# Using JULES for impacts assessment to underpin UK and international climate policy

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# 2 major climate policy activities requiring robust input from climate science and related fields

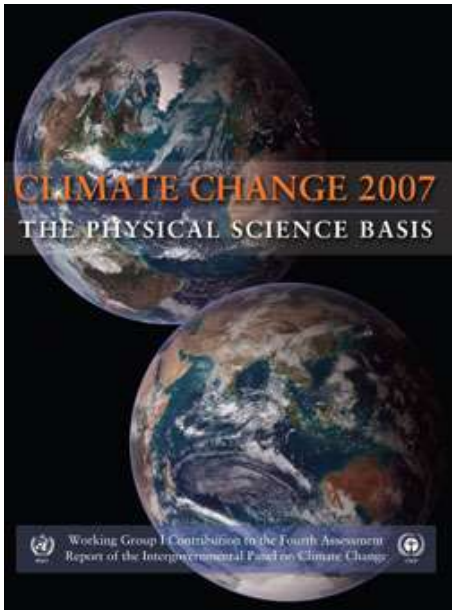
- International: United Nations Framework Convention on Climate Change (UNFCCC)

- UK: Climate Change Risk Assessment (CCRA)

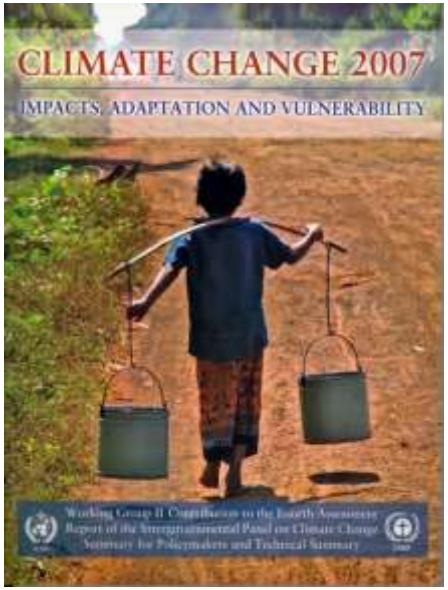
# United Nations Framework Convention on Climate Change (UNFCCC)

- Primary aim is to “avoid dangerous climate change”
- Therefore need to know what “dangerous climate change” actually is
- Emerging issue is facilitating adaptation to committed climate change in developing countries
- Therefore need to assess climate risks, hazards and vulnerabilities at regional scales, in context of other stresses
- Main source of underpinning science advice to UNFCCC is Intergovernmental Panel on Climate Change (IPCC)
- Fifth Assessment Report (AR5) currently being written – due out 2013-2014 (3 phases)

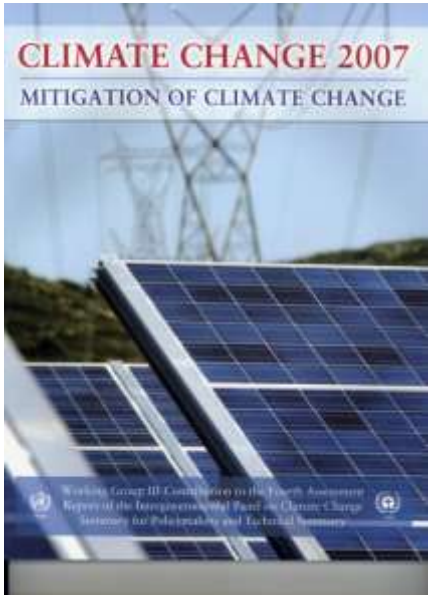
# IPCC Working Groups




WG1
Physical
Science
Basis




WG2
Impacts,
Adaptation &
Vulnerability




WG3
Mitigation

# AR5 WG2 structure

- Context
- Natural and Managed Resources and Ecosystems, and Their Uses
- Human Settlements, Industry, and Infrastructure
- Human Health, Well-Being, and Security
- Adaptation and Development
- Multi-Sector Impacts, Risks, Vulnerabilities, and Opportunities
- Regional aspects

