

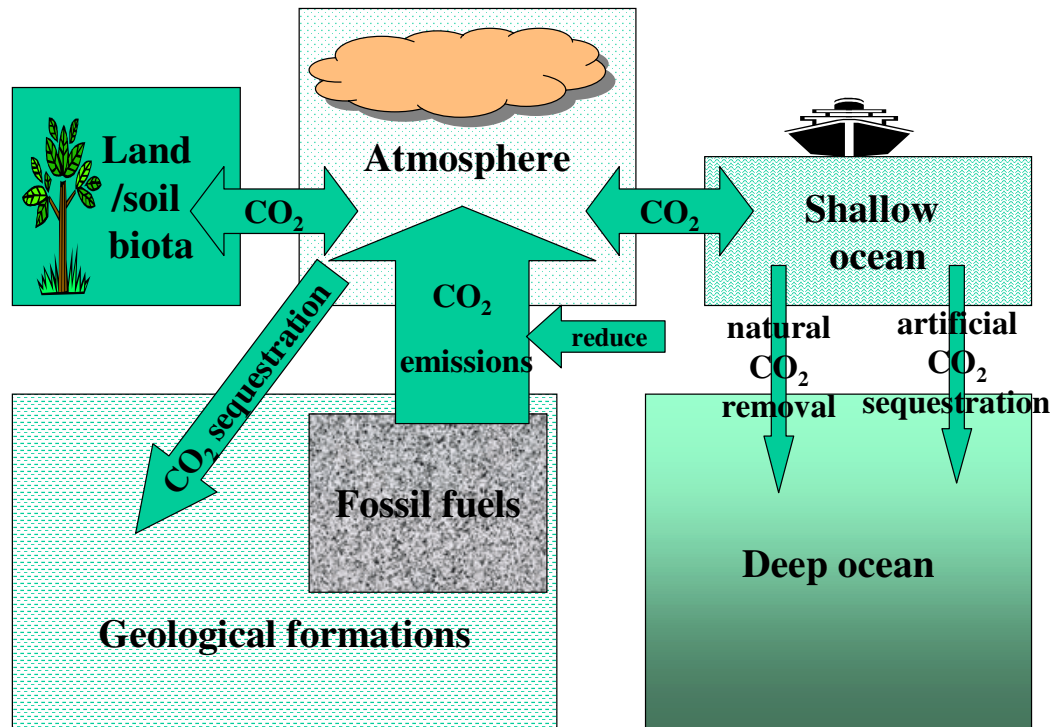
# **Living with Floods: History, Prospects and What To Do**

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Climatologist, Author &  
Jamie's Dad**

