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Flood, famine and dangerous weather:
What can the past tell us about adapting to future climate change?

Jean Palutikof
National Climate Change Adaptation
Research Facility

Australian Government
Department of Climate Change and Energy Efficiency

Griffith UNIVERSITY

Queensland Government

MACQUARIE UNIVERSITY

QUT

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

JAMES COOK UNIVERSITY AUSTRALIA

USQ UNIVERSITY OF SOUTHERN QUEENSLAND fulfilling lives

University of the Sunshine Coast Queensland, Australia

Murdoch UNIVERSITY

Role of NCCARF

- **Mission:** To lead the research community in a national interdisciplinary effort to generate the biophysical, social and economic information needed by decision-makers in government, and in vulnerable sectors and communities, to manage the risks of climate change impacts
- Funded in the current phase to end June 2013 with an appropriation of $50 million
- A national undertaking: activities in 30 of Australia's 41 universities, and in all states and territories

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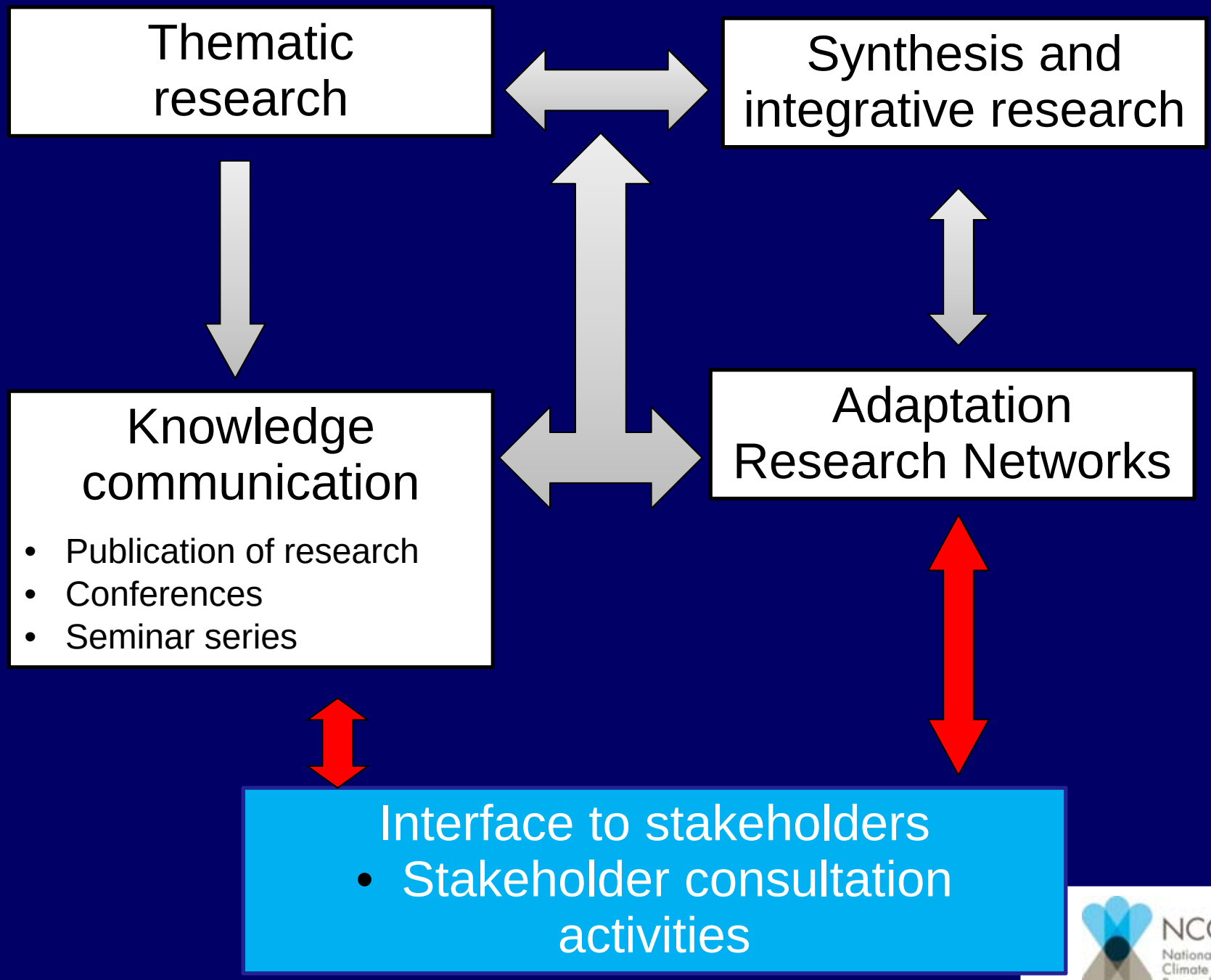
Flows of information around NCCARF



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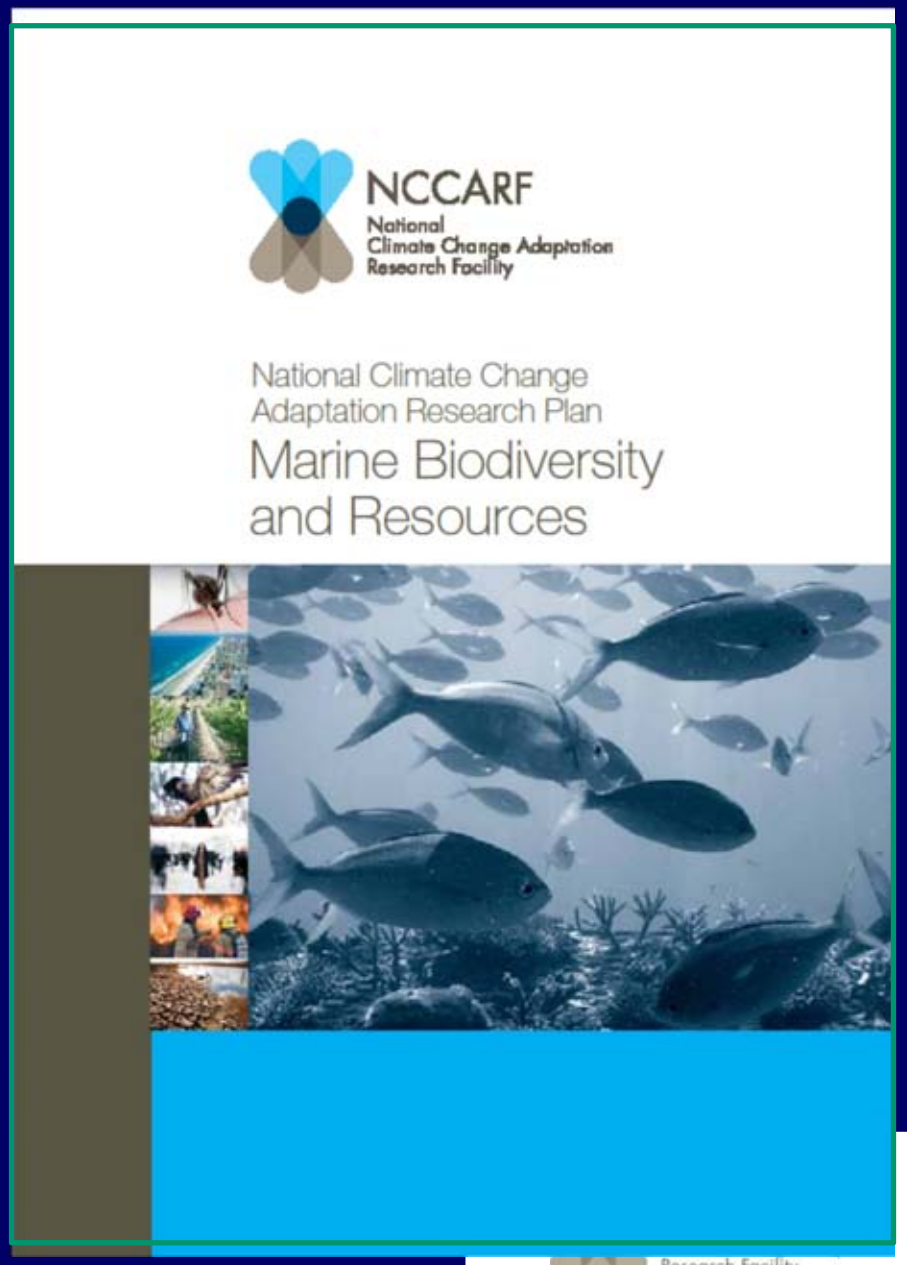
NCCARF's research programs

The ARGP: Australian Research Grants Program: thematic, $34 M

- Freshwater biodiversity: managed by FRDC
- Terrestrial biodiversity
- Marine biodiversity and resources
- Primary Industries
- Human health: managed by NHMRC
- Settlements and infrastructure
- Emergency management
- Indigenous communities
- Social, economic and institutional dimensions



Typical projects

- In human health and well-being
  - Managing heat waves and heat stress
    - Aged care residences
    - Amongst refugee communities
  - Vector-borne diseases
    - Dengue fever
- Settlements and infrastructure
  - Managing coastal communities at risk
  - Legislative and regulatory frameworks
- Finance and business
  - The role of insurance
  - The role of the private sector in disaster management

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Synthesis and integrative research

Its role:

- To provide the interdisciplinary and multidisciplinary approach which is necessarily absent in the thematic stream
- To synthesise across the available literature and deliver to end users in accessible forms
- To integrate existing and new knowledge to address the knowledge needs of end users for adaptation

Its budget: $6.5 million

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Historical case studies of extreme events

Key findings:

The 2008 Floods in Queensland: Charleville and Mackay

The events

In this case study, we compare the impact of riverine flooding, the response at the time and subsequent adaptations in two Queensland towns, Charleville and Mackay. Both towns were flooded in early 2008: Charleville in a widespread and slowly developing event in January; Mackay in a flash flood in February.

