# Current Research on Assessment of Climate Change Impacts

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**IAIA Ireland - UK Branch Event (with IEMA)**

**'Changing Climates for Environmental Assessment', Manchester, 24th October 2007**

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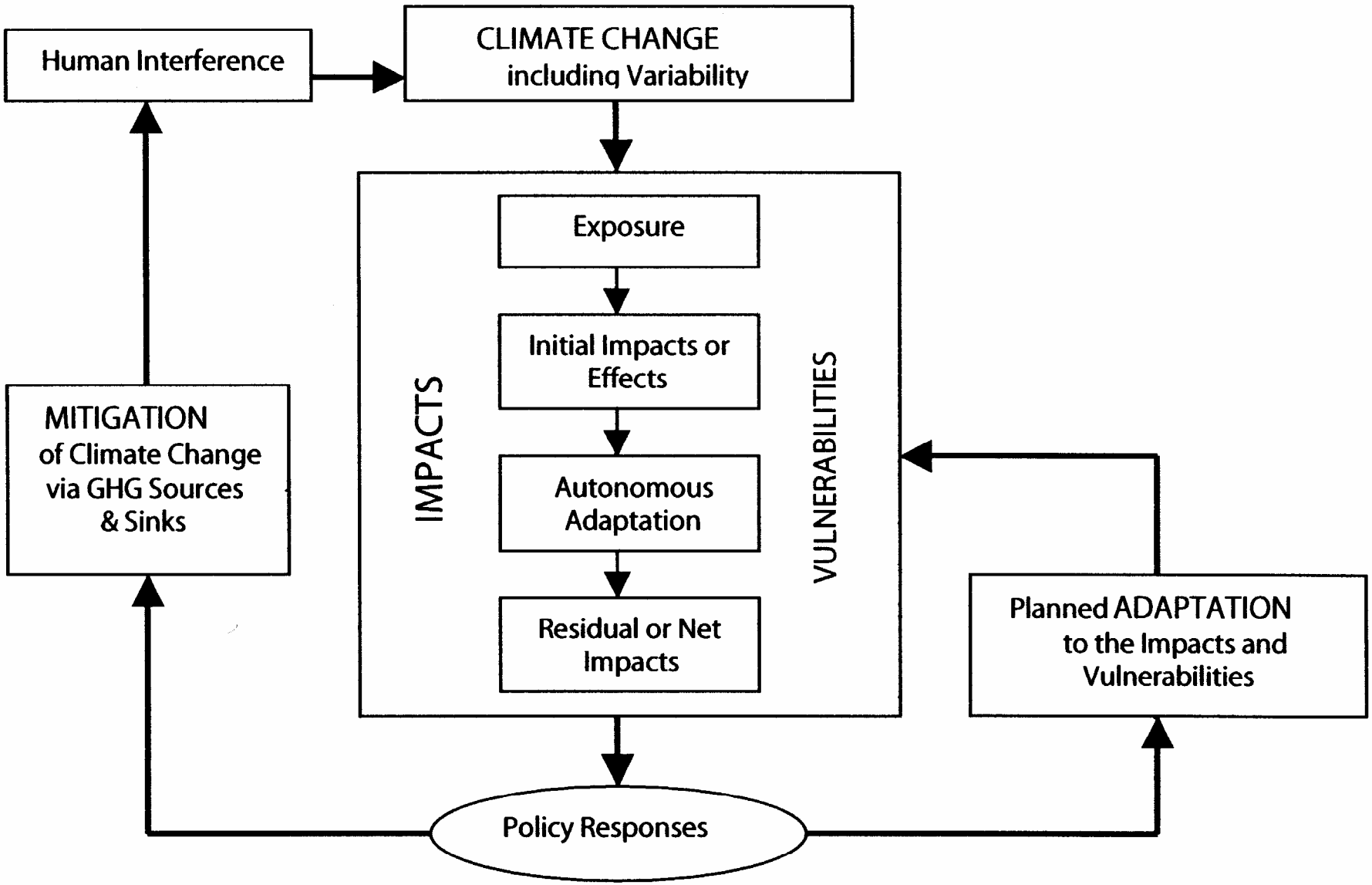
‘Our scientific understanding of climate change is sufficiently sound to make us highly confident that greenhouse gas emissions are causing global warming. The science clearly points to the need for nations to take urgent steps to cut greenhouse gas emissions into the atmosphere… (and to)… prepare for the impacts of climate change, some of which are already inevitable.’