# Synopsis

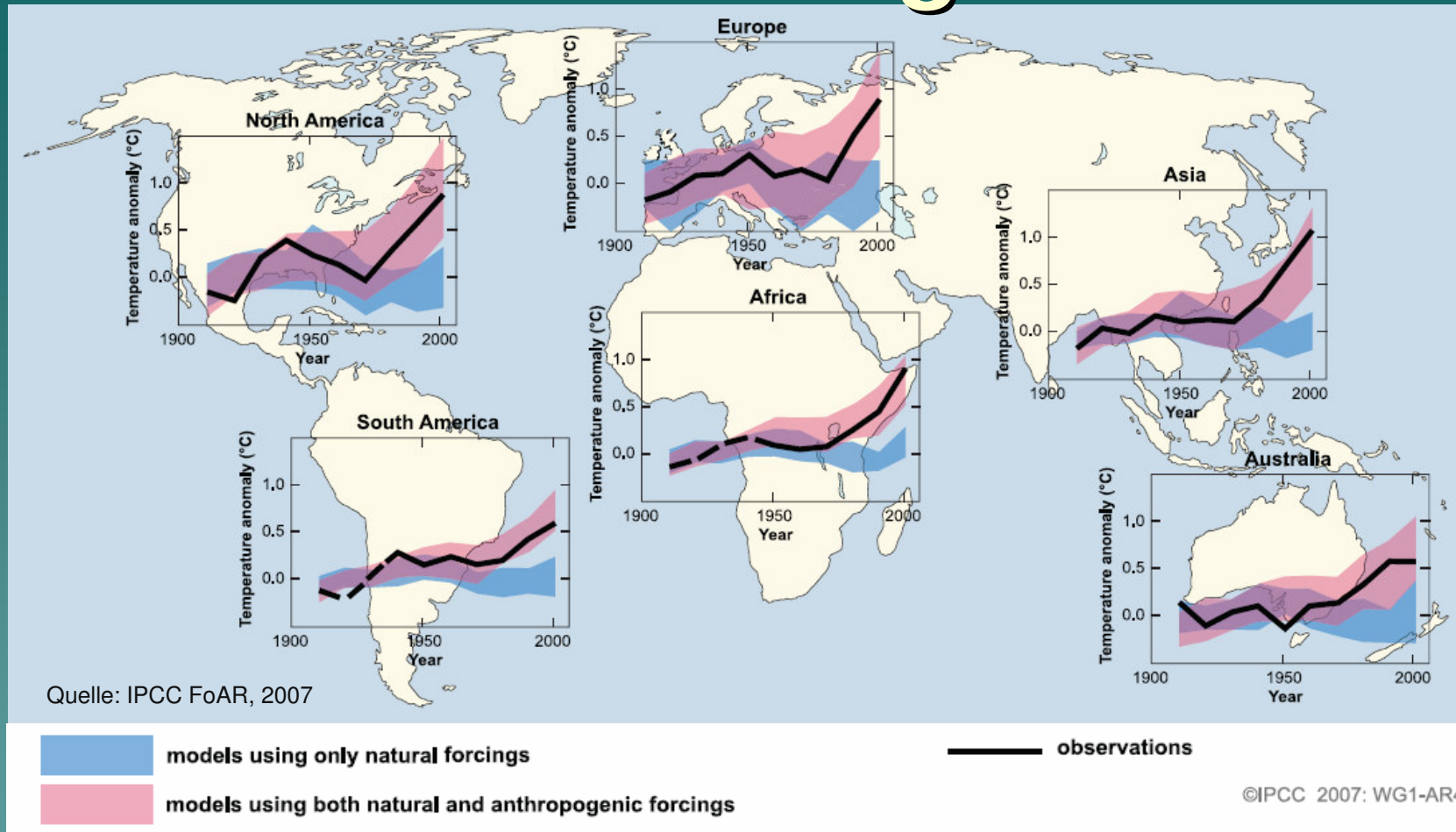
- ◆ **Climate change context**
- ◆ **Changes in extreme events**
- ◆ **Recent floods with consequences**
- ◆ **Warnings unheeded**
- ◆ **Risk management**
- ◆ **Dealing with floods**
  - **Gilbert White's 8 forms of adjustment**
- ◆ **What to do?**

# The nub of the problem



- ◆ Huge fossil CO<sub>2</sub> emissions
- ◆ Rapid CO<sub>2</sub> exchange between atmosphere, biota & upper ocean
- ◆ Slow natural sink
- ◆ Need to equalise emissions & sinks
- ◆ Need reduced emissions & increased sinks

# Global Warming is Real!




Black lines: decadal averages of observations

Blue band: 5-95% range 19 simulations from 5 climate models using only natural forcings