In January 2008, flood-producing rains occurred along the Queensland coast between Townsville and Mackay and inland over central and southwestern Queensland. These heavy rains were associated with a low pressure centre tracking southward across the state, the remnant of Tropical Cyclone Helen. Coastal and inland river catchments flooded. The Warrego River, which flows along the northern edge of Charleville, rose by 6m, peaking on 22 January, and Bradley's Gully, which flows through the middle of town, rose by 3m, peaking on the 18 January.

The coastal region of Mackay experienced minor flooding in the January event. However, on 15 February, an intense and localised rainstorm produced a flash flood that damaged 4000 houses, caused schools to close and damaged the local road network. Power was lost to 6200 homes and mobile and land line communications were disrupted.

Scale of the disaster

Charleville

The town of Charleville is located on the flood plain of the Warrego River, with Bradley's Gully flowing through the centre of the town. Flood events are relatively common: according to the Bureau of Meteorology there were 10 major flood peaks and 10 moderate flood peaks of the Warrego at Charleville between 1924 and 2008. It is a characteristic of Charleville floods that they are slow to develop, generally giving residents some time to prepare, spatially extensive and slow to retreat, meaning that roads and communications may be cut for several days.

The floods in January 2008 were not the worst in its history, but the Warrego River reached a peak of 6.1m (highest since 1997) and flood waters in Bradley's Gully reached 3.1m, its biggest flood event since 1963. Charleville is protected from the Warrego by a levee, built following the floods of 1990, but currently there is no protection from Bradley's Gully.

Flood management Charleville. Image: Hydro Response

Mackay

The Pioneer River runs out to sea through the city of Mackay. Relatively small in area, with steep slopes in parts of the upper reaches, the catchment of the Pioneer poses a flood threat to the town. Major flood levels have been reached 20 times since 1884. The rainfall event on 15th February 2008 was extremely intense and rare (100 year average recurrence interval). Around 4000 homes were flooded.

Impacts of the events

Charleville

Some 15 commercial premises and 30 residences had to be evacuated, involving a total of 55 people. Power was out to some areas. At the time of the flood, Charleville's permanent levee system was still under construction. Emergency Management Queensland coordinated the supply and transport of a flood barrier system into Charleville to plug two gaps in the town's levee system. Support personnel from New Zealand and NSW were flown in to assist with the construction of a temporary flood barrier and the system with put in place in 21 hours.

Following the floods, 920 families were provided assistance through the Natural Disaster Relief and Recovery Arrangements (NDRRA) grants, totalling over $446,000. The cost of restoration of essential public assets by the State Government totalled $462,000 and a grant of $2.5 million was provided by NDRRA to repair the Murweh Shire road network.

Mackay

Flood damage was caused to around 4000 residences, disrupting power and telecommunications and causing overflow of sewage stations. People were trapped in their homes and vehicles due to the speed with which events unfolded and their failure to heed warnings and behave with due caution. Overall the event is estimated to have cost $410 million in claims for flood damage to private residences and $9.3 million for reconstruction of roads and infrastructure.

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Synthesis and Integrative Research Program

Outputs from Synthesis and Integrative Research Phase I

- Historical case studies
- Study of adaptive capacity
- Forest vulnerability assessment

www.nccarf.edu.au

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S&I Research Phase III

- Economics of climate change
- Decision support tools
- Floods
- Industry and business
- Bridging the gap between science and policy
- Communication for adaptation
- Food and water security
- Barriers to adaptation
- And so on....

Phase IV: bringing the literature together into State level evaluations of impacts, vulnerability and adaptive capacity

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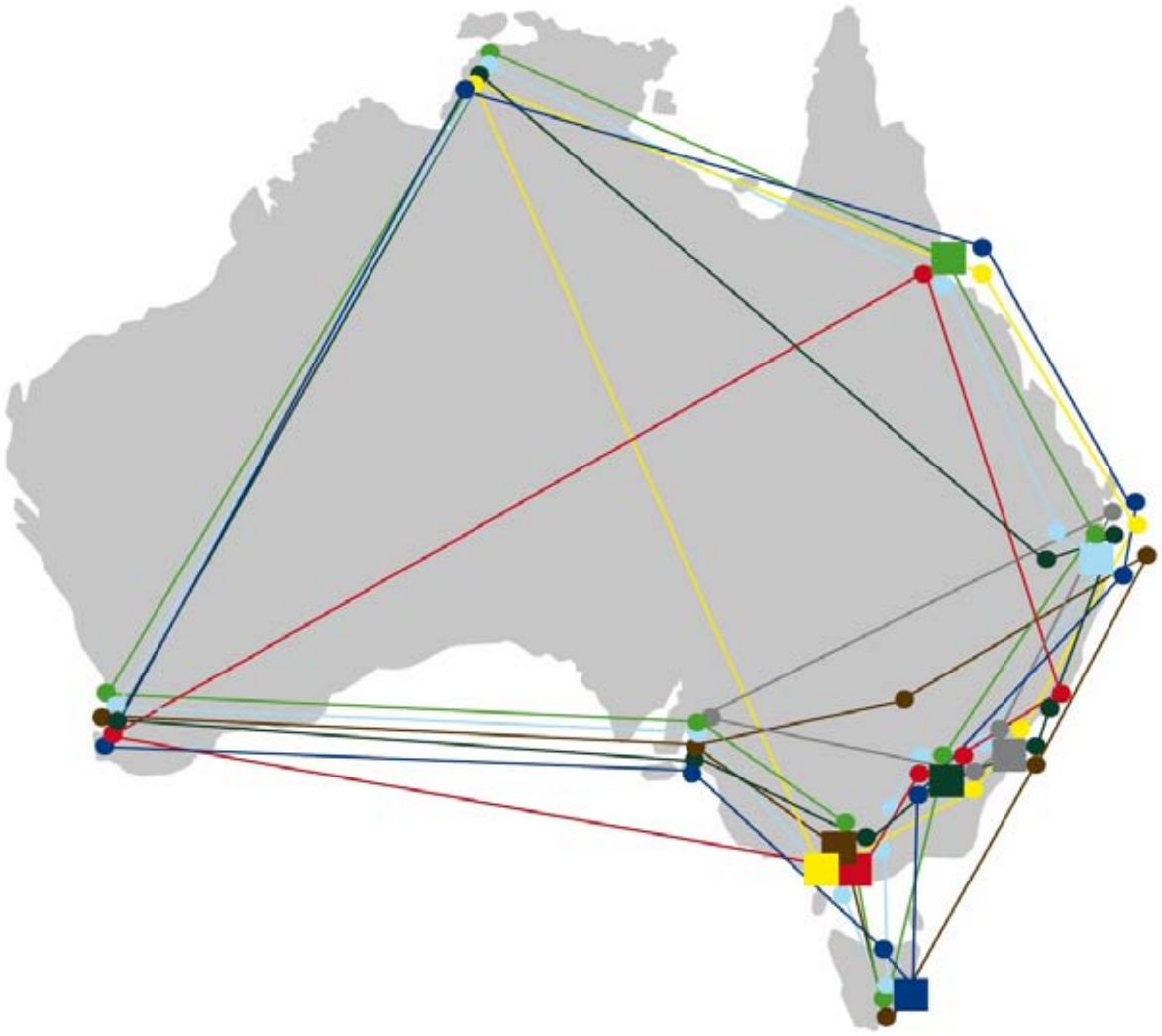
Adaptation Research Networks



Terrestrial Biodiversity
James Cook University

Water Resources and Freshwater Biodiversity, Griffith University

Settlements and Infrastructure
University of NSW

Human Health
Australian National University

Emergency Management
RMIT University

Primary Industries
University of Melbourne

Social, Economic and Institutional Dimensions, University of Melbourne

Marine Biodiversity and Resources
University of Tasmania

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Adaptation Research Networks

- Build:
  - National research capacity
  - Interactions between researchers and decision-makers
- Activities:
  - Workshops for early career researchers
  - Grants to post-graduate researchers
  - Newsletters and fact sheets
  - Stakeholder and research workshops
  - Roadshows

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The contribution of NCCARF

1. Working towards a well-adapted Australia
2. By identifying and managing a research portfolio
3. That provides the knowledge that decision makers and policy makers need
4. And delivering that knowledge through the development of accessible and useful products – **communication activities**