Royal Society, 2007

# Adaptation in climate change management



# The Case for Climate Change Adaptation

- Climate change cannot be avoided
- Climate change may be experienced more rapidly than scenarios suggest
- Planned adaptation is more cost effective than emergency measures and retrofitting
- Planned adaptation reduces likelihood of maladaptation
- Immediate improvement gives protection from climate extremes and other benefits
- Captures benefits of climate change where these are applicable
- Develops a receptive policy environment

(Adapted from Burton, 1996 and Willows and Connell, 2003)

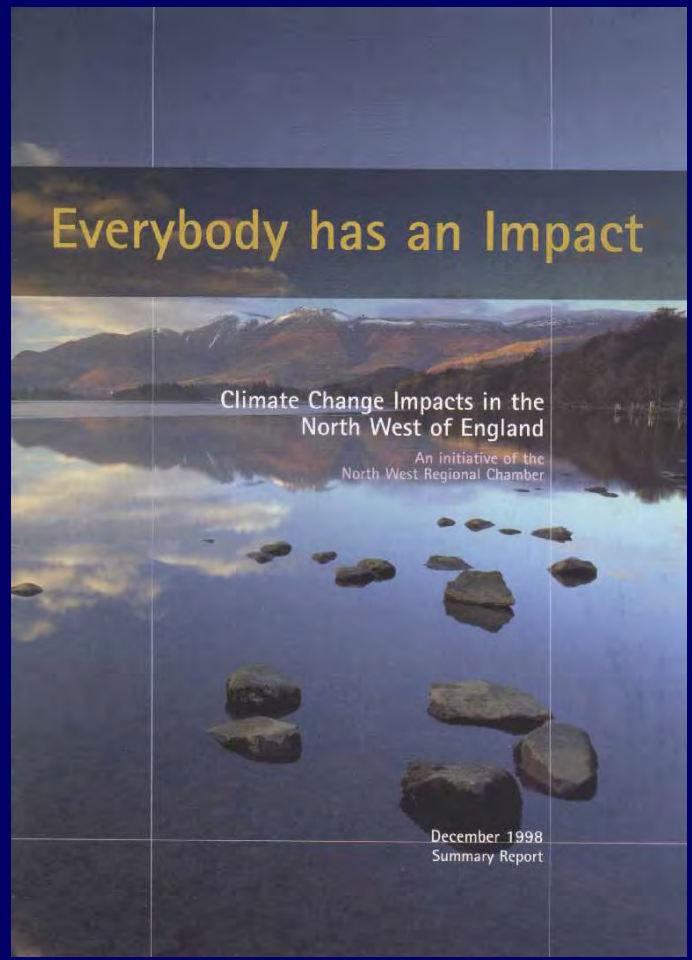
# CURE Research on Assessment of Climate Change Impacts

- North West Regional Scoping Study, 1998
- Regional Climate Change Impact and Response Studies (REGIS)
- DEFRA Climate Change and the Visitor Economy (CCVE), 2004-2006
- EPSRC Building Knowledge for a Changing Climate (BKCC) - Adaptation Strategies for Climate Change in the Urban Environment (ASCCUE), 2003-2006
- Climate change, species range expansion and the institutional response, 2005-2008
- EPSRC Sustaining Knowledge for a Changing Climate (SKCC), 2006-2008

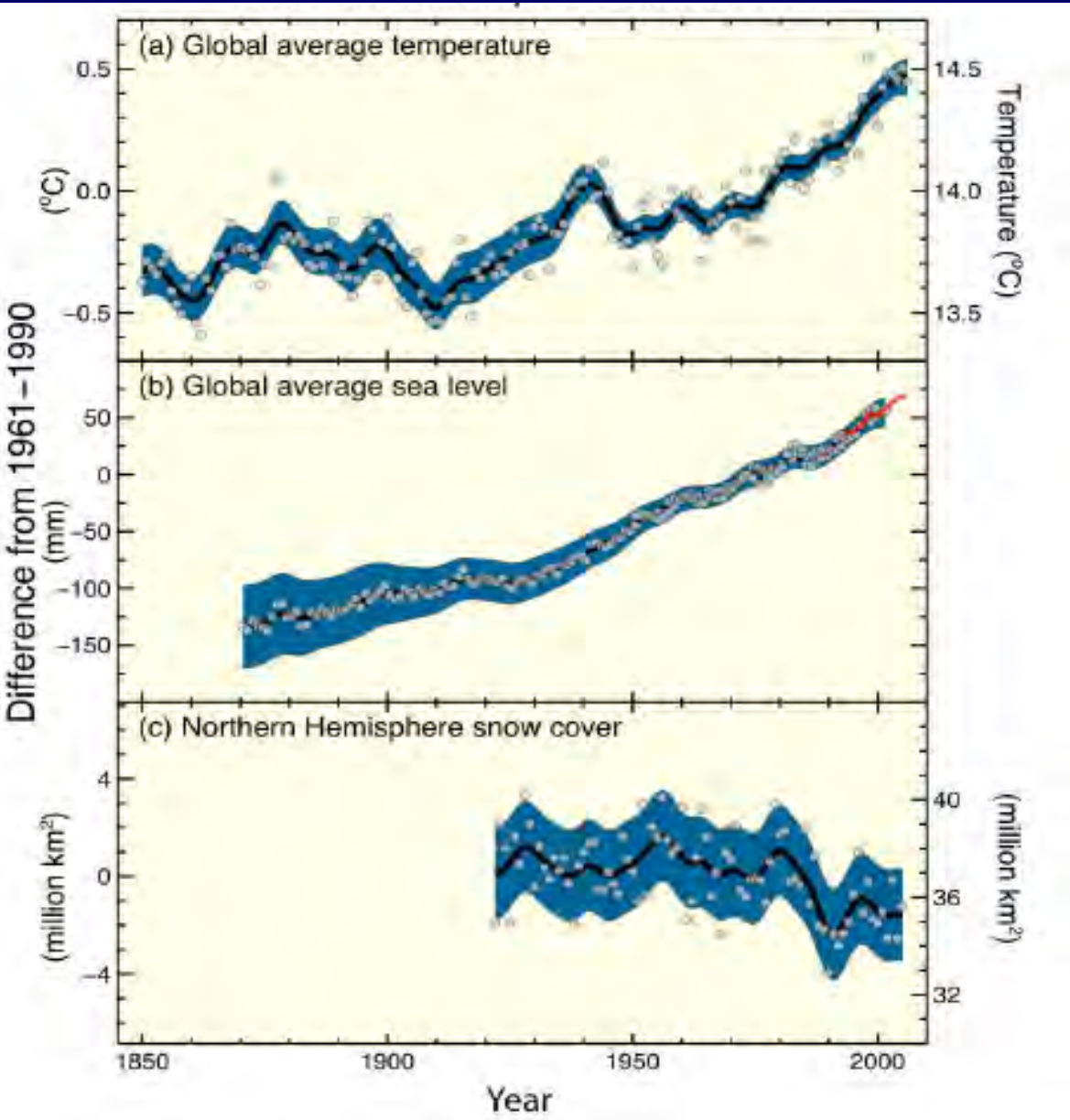
# North West Regional Impacts Assessment

