STORYLINES OF HIGH-IMPACT CLIMATE EVENTS

Sharing is encouraged

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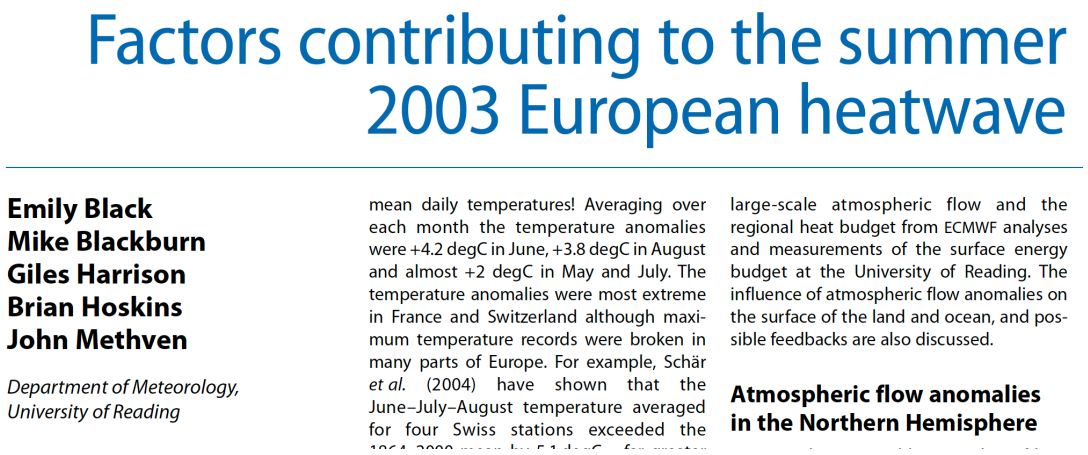
A study in contrasts

- Black et al. (2004) explored in detail the various causal factors behind the 2003 European heatwave: persistent anticylone, SST anomalies, drying of land surface, surface fluxes....
  - "*It is not known at this time why the large-scale circulation had the character it did*."
- Stott et al. (2004) ignored all those factors and targeted a much weaker, coarse-grained 'event' of only 1.6°C above the mean, to avoid 'selection bias'
- Black et al. is certainly highly cited, but Stott et al. has become the dominant paradigm



Factors contributing to the summer 2003 European heatwave

Emily Black
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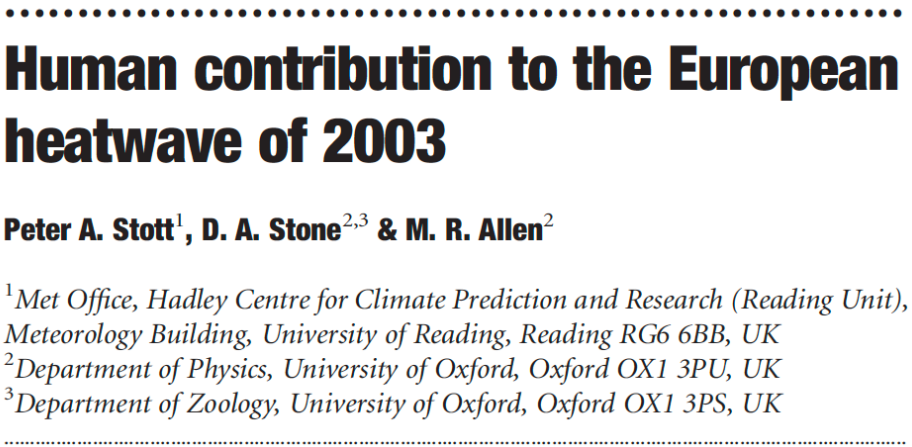
mean daily temperatures! Averaging over each month the temperature anomalies were +4.2 degC in June, +3.8 degC in August and almost +2 degC in May and July. The temperature anomalies were most extreme in France and Switzerland although maximum temperature records were broken in many parts of Europe. For example, Schär *et al.* (2004) have shown that the June–July–August temperature averaged for four Swiss stations exceeded the

large-scale atmospheric flow and the regional heat budget from ECMWF analyses and measurements of the surface energy budget at the University of Reading. The influence of atmospheric flow anomalies on the surface of the land and ocean, and possible feedbacks are also discussed.