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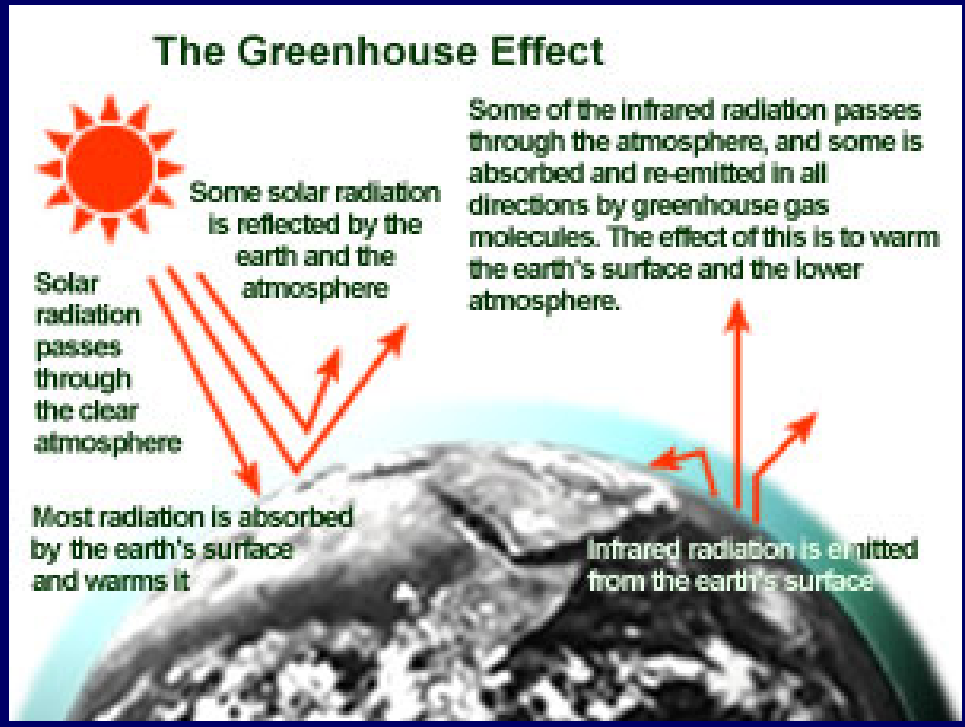
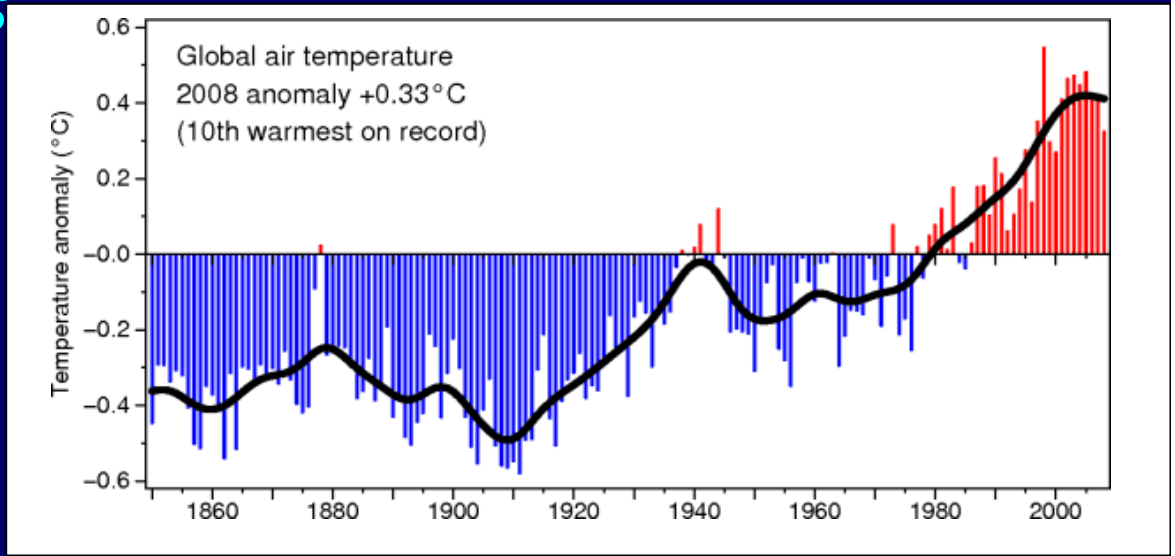
Adaptation – what is it?

- ***Adaptation*** is the adjustment in natural or human systems in response to present of future climate change, to moderate harm or exploit opportunities.
- *It's not mitigation: that's done to stop climate change happening: ERSs*
- *Adaptive capacity* is the capacity of a system to adapt when its environment changes





Autonomous adaptations

- ***Autonomous adaptations*** are widely interpreted as initiatives by private actors rather than by governments, usually triggered by market or welfare changes
- What you and I do to cope with climate change that's happened or is going to happen, e.g., buy a water tank

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Planned adaptation

- ***Planned, or public policy adaptations*** are the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required.
- Build a dam, a desalination plant….write a report

Scottish Water:
Current leakage: 1.17 billion litres per day
Target leakage reduction for 2006 -10: to reduce leakage to 50% of the way toward the Economic Leakage Level
ELL is to be achieved by 2013-14.

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Present-day adaptation to future climate change: engineering solutions

- The Confederation Bridge links Prince Edward Island to the mainland
- Designed to withstand a 1 m SLR

- Maeslantkering, Netherlands
- Largest moving structure on Earth
- Closure rate anticipated to change from 1 in 10 yr now to 1 in 5 years in 50 years time

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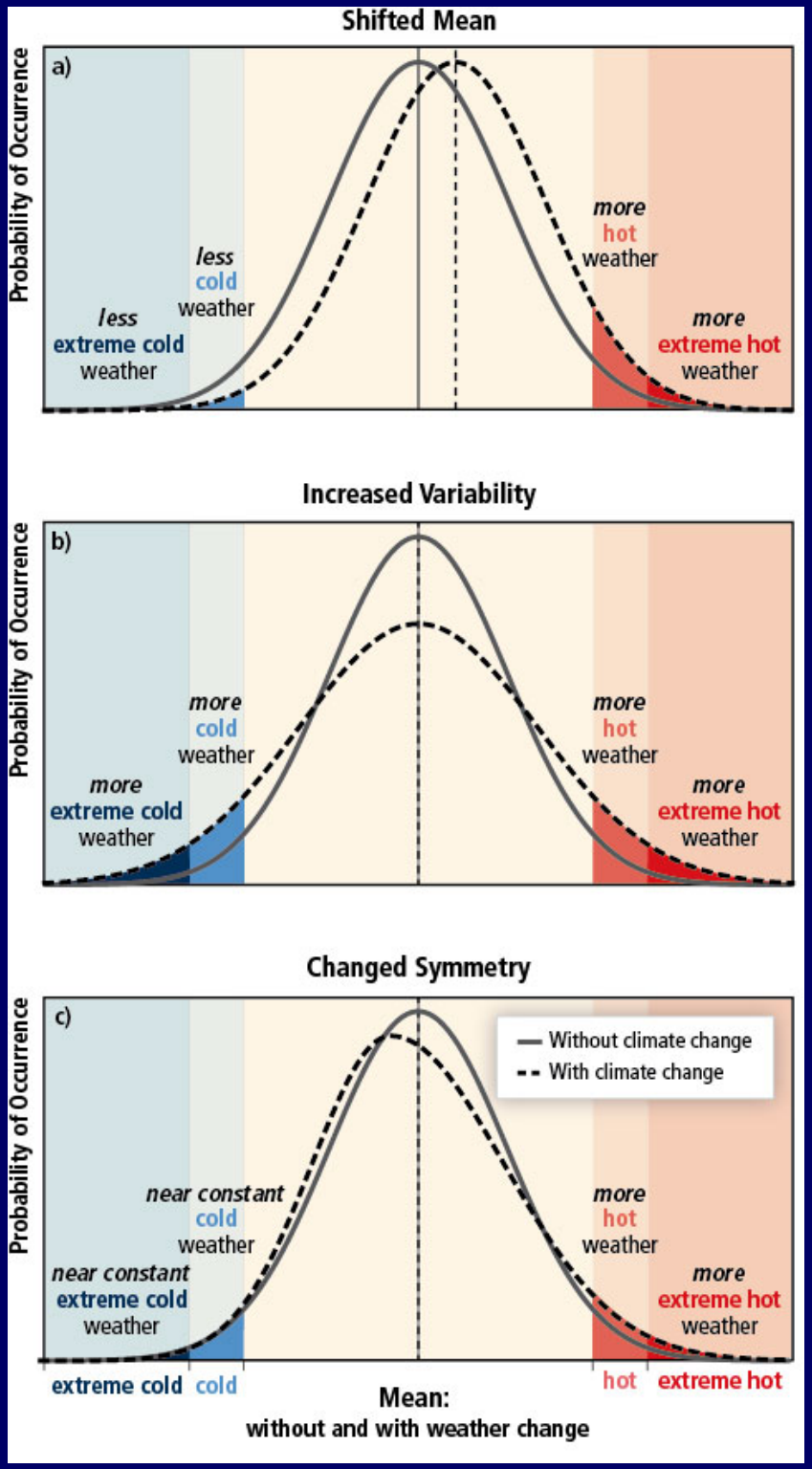

Adaptation to climate change is, in large part, a continuous *process* that involves the adjustment of society to *risks* that arise from climate change

IPCC SREX, 2011

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Some Australian examples

THE AUSTRALIAN WEDNESDAY APRIL 8 2009

8 THE NATION

Murray inflows slow to a trickle

Siobhain Ryan

THE Murray-Darling Basin has made an appalling start to 2009, reporting the lowest three

Algal blooms, caused by warm temperatures and the lack of fresh inflows, are threatening what reserves of water remain.