Key messages:

- The climate is changing
- Climate change will intensify
- Climate change impacts all sectors and landscapes
- Climate change brings opportunities as well as threats



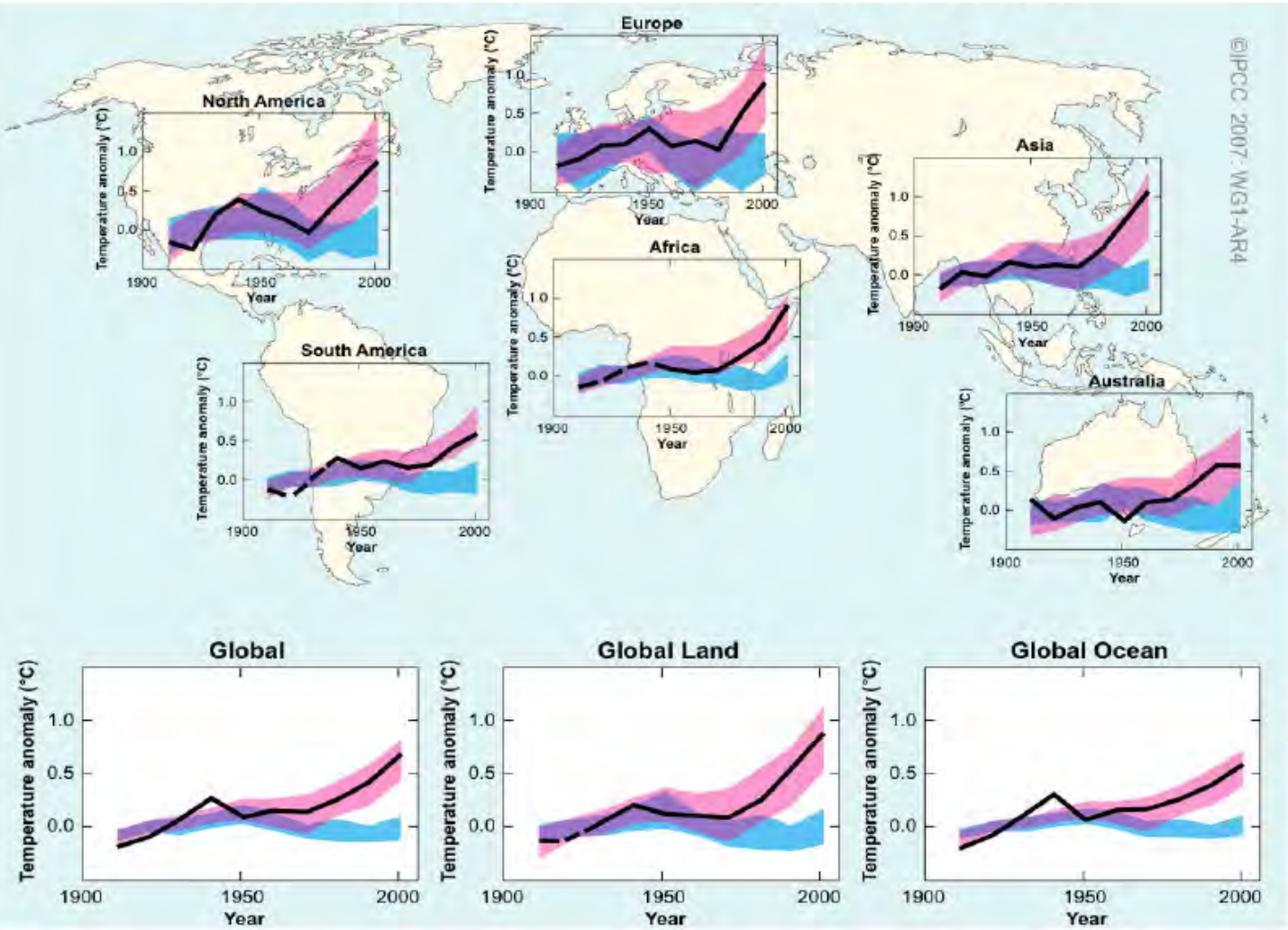
# The Climate is Changing




- Warming of the climate system is unequivocal