Atmospheric flow anomalies in the Northern Hemisphere

Weather (2004)



Human contribution to the European heatwave of 2003

Peter A. Stott[1], **D. A. Stone**[2,3] **& M. R. Allen**[2]

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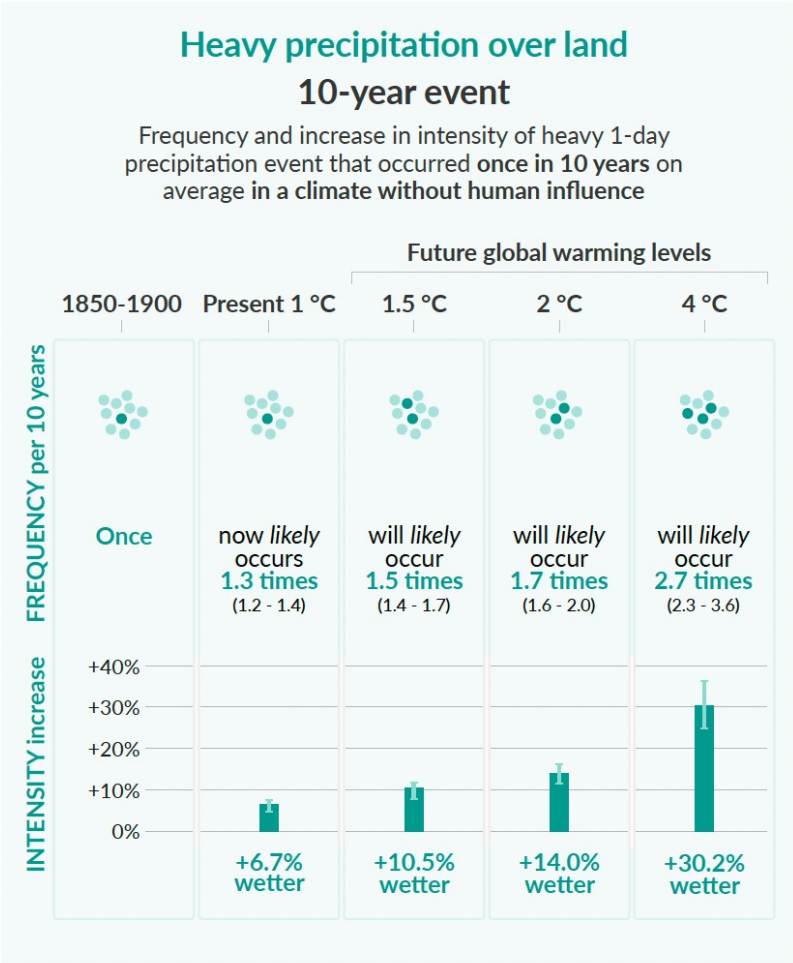
Nature (2004)

- Climate scientists like to describe changes in extreme events **probabilistically**, which requires **aggregation**



IPCC AR6 WGI SPM (2021)

- Here the aggregation is over the **entire land surface** and **all kinds of heavy precipitation events**
  - Does this make any sense?
- Note that the increased intensity simply follows Clausius-Clapeyron scaling
  - This is informative, but it is really only a prior
- A factor that increases risk across a (statistical) population, while of relevance for anybody interested in effects on entire populations, **cannot be reliably applied to individuals within that population,** because **the real world is not iid** (e.g. Bueno de Mesquita & Fowler 2021 *Thinking Clearly with Data*)
- This is very well understood in other disciplines; **so why is it not understood within climate science?**

- The most severe climate impacts are often exacerbated by the **human-modified environment**
  - Rather than being a ‘confounding effect’ for the effects of climate change, **the urban heat island effect is a threat multiplier for heat waves**