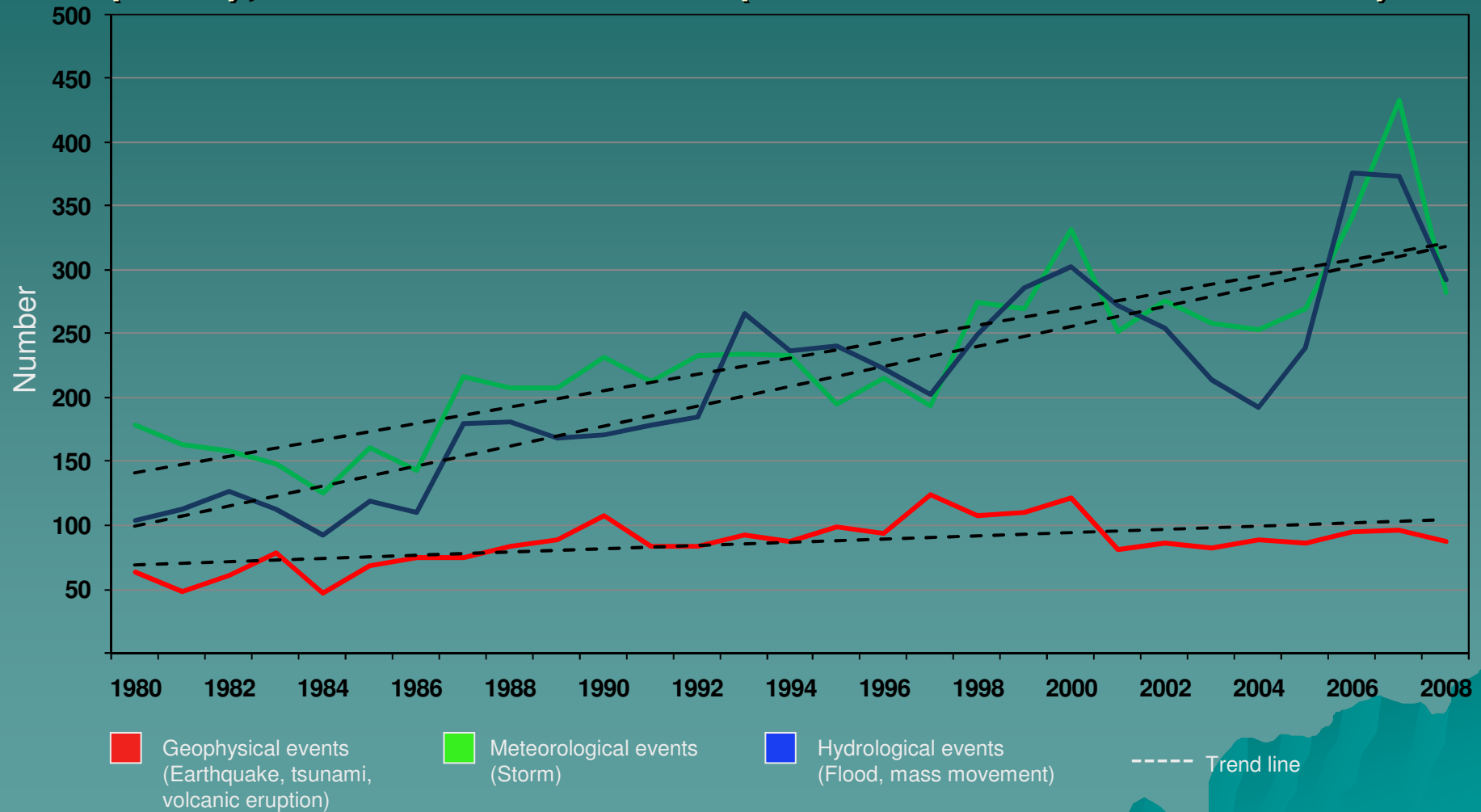
Red band: 5-95% range for 58 simulations from 14 climate models using natural and anthropogenic forcings

# Why More Extreme Rainfall?

- ◆ Over ocean warmer water and air  
—> more evaporation  
—> more humid air
  - ◆ Where uplift occurs (convective storms or flow over mountains) get more condensation & release of more latent heat
  - ◆ This strengthens convection —> more intense rainfall
- 
- A stylized silhouette of a mountain range in shades of teal, located in the bottom right corner of the slide.