- Coherent changes in many aspects of the climate system not just temperature

(source: IPCC, 2007)

# Changes go beyond natural variability



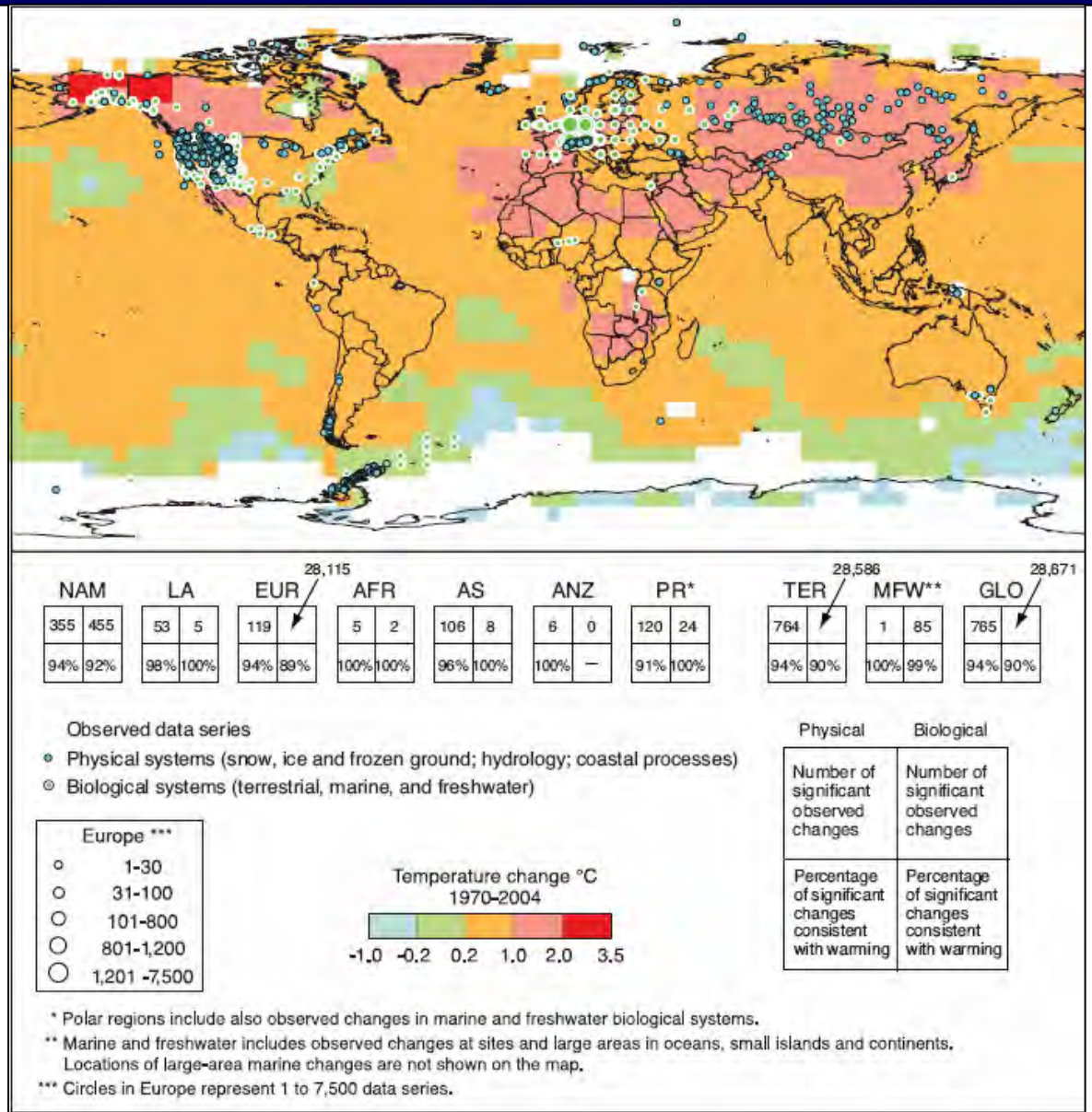

Temperature change in last 50 years is *very likely* (>90% chance) due to increase in anthropogenic greenhouse gas concentrations