# Natural and Managed Resources and Ecosystems, and Their Uses

3. Freshwater resources

4. Terrestrial and freshwater ecosystems

   - (R Betts one of Lead Authors)

5. Coastal ecosystems and low-lying areas

6. Ocean ecosystems

7. Food systems and food security

# Human settlements, industry and infrastructure

8. Urban Areas

9. Rural Areas

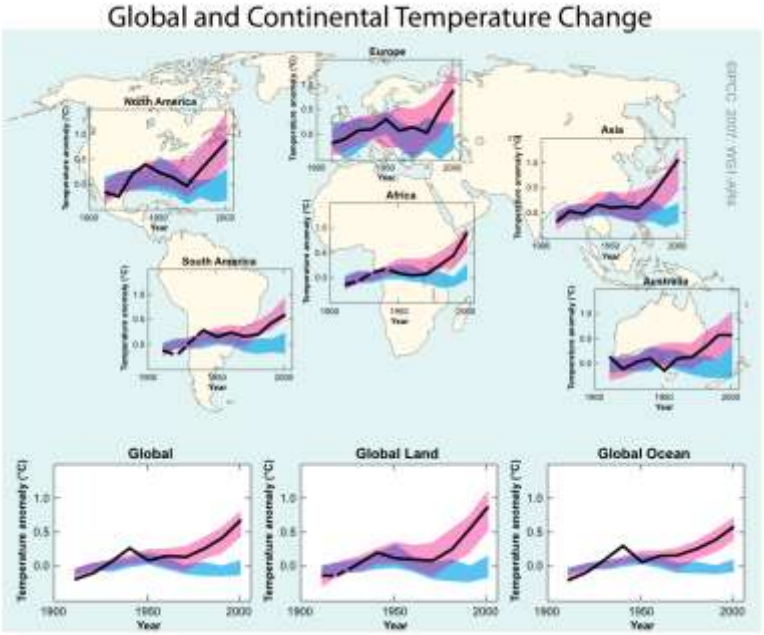
10. Key economic sectors and services

# Multi-Sector Impacts, Risks, Vulnerabilities, and Opportunities

18. Detection and attribution of observed impacts

19. Emergent and key risks and vulnerabilities

20. Climate-resilient pathways: adaptation, mitigation, and sustainable development



# Regional aspects

21. Regional context (R Jones one of Lead Authors)
22. Africa
23. Europe
24. Asia
25. Australasia
26. North America
27. Central and South America
28. Polar Regions
29. Small Islands
30. International Waters

# UK Climate Change Risk Assessment: Aims

- "To undertake an assessment of the risks (including opportunities) from climate change to those things that have **social, environmental and economic value in the UK**, to help the Government create an enabling environment for the UK **to adapt and identify priorities for action**."
- To fulfil Climate Change Act 2008
- To understand current and future risks and opportunities
- To inform Government adaptation actions
- To raise awareness of UK climate risks
- To develop capacity – learning process
- To identify research needs (inform *next* CCRA – 5 year cycle)
- 1st CCRA reports to Parliament 26th January 2012

# CCRA Sectors and themes

## SECTORS

- Agriculture
- Biodiversity & Ecosystem Services
- Built Environment
- Business, Industry & Services
- Energy
- Flooding & Coastal Erosion
- Forestry
- Health
- Marine (incl. fisheries)
- Transport
- Water

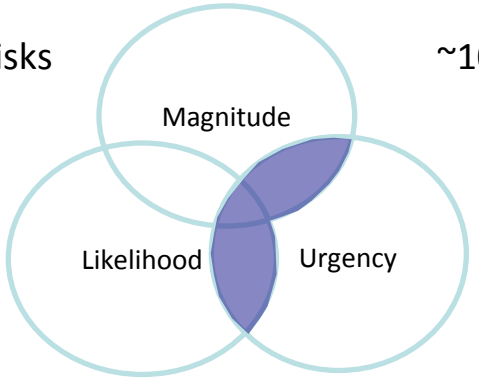
## THEMES

- Natural Environment
- Agriculture & Forestry
- Business
- Buildings & Infrastructure
- Health & Well-being