# Global natural disasters 1980 – 2008

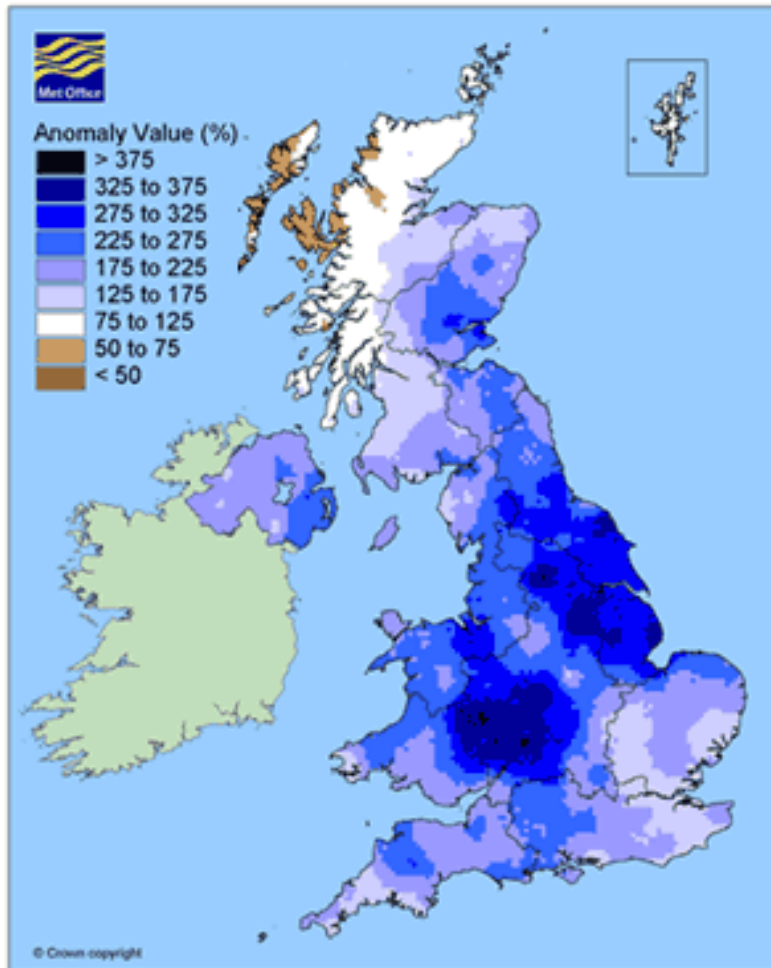
Geophysical (red), meteorological (green), hydrological (blue), number of events (Munich Reinsurance data)



# Floods in the UK, June- July 2007

## Largest flood loss ever!

Rainfall 1 June - 22 July 2007  
Percent of long-term average (1971-2000)