(source: IPCC, 2007)

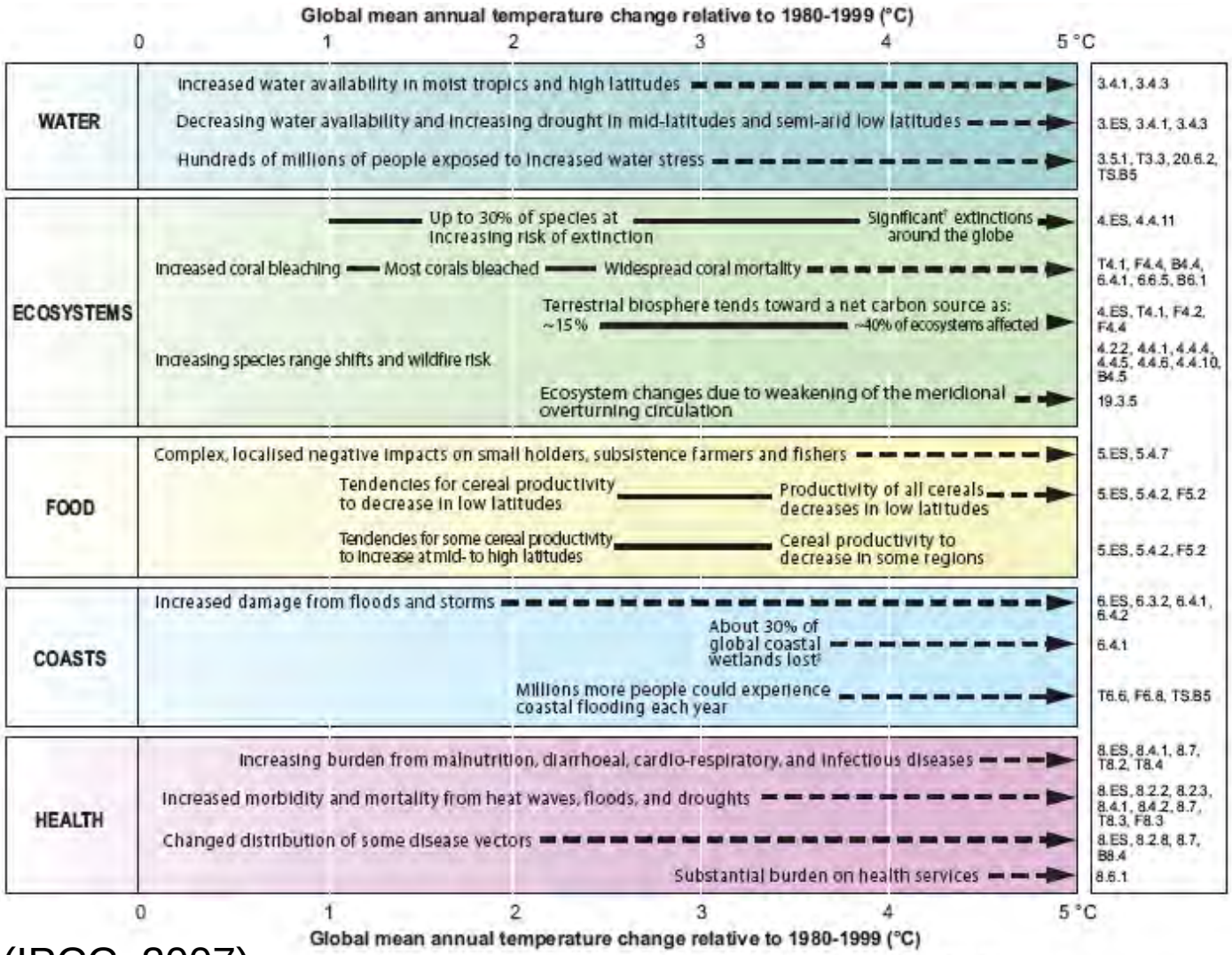
# Environmental change is pervasive

Changes in physical and biological systems and surface temperature 1970-2004

(IPCC, 2007)

