate storyline: physically self-consistent unfolding of past events, or of plausible future events or pathways (Shepherd et al. 2018 Climatic Change)

Zappa & Shepherd (2017 J. Clim.)

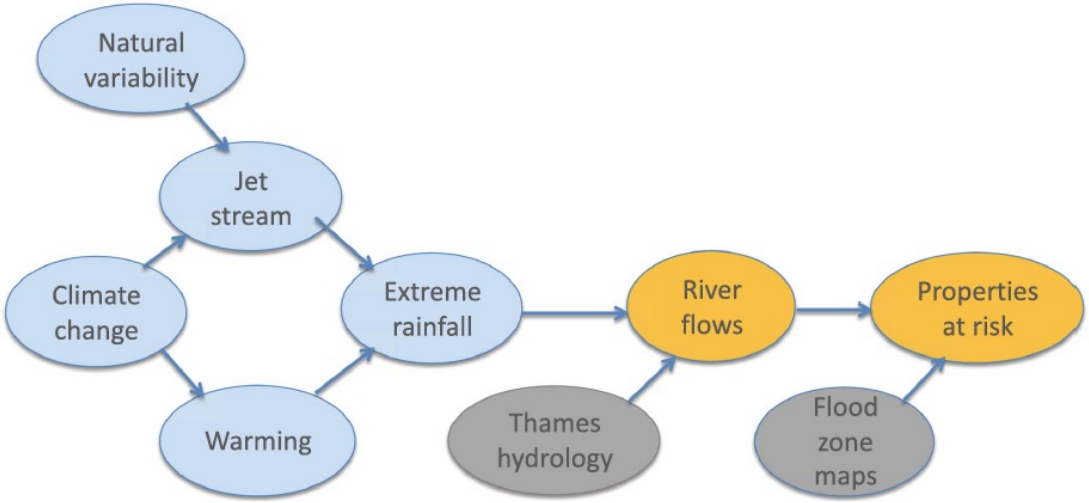
Understanding historical events: Thames Valley flooding in early 2014

- The proximate explanation for the record precipitation was the “stuck” jet stream, but there is no accepted view on whether this is more or less likely under climate change (let alone by how much)



Shepherd (2016 Curr. Clim. Change Rep.)

- Different storylines (causal accounts) of the event, and of potential future such events, can be represented through a causal network
- Provides a way to represent complex environments and adaptation options, bringing meaning to the climate information



Lloyd & Shepherd (2020 Ann. NY Acad. Sci.)

- We actually have a wealth of information relevant to climate change, even (and sometimes more so) on the local scale (e.g. Hall 2014 Science)
  - Rather than being a ‘confounding effect’ for the effects of climate change, **the urban heat island effect is a threat multiplier for heat waves**