A red alert for blue-green

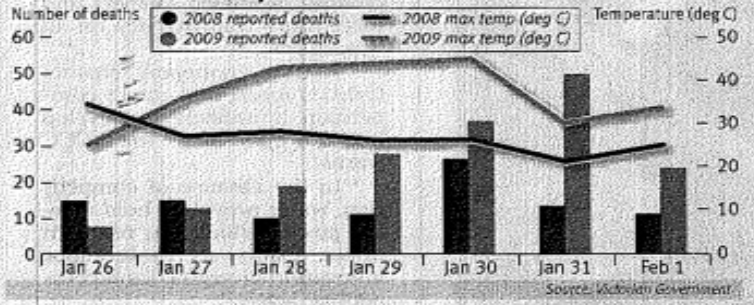
THE AUSTRALIAN TUESDAY APRIL 7 2009

6 THE NATION

Heatwave killed 347 people in one week

HOT DAYS

Number of deaths reported in Victoria



Rick Wallace
Victorian political reporter

HEALTH authorities have revealed that the week-long heat-

Tasmania and parts of southern NSW were similarly oppressive over this period.

The South Australian health department and the coroner are

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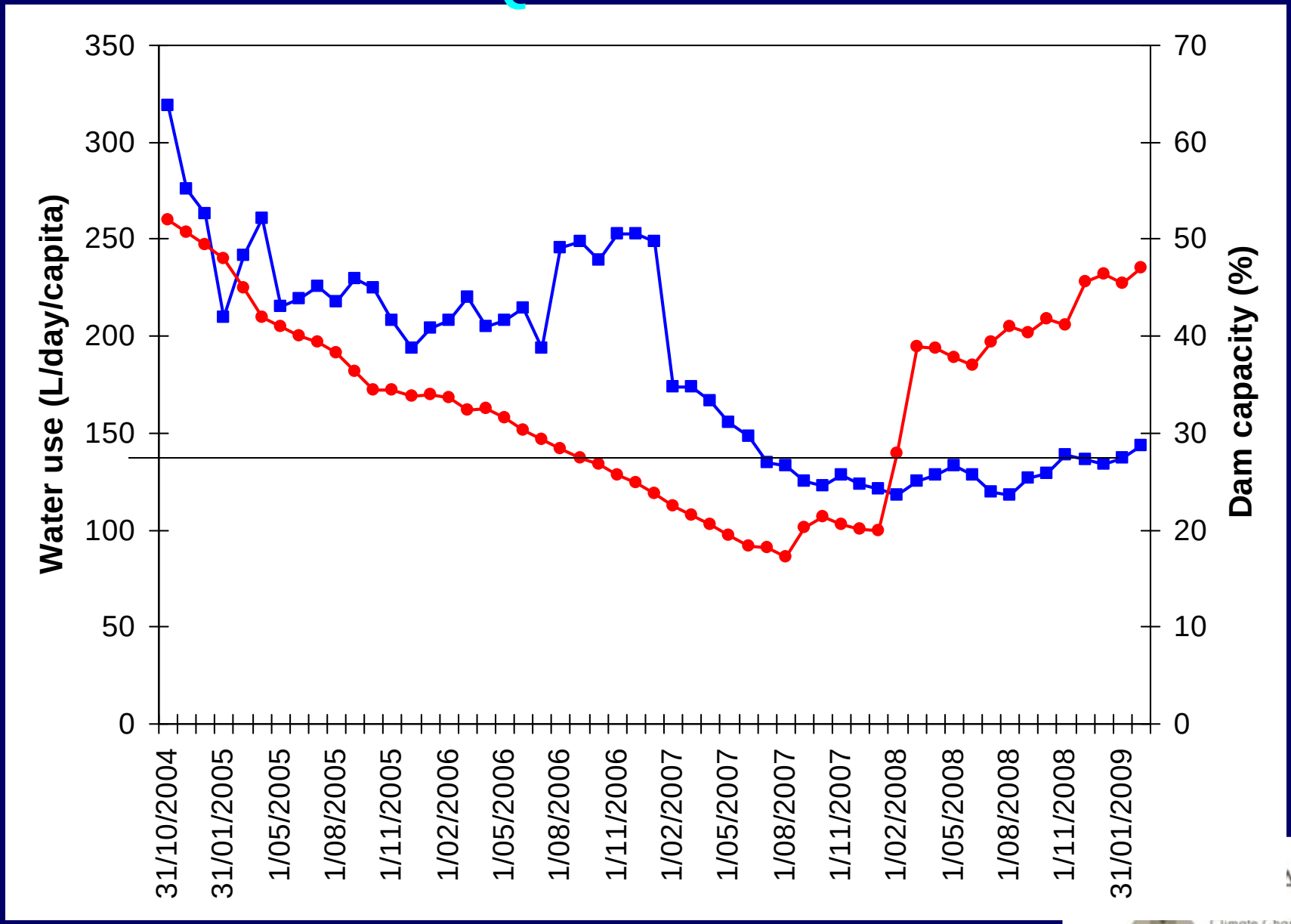
Australian solutions: Urban water use in SE Queensland



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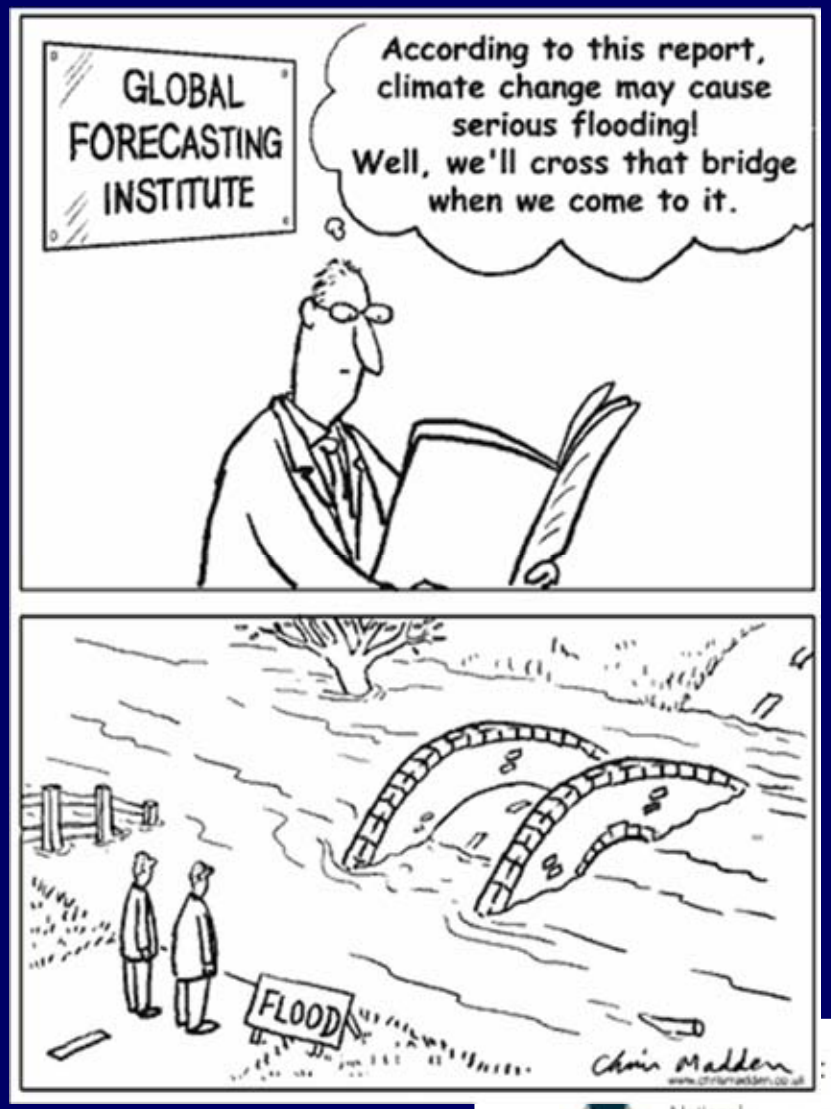
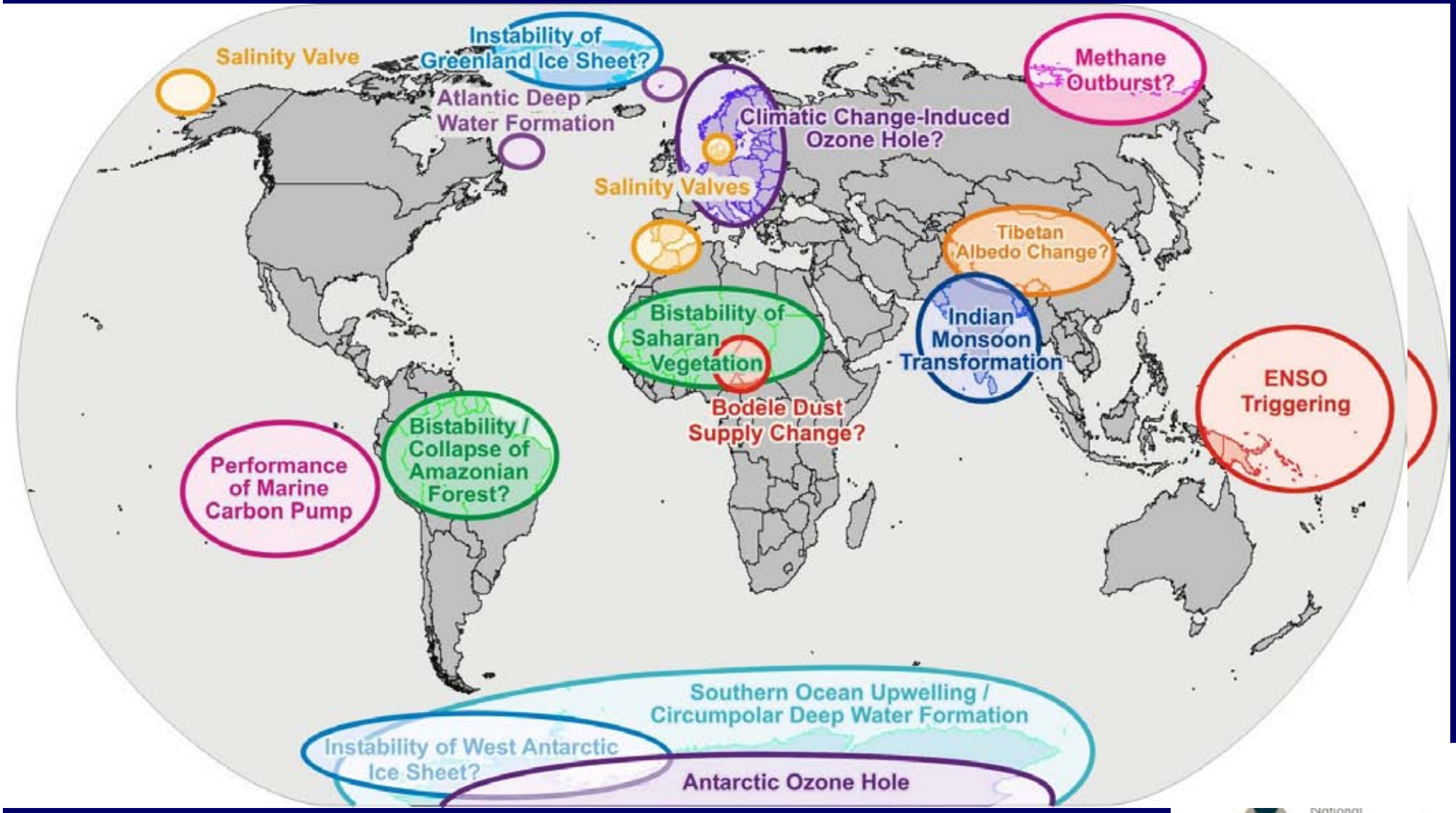
Where does it all go wrong?