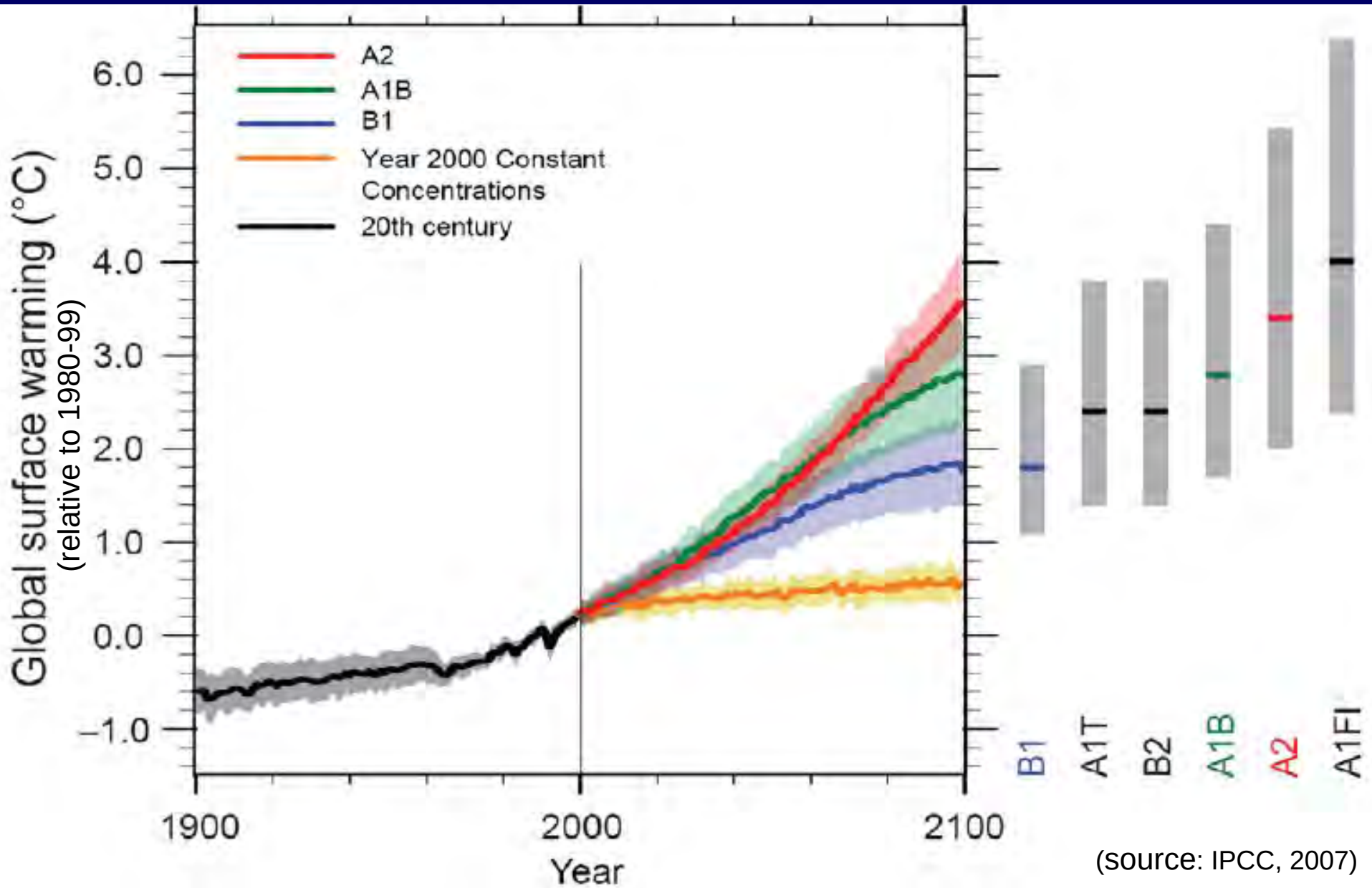


# Key impacts as a function of global temperature change



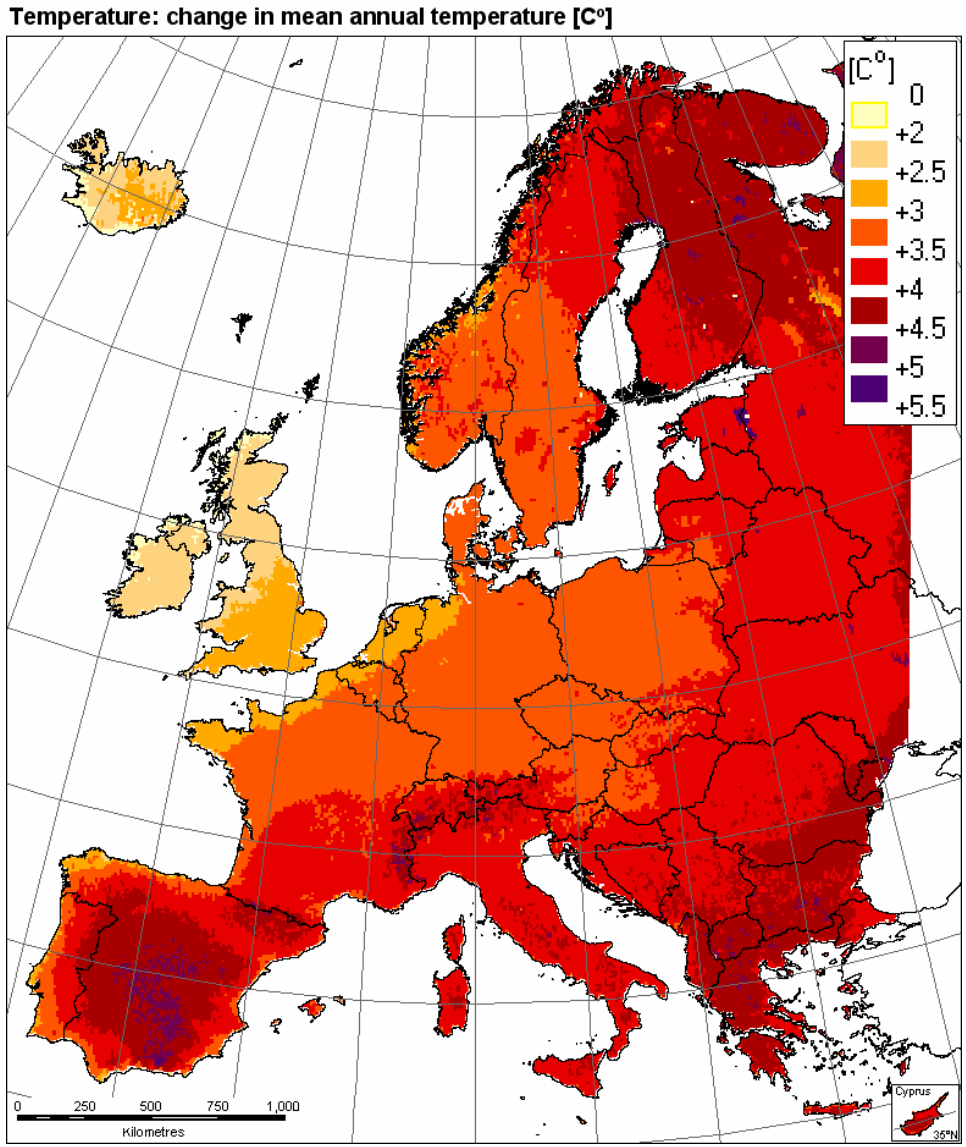

(IPCC, 2007)