# CCRA Method in Brief

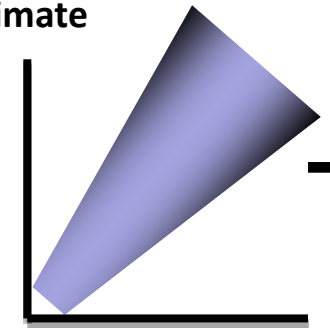
**1. Choose priority risks**

~700risks

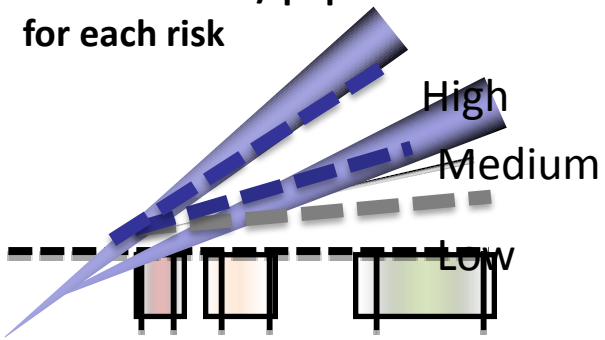



**2. Assess sensitivity of each risk to current climate**

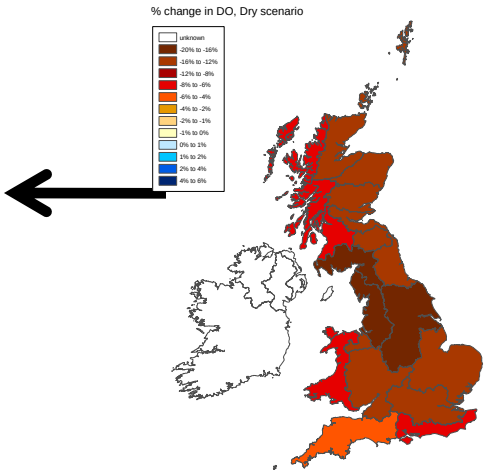
~100risks



**3. Add projections of future climate/ population for each risk**



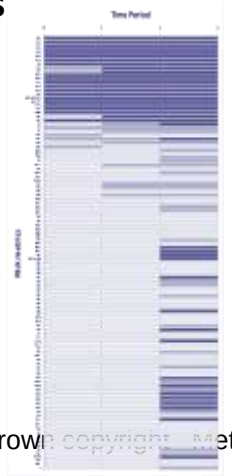

**4. Compare by area for each risk.**




**5. Assign magnitude (logarithmic scale) and confidence scores to each risk**

| Magnitude | Low | Medium | High |
|---|---|---|---|
| Social | 100s | 1000s | Millions |
| Economic | £1 M | £10 M | £100 M |
| Env. | 100km | 1000km | 10,000km |