When the model of effective adaptation to well-behaved climate change breaks down

1. The climate change is too large, too rapid, or crosses thresholds
   - thresholds and tipping points
2. The “Wrong place, wrong time” effect:
   - on mountain summits
   - on coastal wetlands
   - on small islands
3. Ideologies, governance and civil strife



Large/rapid climate change: tipping points



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Wrong place, wrong time effect

- Australian Alps and the Mountain pygmy possum:
  - Hibernates under snow in winter
  - Likely to disappear if temperatures increase by +1˚C.
- Nations under threat from small rises in sea levels:
  - Pacific island states of Vanuatu and Kiribati
  - Bangladesh – heavily-populated coastline

Governance: Great Irish potato famine 1845-52

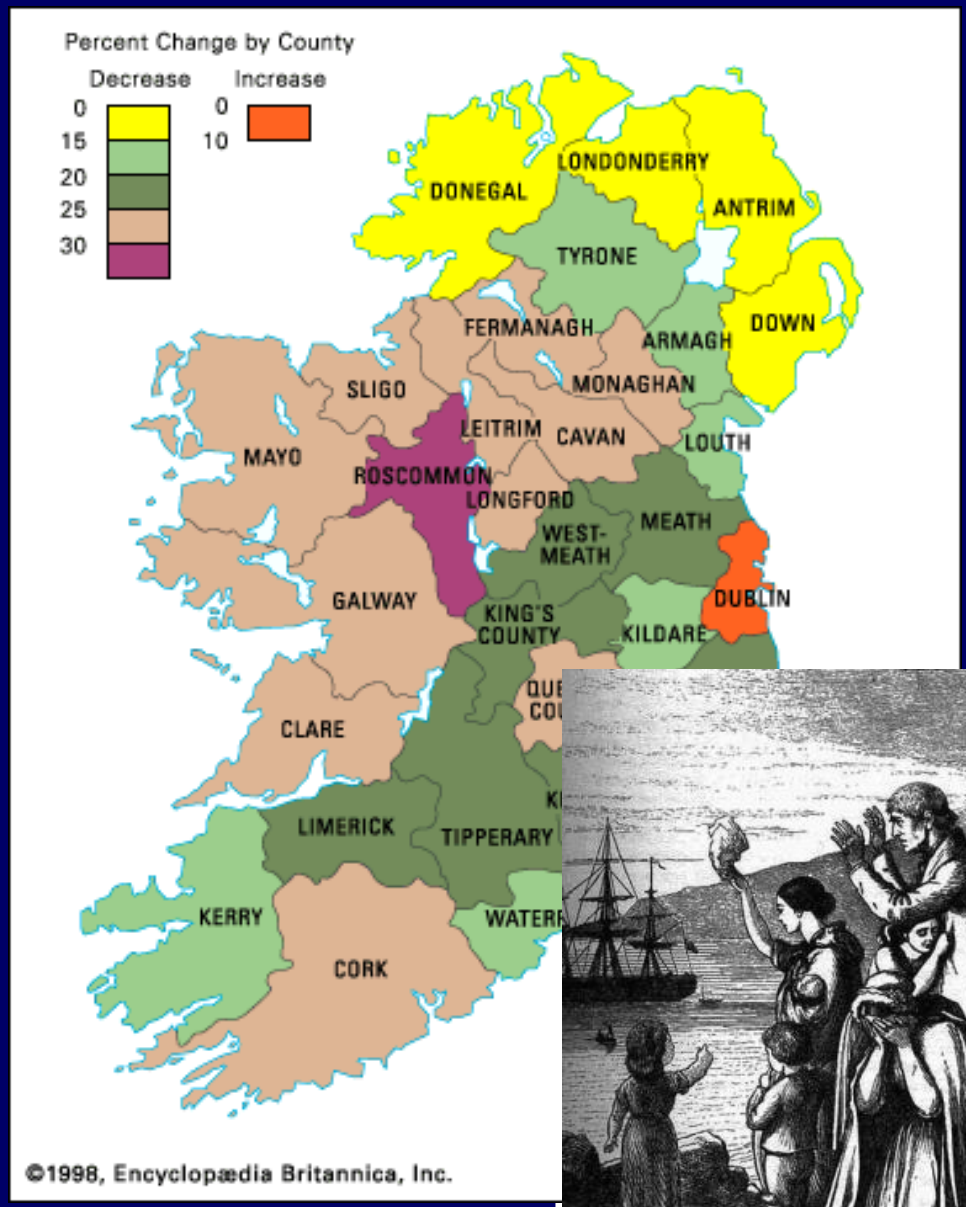
The fungus Phytophthora infestans

The national famine memorial, Co. Mayo

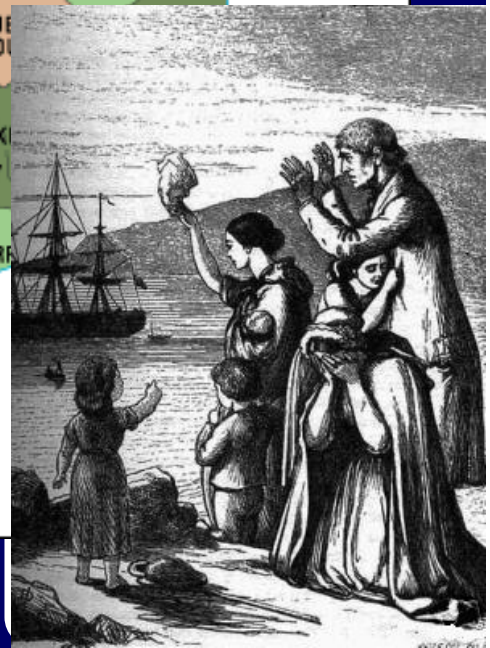
- More than one-third of the people lost their usual means of subsistence for 4-5 years in a row.
- One million died
- Two million emigrated
- Failure of British Government to act:
  - terminated the soup-kitchen scheme in September 1847 after only six months
  - refused to undertake any large scheme of assisted emigration
  - wages on public works in the winter of 1846-47 too low for subsistence

The Irish diaspora

- 1845-1850: ~ 1.5 million people emigrated from Ireland.
- The voyage to America cost £4-£5, half a year's wages.
- On average, 1 in 7 passengers died
- Liverpool and Canada were cheaper destinations
- Population of Ireland:
  - 1845: 8.5 million
  - 1851: 6.5 million
  - 2007: 6.1 million