# Global climate change projections




(source: IPCC, 2007)

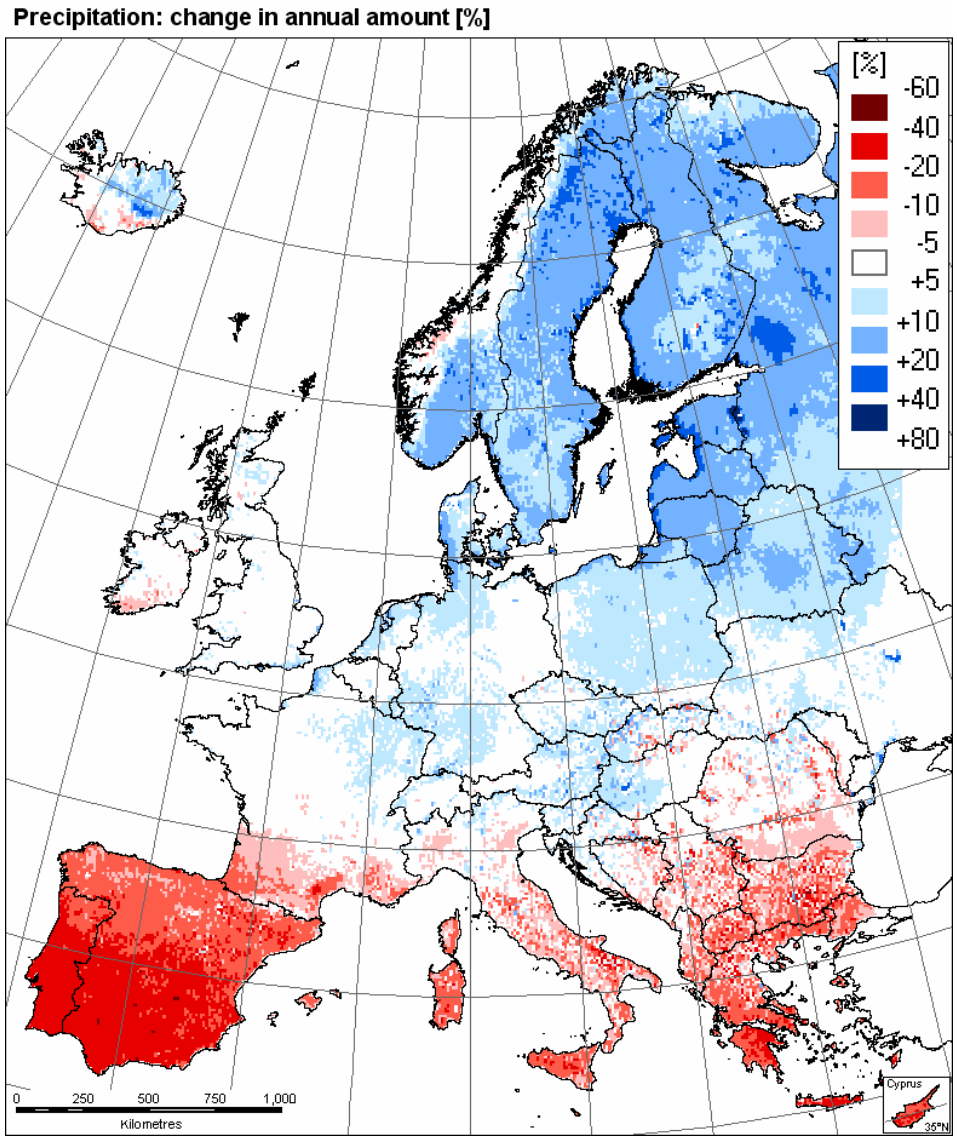
# Change in mean annual temperature by the end of this century