**6. Compare scores of all risks**

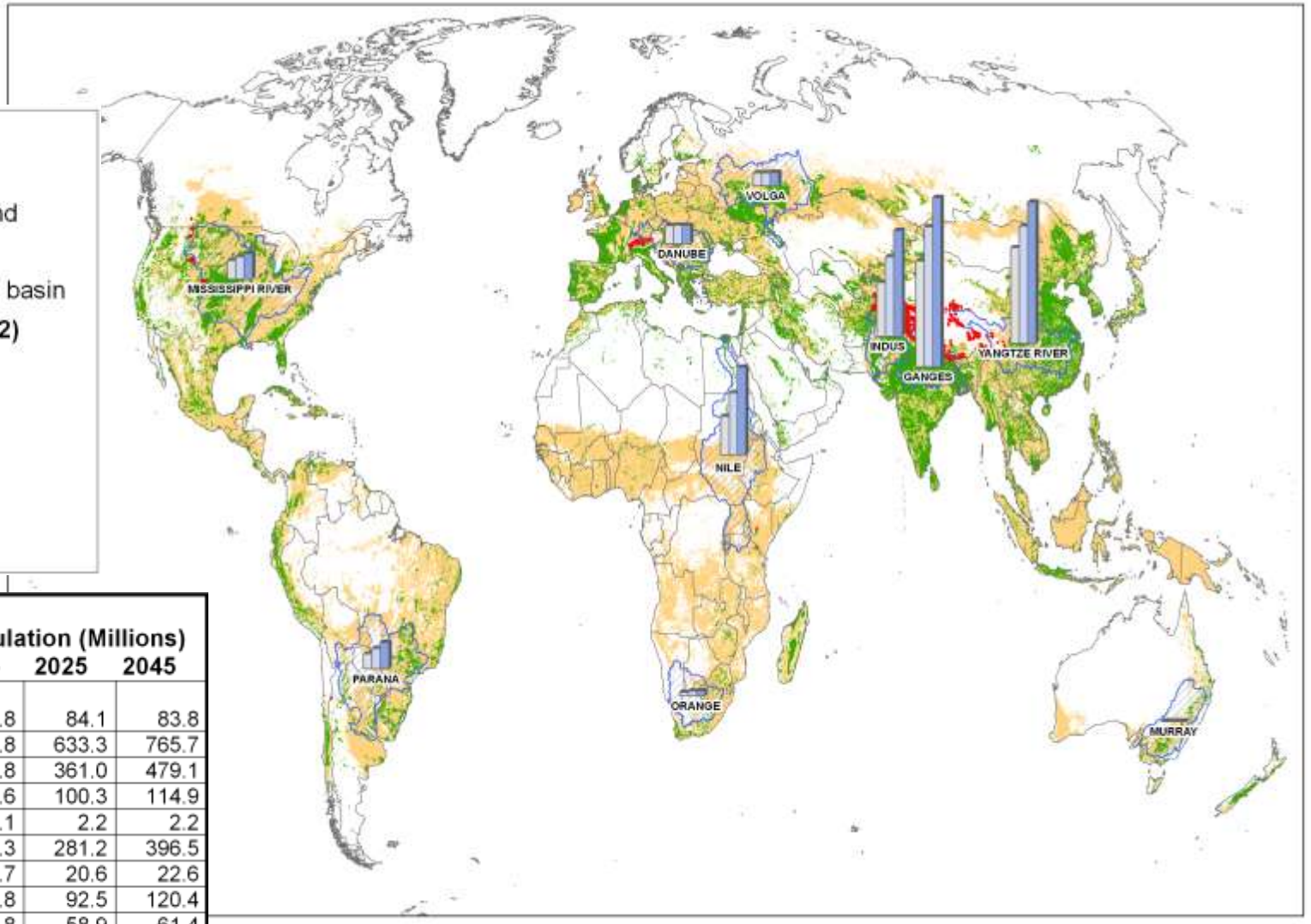


# How can JULES contribute to current IPCC and next CCRA?

- Both IPCC and CCRA take a fragmented, sector-focussed approach
- Often the user-focussed impacts work done quickly to customer timescales not scientific ones!
- Need for a robust, scientifically-proven tool that can be easily and rapidly applied
- Individual sectors (food, water, energy, etc) generally examined independently of each other (so inconsistent)
- Real world more integrated
  - Physical interdependencies
  - Socio-economic interdependencies
- As a process-based model of terrestrial systems, JULES can be a framework for accounting for physical interdependencies
- Very little work done on detection and attribution of impacts