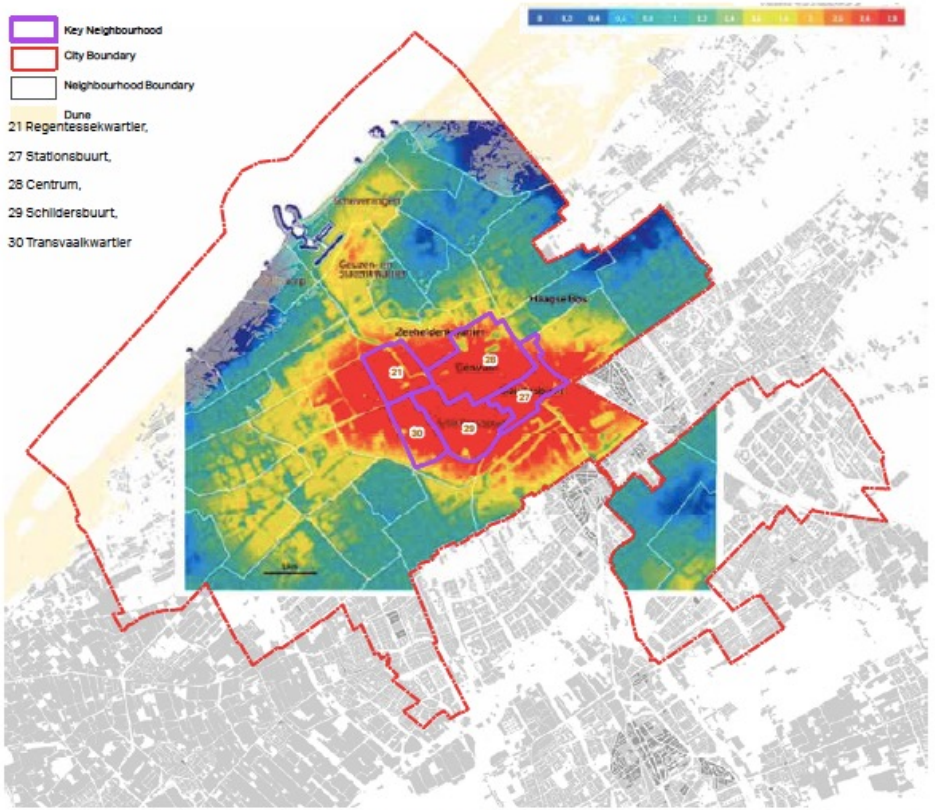


Figure 2–8: The urban heat island effect in The Hague – increased heat will affect more vulnerable neighbourhoods in The Hague

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)

There is no such thing as a "natural" disaster

- Representing the socio-economic situation and the managed environment at a local scale is crucial, as **there are always multiple causal factors**

- **We need a forensic approach**, not a yes/no attribution to climate change
- Moreover, the socio-economic situation and the managed environment are precisely the causal factors that are to be addressed through adaptation measures!