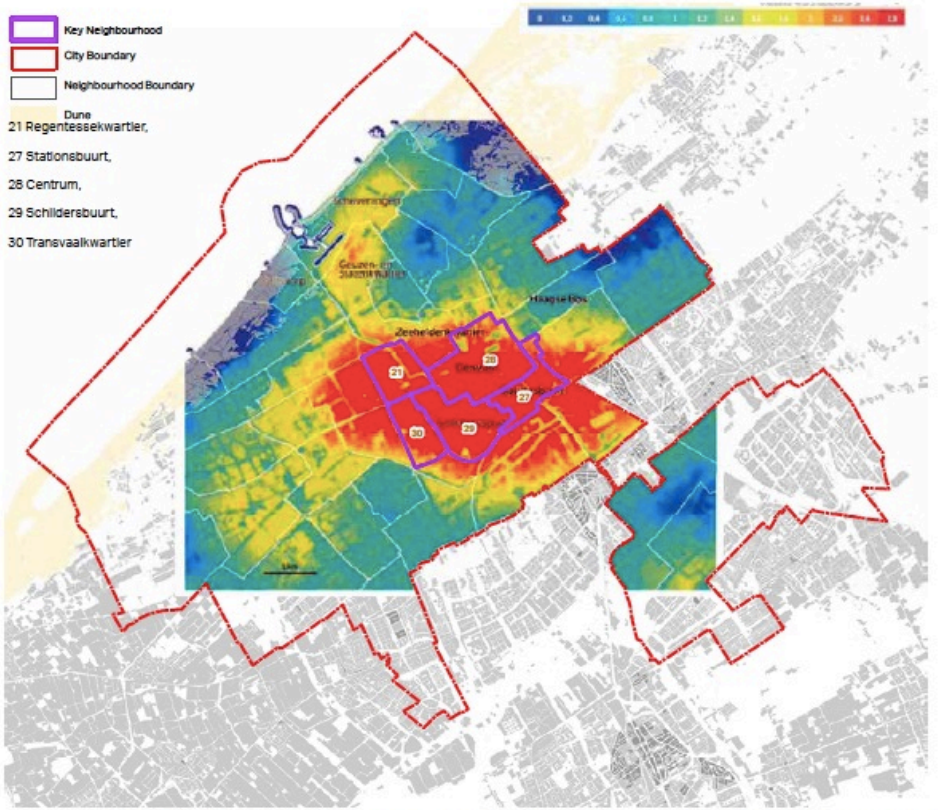


Figure 2–8: The urban heat island effect in The Hague – increased heat will affect more vulnerable neighbourhoods in The Hague

Urban heat island effect in The Hague, based on a recent heat wave

Not surprisingly, the poor neighbourhoods were disproportionately affected

From The Hague Resilience Assessment (January 2018)

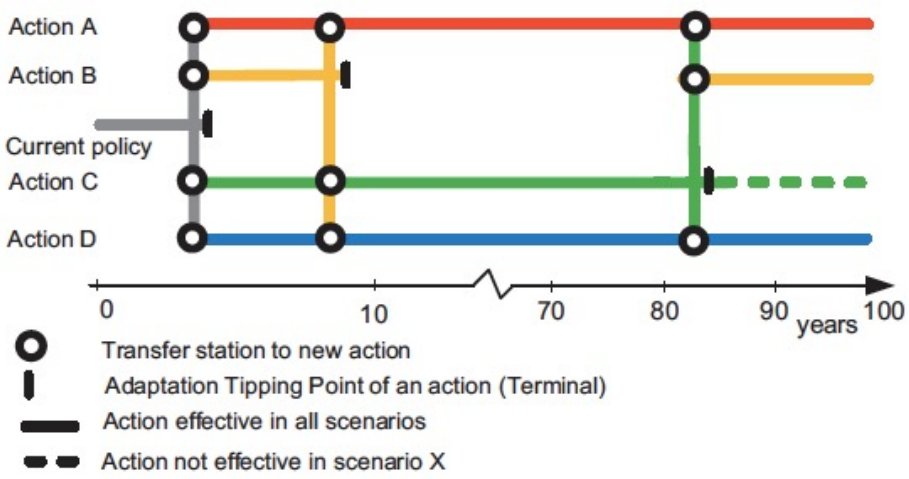
Climatic Change (2021) 166:8
https://doi.org/10.1007/s10584-021-03108-x

Check for updates

Usable climate science is adaptation science

Adam H. Sobel [1]

- The **Dynamic Adaptation Pathways** approach relates future climate scenarios to policy options, providing guidance on required decision points
- Here, Action B might be a local adaptation measure, C a regional infrastructure measure, and A and D major land use changes



Haasnoot et al. (2013 Glob. Env. Change)

Concluding Remarks

- To address adaptation challenges, we need to navigate the "**cascade of uncertainty**" in climate projections, and connect to the decision space
- We need to find a scientific language for describing the "**plural, conditional**" state of knowledge that exists at regional and local scales, and **resist aggregation**
  - The **storyline approach** to regional climate information does exactly this (see Shepherd 2019 Proc. Roy. Soc. A, doi: 10.1098/rspa.2019.0013)
- Linking to historical events, in their proper context, brings a **salience to the risk**; well understood psychologically
  - Storylines also provide a **built-in (not contrived) narrative**, hence an emotional element, which is essential for decision-making (Damasio 1994; Davies 2018)
- We need to explore storylines of climate risk, combining the best information from all sources — **interpreted not as a prediction but as representing plausible futures**

This is our ambition in the WCRP's "My Climate Risk" Lighthouse Activity, starting from the decision space in locally-based Communities of Practice