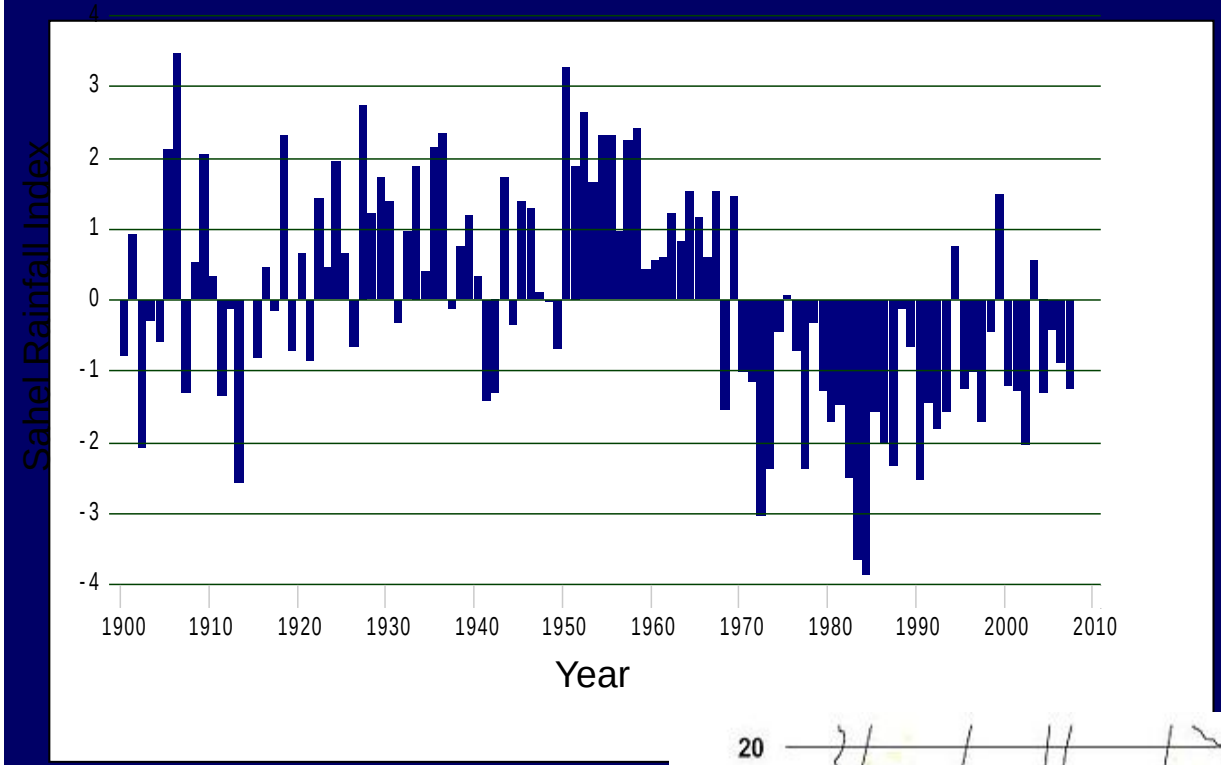
Population change 1841 to 1851



Why was there a failure to adapt?
Why didn't the British government do more?

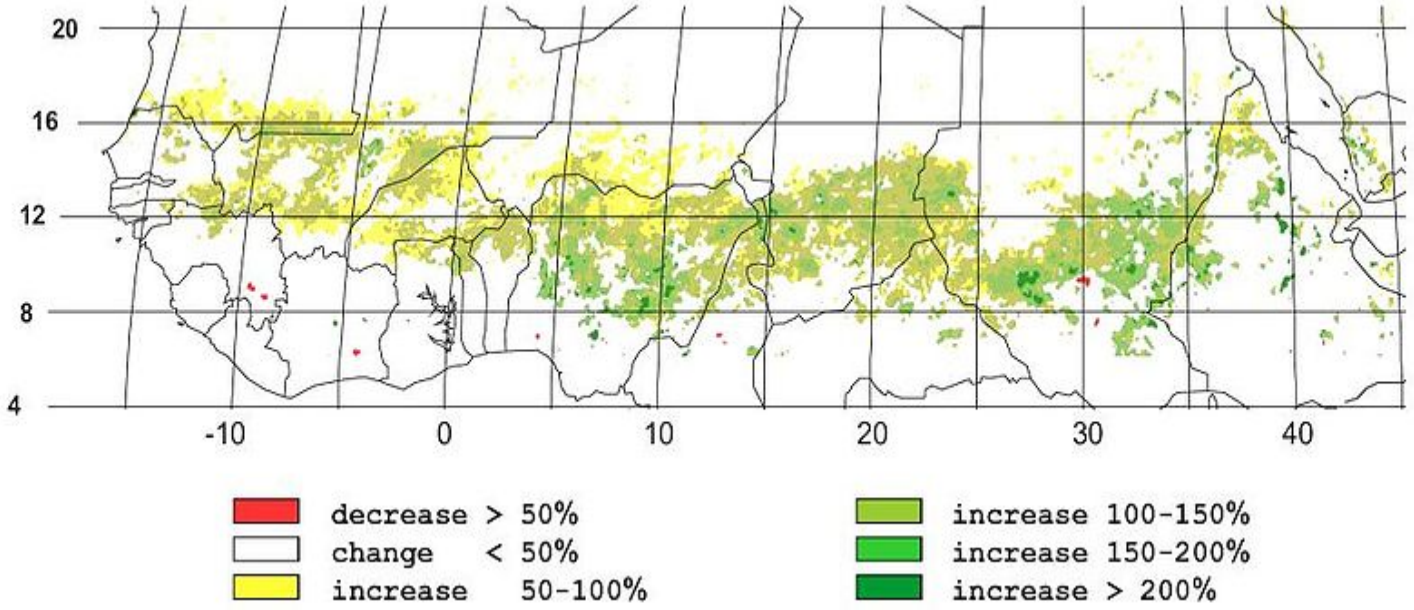
- Ideologies militated against relief:
  - the economic doctrines of laissez-faire,
  - the Protestant evangelical belief in Divine Providence,
  - ethnic prejudice against the Catholic Irish
- But some adaptation did occur:
  - first public health bye-laws in Liverpool

Sahelian drought 1968 -74



Rainfall 1900 to present day (anomalies from the long-term mean)

Greening of the Sahel, 1982-99



Sahelian drought of 1968-74

Proposed causes - governments:

- Famine rather than drought, due to overgrazing, deforestation and poor land management

Proposed causes – scientists:

- Albedo-related feedbacks
- Global dimming
- Warming SSTs/changes in SST patterns

Impacts:

- deaths of c.100,000 people and 12 million cattle
- disruption of millions of lives;
- collapse of the agricultural bases of five countries.

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Why were there fewer human deaths in the Sahel?

Provision of the tools to combat famine:

- better roads,
- greater commercialisation,
- modern communication and administration,
- national governments,
- massive international relief efforts and relief camps

Ideological changes:

- Independence and the post-colonial era
- Wealthier countries and international organisations provide disaster assistance as a matter of humanitarian conviction and perceived self-interest; Comic Relief, Red Nose Day

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Hurricane Katrina, August 2005

- The costliest hurricane, and 1 of the 5 deadliest, in US history
- Well forecast: to pass east of New Orleans, with winds coming back from the north,
- Storm surge in Lake Pontchartrain forecast to reach 4 to 5 m, with waves 2 m above the surge
- 1 million people evacuated, 100,000 remained
- Landfall 29 August
- New Orleans escaped major wind damage, but the levees were breached

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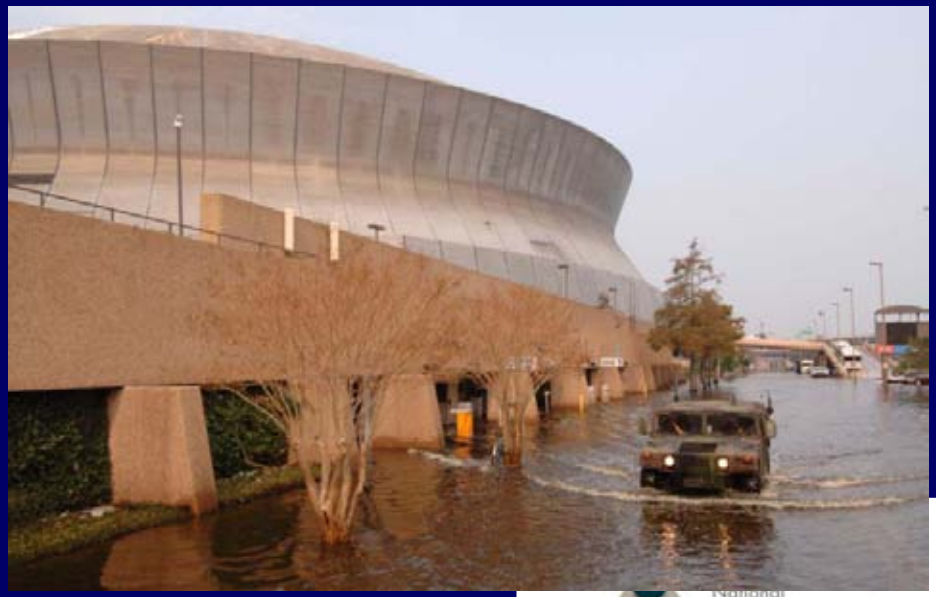
Immediate effects of the flooding