Overall losses: > US\$ 8 bn

Insured losses: US\$ 6 bn



# Recent Australian Floods

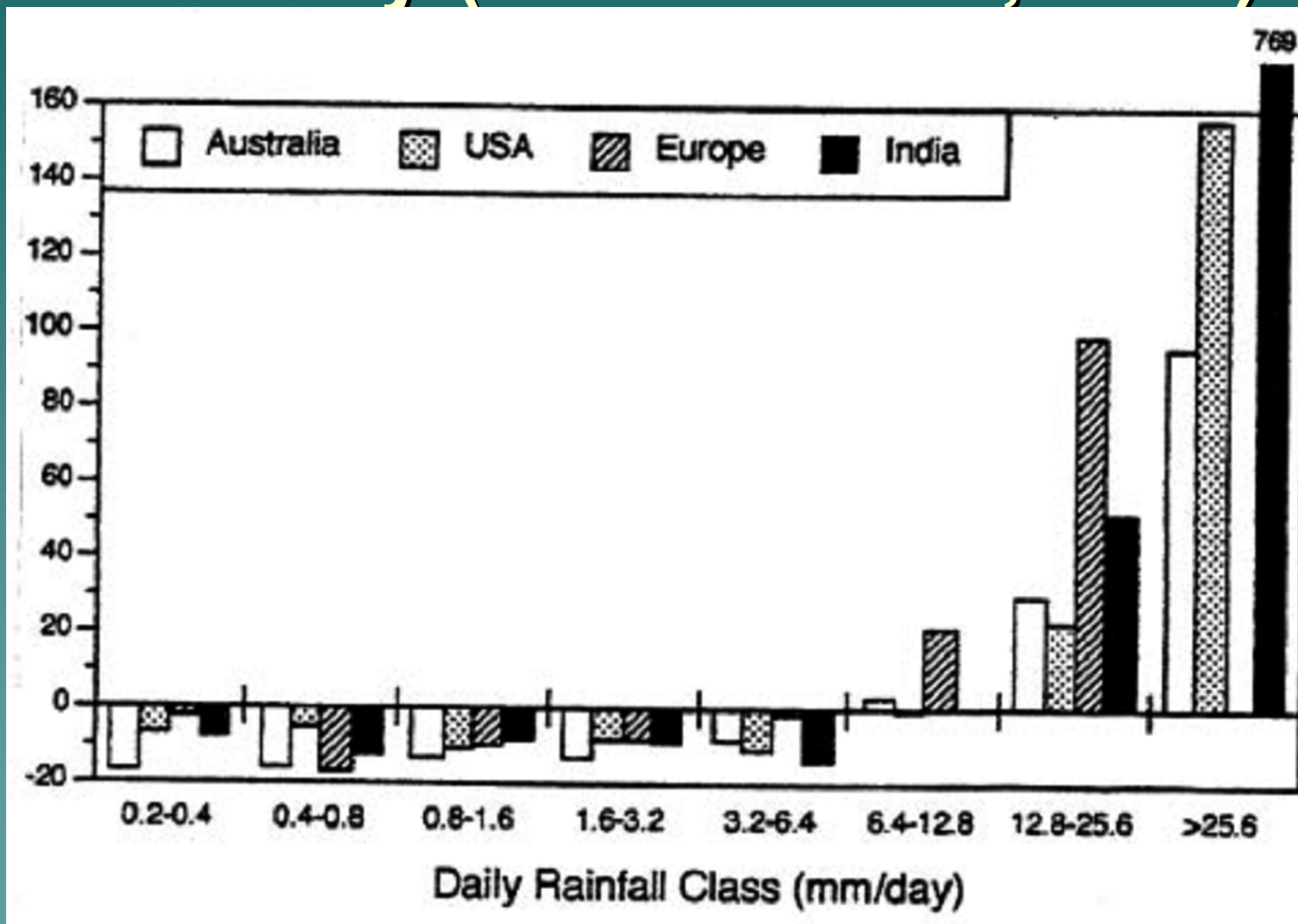
- **Kakadu, past decade wettest on record**
  - **2010-11: Open-cut flooded, runoff + g'd water**
  - **Tailings dam flooded, operations ceased**
  - **ERA response measures \$367 M**
- **Qld open-cut coal mines flooded**
  - **Lost exports**
- **Other Qld flooding & loss of life**
  - **Flash-floods, TC**
- **MDB flooding, including Victoria**



# Warnings re extreme rainfall

- ◆ **Pittock & Hennessy, 1991:**  
“these results suggest a possible environmentally significant increase in the frequency & severity of both floods & dry spells”
- ◆ **Tucker, to RAC re Kakadu 1991:** “the frequency of heavy rainfall may increase (with obvious implications for run-off, etc.)”
- ◆ **Gordon et al., 1992:** “If realistic, , the findings have potentially serious practical implications ... of an increased frequency and severity of floods in most regions”