Libya flooding of 2023
Karim Sahib—AFP/Getty Images

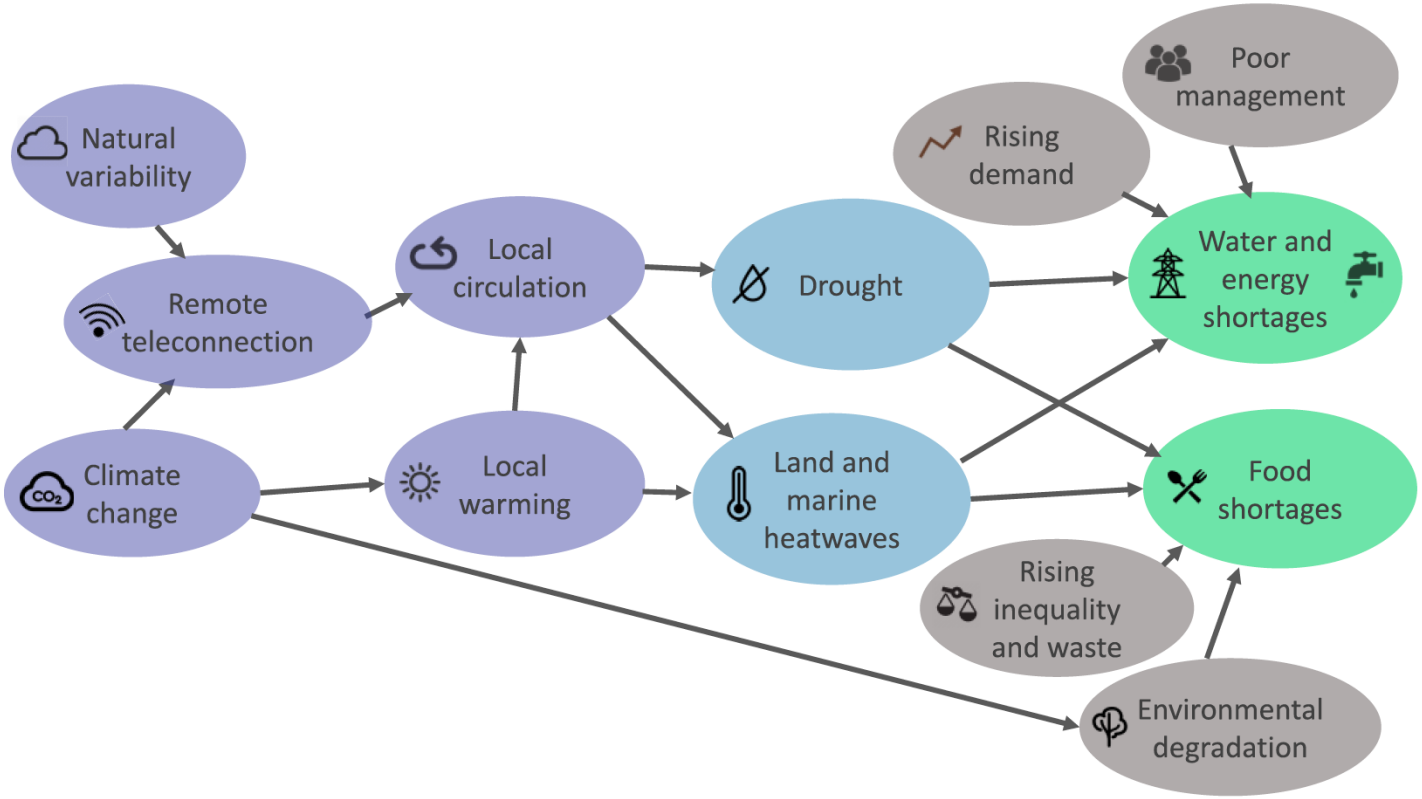
There is no such thing as a "natural" disaster

TABLE 10.1
Comparative Analysis of Four Famines

Which famine?	*Was there a food availability collapse?*	*Which occupation group provided the largest number of famine victims?*	*Did that group suffer substantial endowment loss?*	*Did that group suffer exchange entitlement shifts?*	*Did that group suffer direct entitlement failure?*	*Did that group suffer trade entitlement failure?*	*What was the general economist climate*
Bengal famine 1943	No	Rural labour	No	Yes	No	Yes	Boom
Ethiopian famine (Wollo) 1973	No	Farmer	A little, Yes	Yes	Yes	No	Slump
Ethiopian famine (Harerghe) 1974	Yes	Pastoralist	Yes	Yes	Yes	Yes	Slump
Bangladesh famine 1974	No	Rural labour	Earlier, yes	Yes	No	Yes	Mixed

Amartya Sen (1981 *Poverty and Famines*)