- Power failure
- Lack of clean water
- Telephones, mobiles and internet failed
- Media failures
- Death toll 1,464
- Civil unrest and lack of law enforcement: 1/3 police fled
- Squalid and chaotic conditions in evacuation centres
- By 2 September under control



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Aftermath – rebuilding the levees

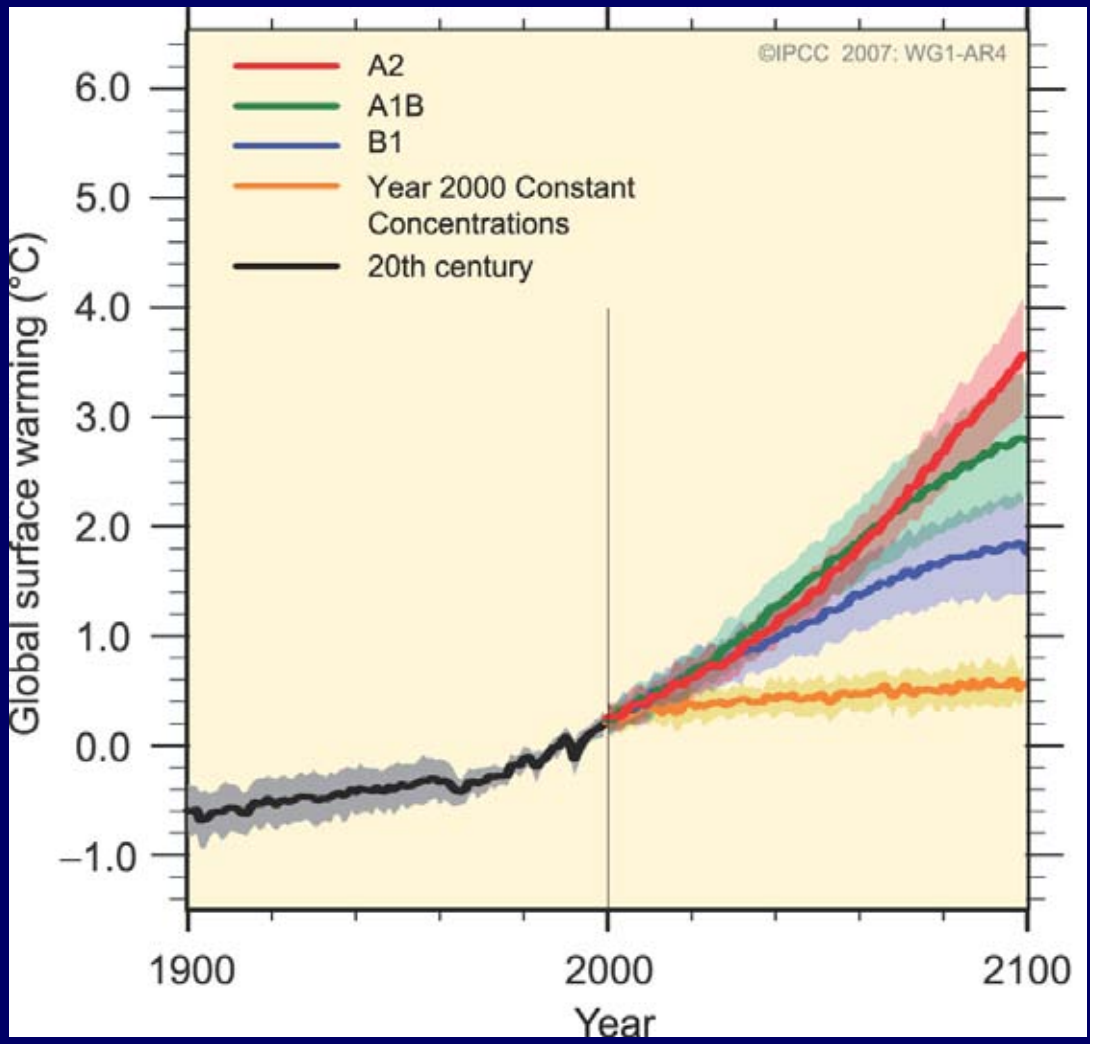
- The Army Corps of Engineers is rebuilding and raising levees, building floodgates, to withstand a 100-year storm
- Cost $14 billion
- To be completed 2011
- Report by the National Academy of Engineering and the National Research Council says insufficient: should protect against a 500-year storm
- Mayor Ray Nagin: the government shouldn't dictate where people can live

October 25th

And so?

- Climate science give us worse-case scenarios
  - Greenland ice cap melting = 5 m SLR
- We need worse-case scenarios for society also
- Prediction of the IPCC temperature graph:

  2012 – 2100 = 88 y
- Time elapsed between Irish famine and present day: c. 160 y



Studies of past extremes and their impacts can aid understanding of future social resilience pathways

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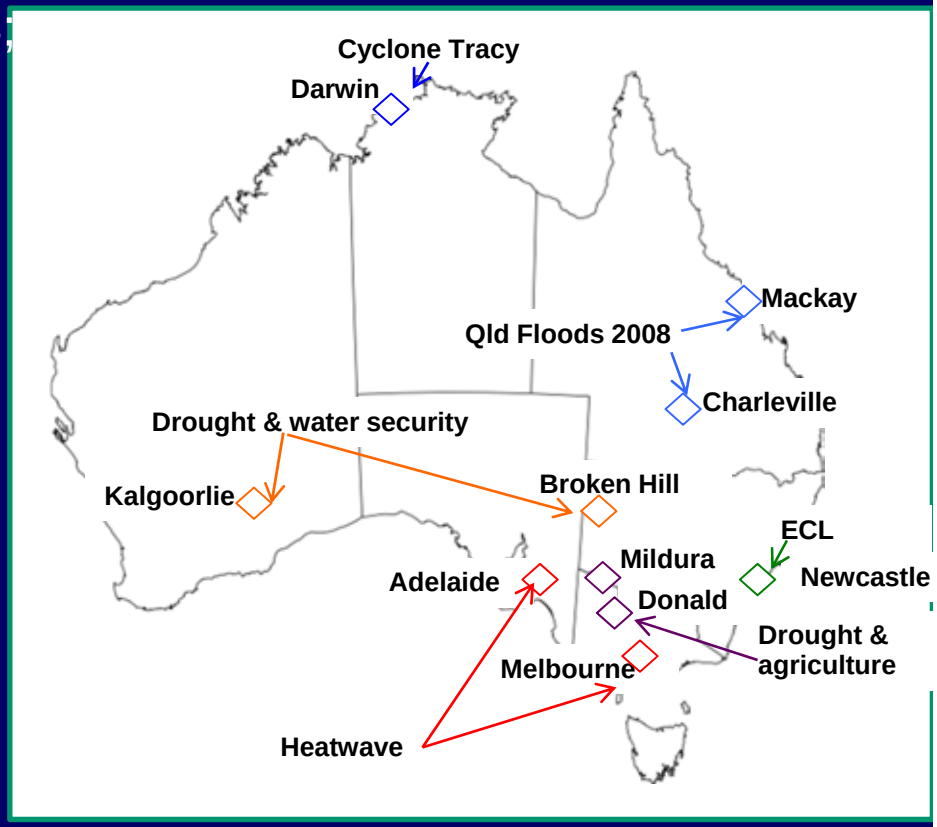
Seven historical case studies

- **Cyclone Tracy,** Darwin Christmas Day 1974;
- **Drought** in small inland towns, looking at:
  - **Agricultural communities**: Donald (dryland) and Mildura, (irrigation)
  - **Mining communities**: Broken Hill and Kalgoorlie
- **Heatwaves**, late January – early February 2009, Melbourne and Adelaide;
- **Queensland floods in 2008**, Charleville and Mackay
- **Storm tides**, the 1950s to the mid 1970s along the east coast of Australia
- **An East Coast Low**: the Pasha Bulker storm which struck Newcastle in June 2007.