# % Change in Daily Rainfall Intensity (Gordon et al., 1992)



# Climate Change and Extreme Weather Events (IPCC, 2007)

Phenomenon <sup>a</sup> and direction of trend	Likelihood that trend occurred in late 20th century (typically post 1960)	Likelihood of a human contribution to observed trend <sup>b</sup>	Likelihood of future trends based on projections for 21st century using SRES scenarios
Warmer and fewer cold days and nights over most land areas	<i>Very likely<sup>c</sup></i>	<i>Likely<sup>d</sup></i>	<i>Virtually certain<sup>d</sup></i>
Warmer and more frequent hot days and nights over most land areas	<i>Very likely<sup>e</sup></i>	<i>Likely (nights)<sup>d</sup></i>	<i>Virtually certain<sup>d</sup></i>
Warm spells/heat waves. Frequency increases over most land areas	<i>Likely</i>	<i>More likely than not<sup>f</sup></i>	<i>Very likely</i>
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	<i>Likely</i>	<i>More likely than not<sup>f</sup></i>	<i>Very likely</i>
Area affected by droughts increases	<i>Likely in many regions since 1970s</i>	<i>More likely than not</i>	<i>Likely</i>
Intense tropical cyclone activity increases	<i>Likely in some regions since 1970</i>	<i>More likely than not<sup>f</sup></i>	<i>Likely</i>

# Post IPCC 2007 Warnings

- ◆ Alexander & Arblaster, 2009:
  - “Multiple ... climate models [for Australia show] a shift towards ... much longer dry spells interspersed with periods of increased extreme precipitation...”
- ◆ Min et al., 2011
  - “Changes in extreme precipitation .. may be underestimated because models seem to underestimate the observed increase in heavy precipitation with warming.”

# Risk Management

- ◆ **Uncertainty → probabilistic risk**
- ◆ **Risk = probability x consequences**
- ◆ **Extreme events have “return periods” which change when climate changes**
- ◆ **Investors & governments both need to take risk into account**
- ◆ **‘Sovereign risk’: govt. changes rules?**
- ◆ **But Nature is the real ‘sovereign’**
- ◆ **So need to heed scientific advice & anticipate risk**

# **Gilbert White, 1911-2006: “father of floodplain management”**

- ◆ **Ph. D. Thesis 1942 : “Human Adjustment to Floods”**
- ◆ **Prof. of Geography & Director, Inst. of Behavioural Science, Uni. of Colorado**
- ◆ **Founder Natural Hazards Research Center, U. of C.**
- ◆ **Quaker, chaired Amer. Friends Service Committee**
- ◆ **President, Sci. C’ttee on Problems of Environment (ICSU), 1976-82**

# Gilbert White's Eight Forms of Adjustment

- 1. *Elevating land or buildings:* a permanent solution, but costly**
- 2. *Abating floods by land treatments:* eg., decrease upstream erosion & runoff, fire control, & tree plantings**
- 3. *Protection via dams, diversions & levees:* 'obvious', 'easy', but environmentally & economically costly, & may increase exposure to larger extremes**
- 4. *Emergency warning & evacuation;* good if timely and efficient**

# White's Adjustments, cont.

5. ***Structural changes to buildings & transport:*** reduces losses & safeguards essential services
6. ***Changing land use:*** prevents loss of vulnerable investments not appropriate to flood plains, esp. urban developments
7. ***Distributing relief:*** essential if other adjustments inadequate; can be repetitive
8. ***[Compulsory] insurance:*** should require systematic identification of risks & incentives to adopt other measures



# Gilbert White Summary

**“.. it will be necessary to adopt a broad geographical approach ... [that will] demand an integration of engineering, geographic, economic, and related techniques. The solutions will call for a combination of all eight types of adjustment, judiciously selected with a view to the effective use of flood plains.”**

# What to Do?

- ◆ **Adaptations:**
  - Heed warnings
  - Take broad range of measures
  - Anticipate large costs and limitations
- ◆ **Mitigation (tackling the root causes) :**
  - enhanced GH effect
  - uncontrolled growth
  - inappropriate technology
- ◆ **Reduce GH gas emissions:**
  - Show how, get international action,
  - Seize opportunities: energy efficiency, renewable energy - need incentives and startup initiatives – eg. national electrical grid, cf. DESERTEC
- ◆ **Engineers have a key role**

# DESERTEC: Energy, Water and Climate Protection



SSEE Brisbane August 2011

# Desertec Industrial Initiative (DII)

12 companies signed a Memorandum of Understanding to establish a Desertec Industrial Initiative (DII) in 2009.

The objective of this initiative is to analyse and develop the technical, economic, political, social and ecological framework for carbon-free power generation in the deserts of North Africa.



**Q. Why cannot Australian companies do this here?**