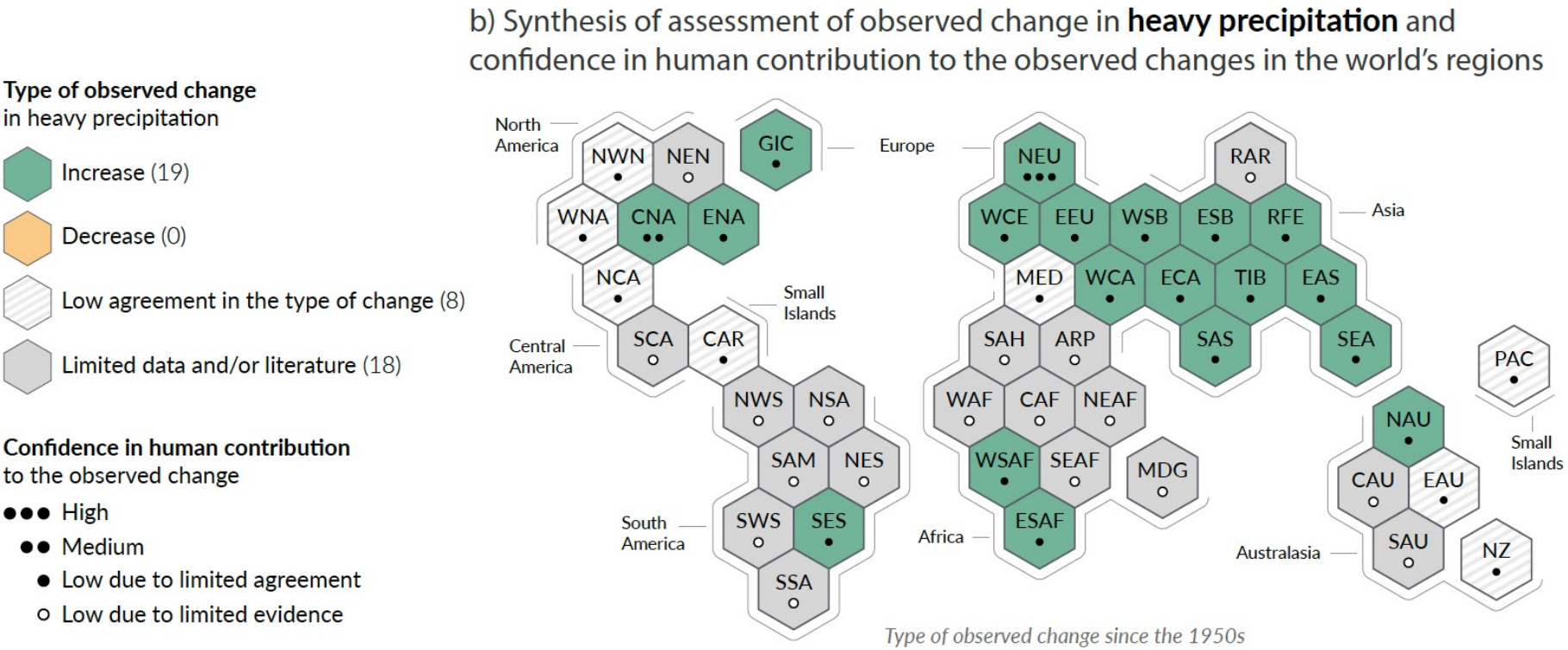
- The relevant causal factors and their connections to impacts can be represented in a **causal network,** which can be used to define **storylines**
  - Provides a powerful alternative to traditional (unconditional) attribution when uncertainties are high (Lloyd & Shepherd 2023 Env. Res. Clim.)



Example of the crisis across the food-water-energy nexus in SE Brazil from the failure of the 2013/14 monsoon

Rodrigues & Shepherd (2022 PNAS Nexus)

- Storylines can also be used to overcome the limitations faced by probabilistic attribution of changes in extremes which arise not only by **uncertainties in model projections**, but also by a **lack of verifying data**
  - Represents a form of epistemic injustice (Shepherd & Sobel 2020 CSAAME)



IPCC AR6 WGI SPM (2021)

Concluding Remarks

- To address adaptation challenges, we need to navigate the **'cascade of uncertainty'** in climate projections, and connect to the decision space
  - The **societally relevant question** is not "What will happen?" but rather "What is the impact of particular actions under an uncertain regional climate change?"
- 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)
- A factor that increases risk across a (statistical) population cannot be reliably applied to individuals within that population – **why don't we get this?**
  - Generalizations (e.g. through climatic impact-drivers) are **useful priors, but no more**
- **There is no such thing as a "natural" disaster**; there are always multiple causal factors
  - We are doing a scientific disservice if we do not consider the local, contingent factors that can lead to high-impact climate events; these are our adaptation targets