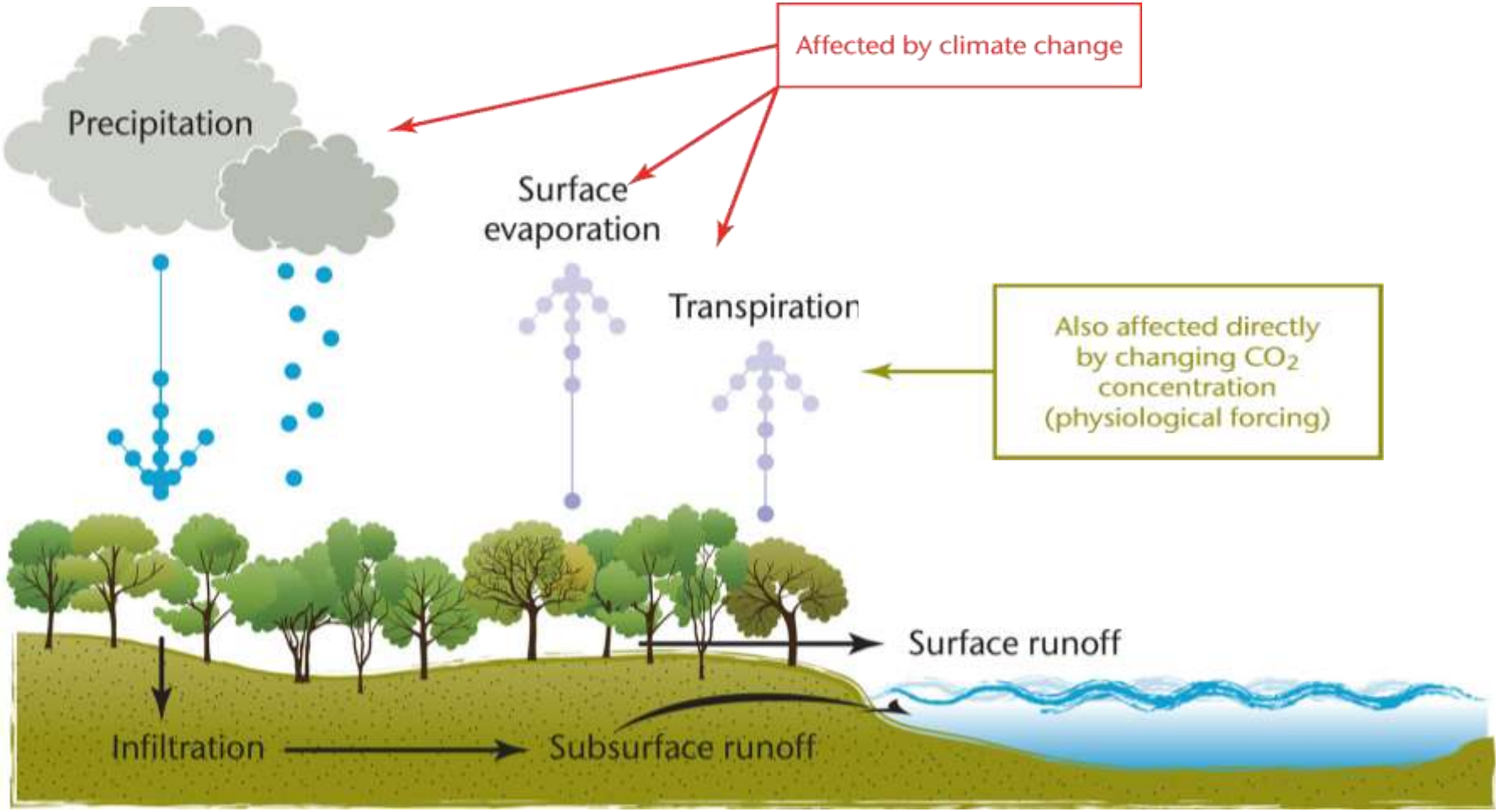
# Integrated land impacts modelling

Met Office
Hadley Centre

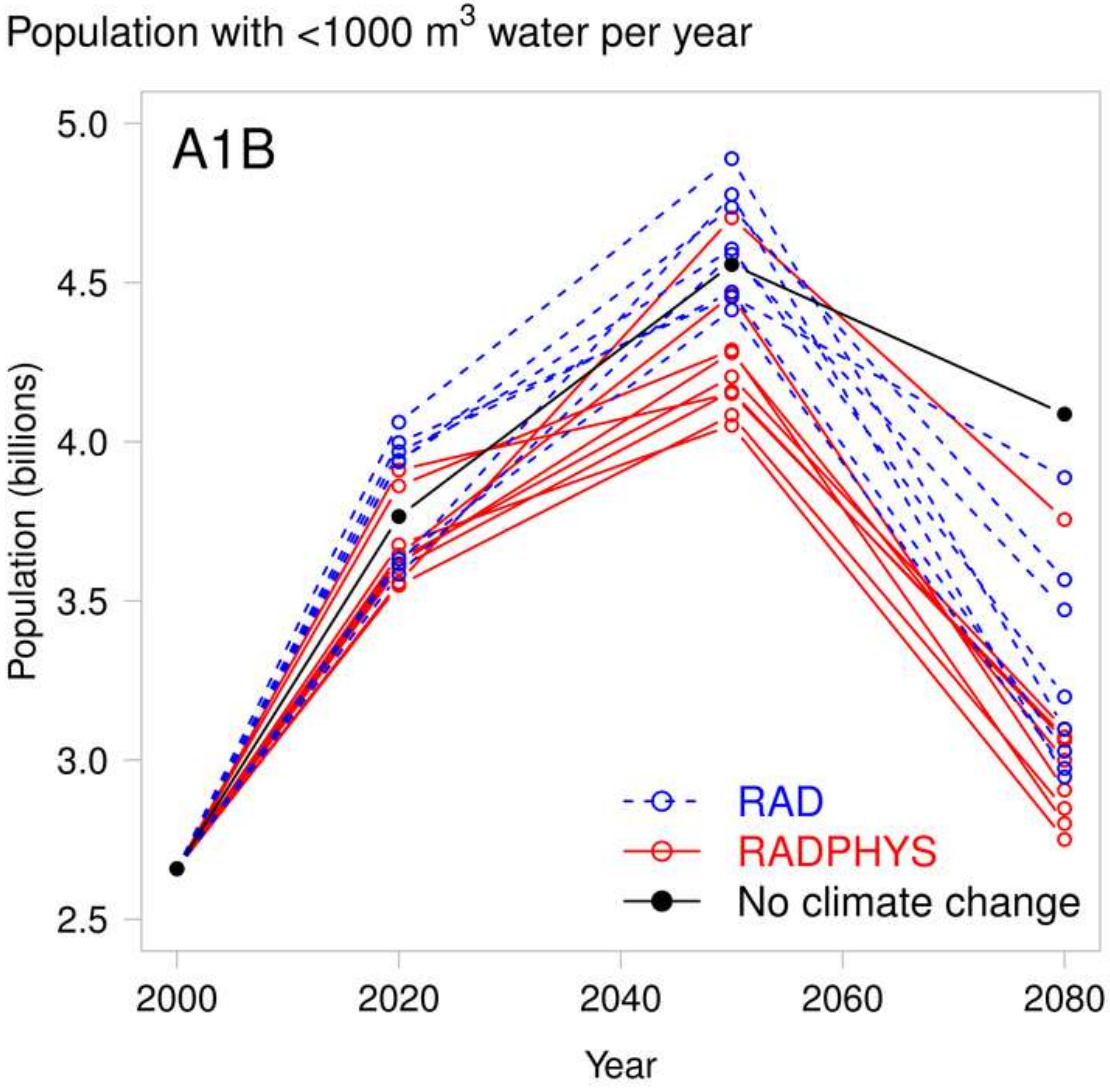



| Basin Name | Population (Millions) 2005 | 2025 | 2045 |
|---|---|---|---|
| DANUBE | 82.8 | 84.1 | 83.8 |
| GANGES | 478.8 | 633.3 | 765.7 |
| INDUS | 244.8 | 361.0 | 479.1 |
| MISSISSIPPI | 84.6 | 100.3 | 114.9 |
| MURRAY | 2.1 | 2.2 | 2.2 |
| NILE | 174.3 | 281.2 | 396.5 |
| ORANGE | 16.7 | 20.6 | 22.6 |
| PARANA | 67.8 | 92.5 | 120.4 |
| VOLGA | 58.8 | 58.9 | 61.4 |
| YANGTZE | 432.2 | 531.2 | 639.3 |