Cyclone Tracy: the event

- Very small, slow moving Category 4 tropical cyclone
- Struck Darwin Christmas morning 1974
- 71 deaths, 650 injured
- 94% of housing uninhabitable
- 40 000 people homeless, 80% evacuated
- A ‘national horror’
- Housing built for daily conditions not extreme events

Journal of the Australian Department of Health Volume 25 Number 2

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Cyclone Tracy – response

- Military style command
- Evacuation –permit system to control return
- Assessment – all buildings, why buildings failed
- Construction moratorium
- New building standards adopted in cyclone prone areas
- Standards tested during subsequent cyclones

The reconstruction process.
Image: ABC TV Collection

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Successful adaptation

House condition reporting following Cyclone Yasi
Building damage largely restricted to older houses (pre-Tracy regulations)

Damage to pre-Tracy home (Cyclone Yasi, Cardwell)

Damage to modern house (Cyclone Yasi. Cardwell)

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The Indigenous experience

- Limited documentation of Indigenous people
- Experience specific to background & context
- Psychological impacts
- Strong desire to return to country (Darwin)

"…An Aboriginal person can't live on someone else's land. They've got a thing of homeland, their homelands (Respondent 4)"

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Storm tides on the east coast

- Wind storm increases sea level, *plus* large waves result in coastal erosion & inundation
- Stormy periods and calm periods (Inter-decadal Pacific Oscillation; SOI)
- Particularly stormy period in the 1950s - 1970s resulted in severe erosion, property and economic loss
- Three case study communities

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Storm tides on the east coast

- Immediate response *ad hoc*
  - Dumping car bodies, private sea walls
- Longer term:
  - Research & understanding of erosion processes and coastal protection (identify at risk properties)
  - Statutory bodies, regional strategies
  - Protection strategies (sea walls, beach nourishment, groynes)
  - Planning measures (buybacks and setbacks)

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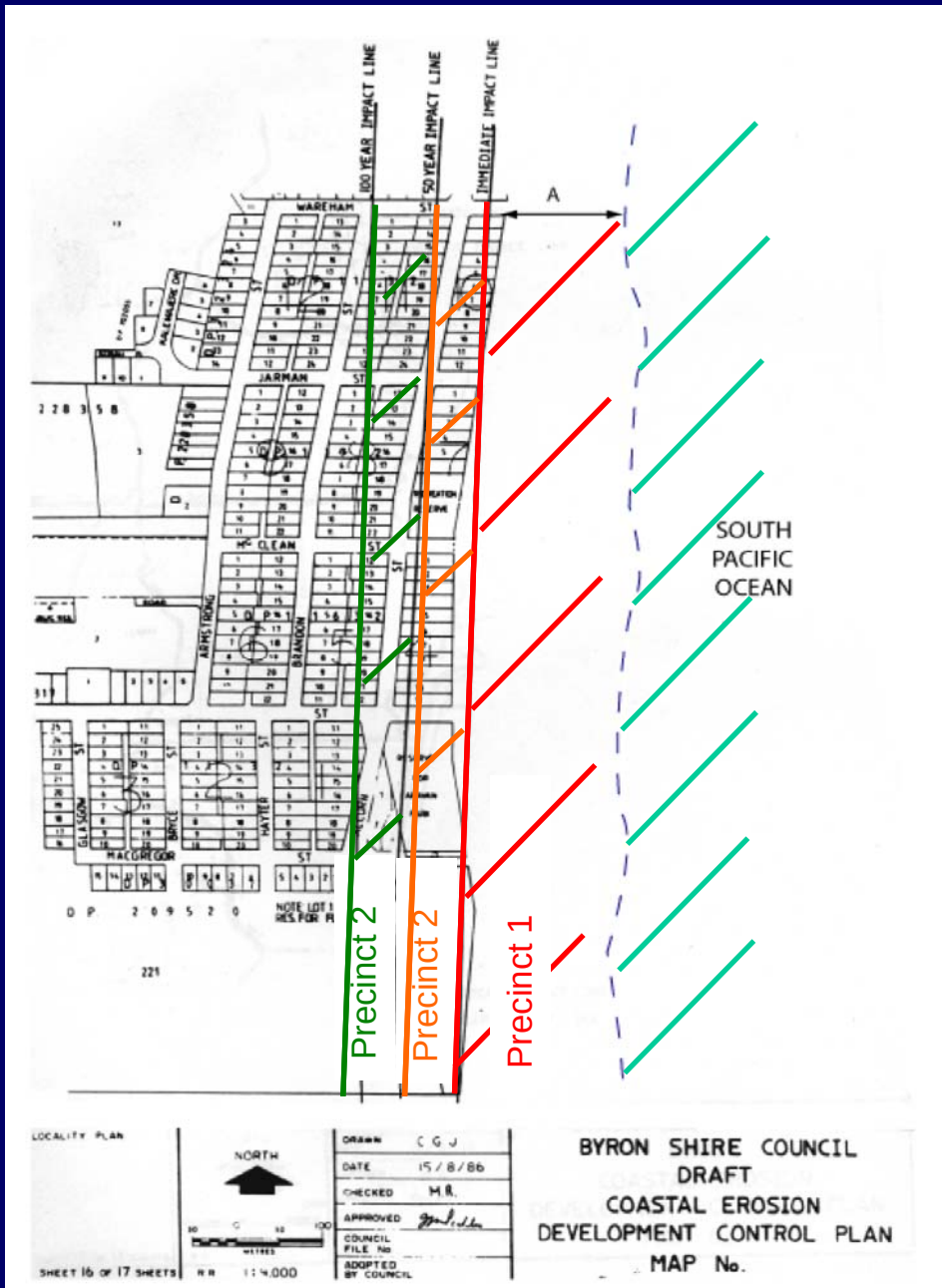
Storm tides – the response

Example from Byron Bay

- Hazard lines based on storm event return periods
- Planned retreat of development
- Precinct 1: immediate storm threat; no mains power
- Precincts 2 & 3: 50 & 100 year storm risk; building must be re-locatable (surrender land)



But 30 years of calm weather…

- ‘Calm weather’ planning
- No test of protection strategies
- Beach recovery (accretion) hasn’t happened
- Sea level rise threat

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Eight lessons learned

Enabling adaptation:

- Government at all levels need to provide frameworks that enable adaptation through incentives and regulation

Timeliness of adaptation:

- Actions should be pragmatic, realistic & forward thinking
- Some adaptation actions can have unintended consequences for successive events and other sectors
- Short-term solutions are not always suitable for the long-term
- Recognising a new type of disaster or knowing when to call a situation an emergency is critical to successful adaptation

Awareness:

- Communities need to be aware and prepared
- Communities may need to recognise that something has to change

Practicality:

- Vulnerability tied to geography

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...and a few reflections

- Resilience or stoicism?
- Why does nothing happen? Barriers to translating knowledge into action
- Who bears the cost?

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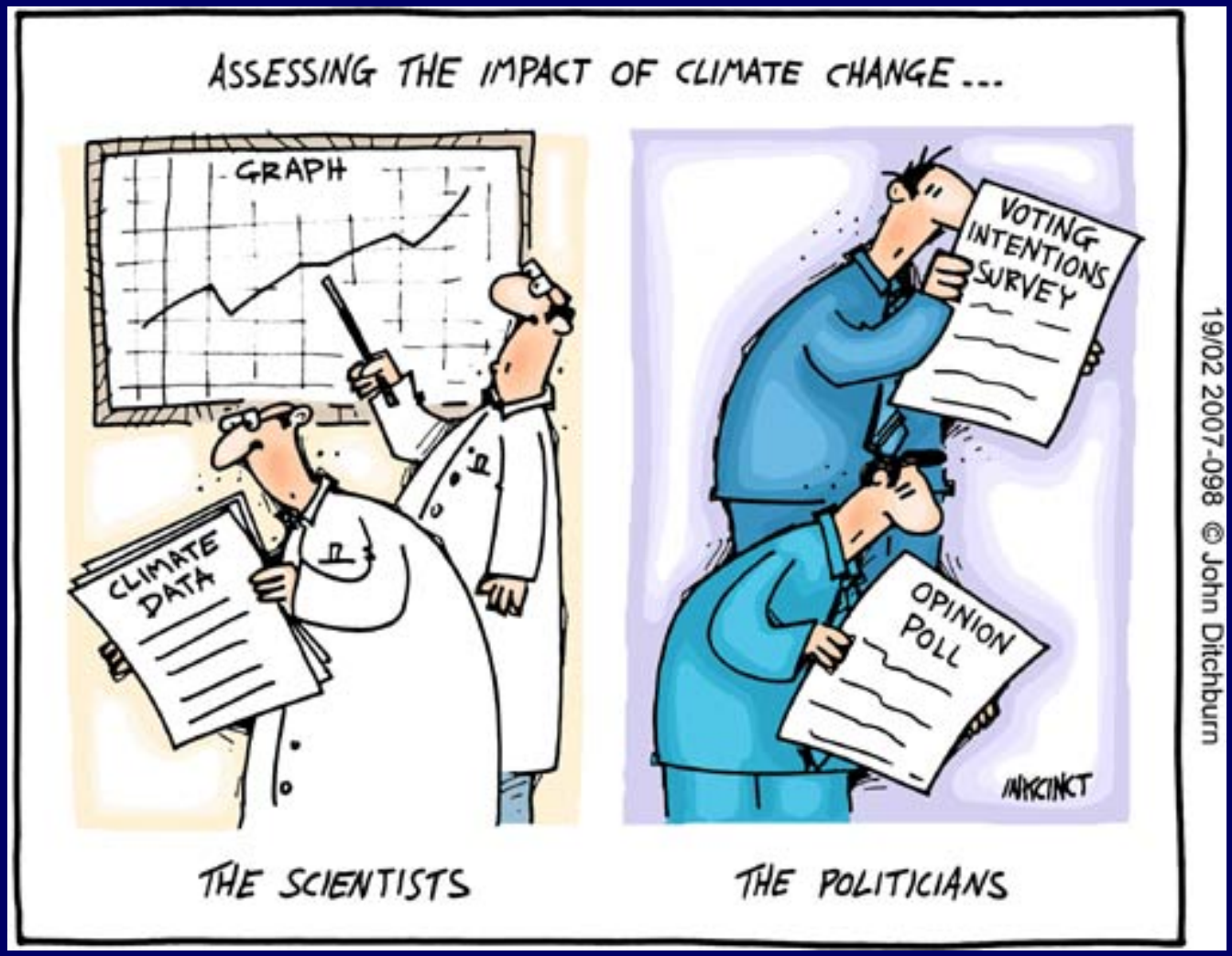

Thank you!

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