# $CO_2$ rise, climate change and the hydrological cycle



# Impacts of changes in population, climate and $CO_2$ on water stress

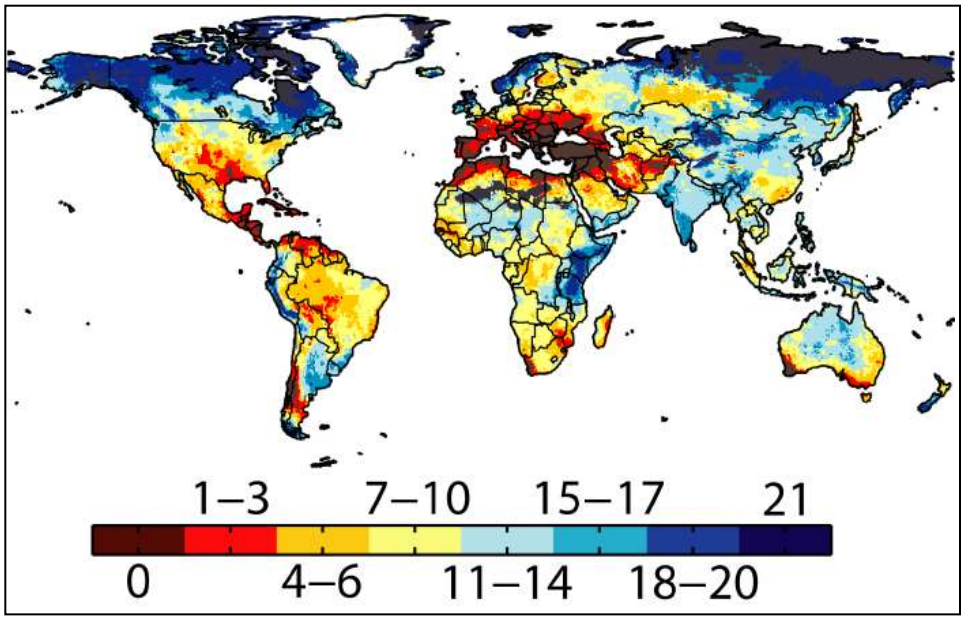



RAD: $CO_2$ only acts as a greenhouse gas

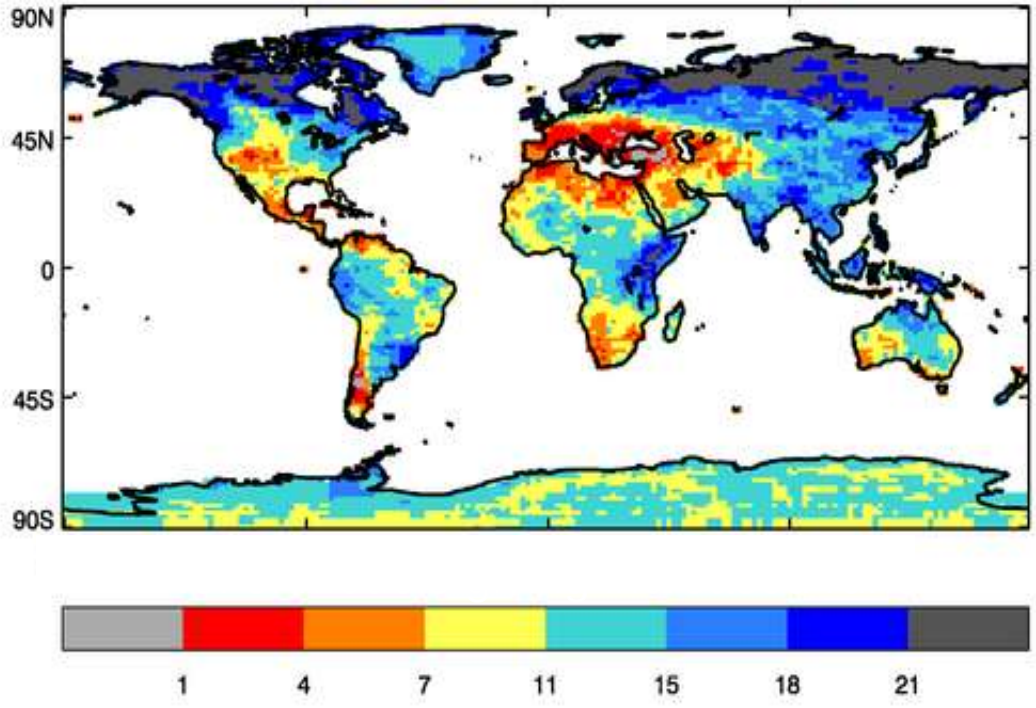
RADPHYS: $CO_2$ also affects plant physiology

# Different predictions using hydrology models inside and outside of climate models

River runoff changes simulated by a hydrology model separate from climate models




River runoff changes directly simulated *within* climate models




(Number of models simulating increased runoff at 4 C warming)

# Proposed work for Fifth Assessment Report (AR5) with JULES: improved impacts projections

- Global-scale projections of biophysical impacts that are internally-consistent:
  - Runoff
  - Groundwater recharge?
  - Terrestrial ecosystems
  - Crop productivity
- Include linkages via large-scale hydrology:
  - Irrigation
  - River flows

# Proposed work for AR5 with JULES: improved attribution

- Global-scale simulations of past biophysical impacts that are internally-consistent:
  - Runoff, river flows
  - Terrestrial ecosystems
- Include more complete treatment of direct and indirect climate processes:
  - Local precipitation + evaporation
  - Remote influences via rivers
  - Indirect effects eg: vegetation impacts on hydrology
  - Other anthropogenic drivers eg: land use, irrigation

# Priorities for delivering impacts to AR5

- Provide more integration between processes that have previously been assessed in AR4
- More complete representation of land hydrology
- Inclusion of crops
- Simulation of existing processes not compromised
- Fully operational on *global* grid:
  - Science works (and is credible!) everywhere in world
  - Driving data / ancillary files available on global grid
  - Validated on global grid
- Deliver in time to be assessed in the report!

# Other priorities

- Remember JULES also intended as land surface scheme for Unified Model – both climate and weather forecast configurations
- JULES developments which reduce performance of atmosphere model will not be used in operational Met Office configurations of UM!  (both climate and weather configurations)
- Limit divergence from UM version of JULES as far as possible – easier to test and maintain

# Timescales for inclusion in AR5 Working Group 2 report (Impacts, Adaptation and Vulnerability)

- Zeroth Order Draft (ZOD) underwent informal review Autumn 2011
  - Several members of JULES community took part in informal review – thank you, very useful indeed!
- First Order Draft (FOD) currently being written.
  - Lead authors need to be familiar with current work **NOW**
- FOD out to formal review June 2012
  - Please consider volunteering to be expert reviewer
- Second Order Draft (SOD) to be written early 2013
  - Cited papers need to be submitted by 31st January 2013
- Final draft late 2013
  - Cited papers need to accepted by 31st August 2013
- Report publication April 2014