Based on IPCC SRES Scenario A2

(EC Green Paper, 2007)

# Change in mean annual precipitation by the end of this century



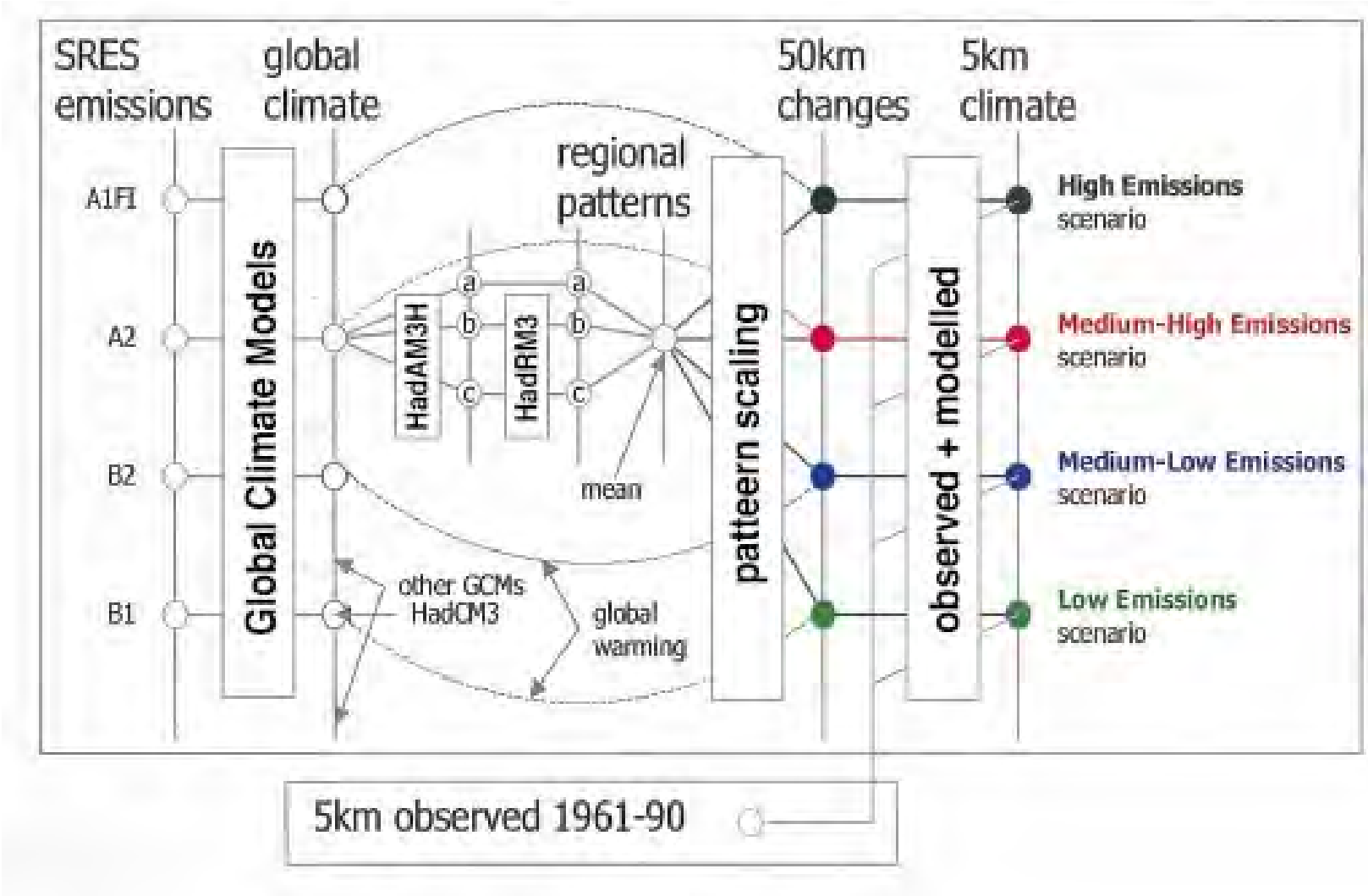

Based on IPCC SRES Scenario A2

(EC Green Paper, 2007)

# What does this mean for the UK?

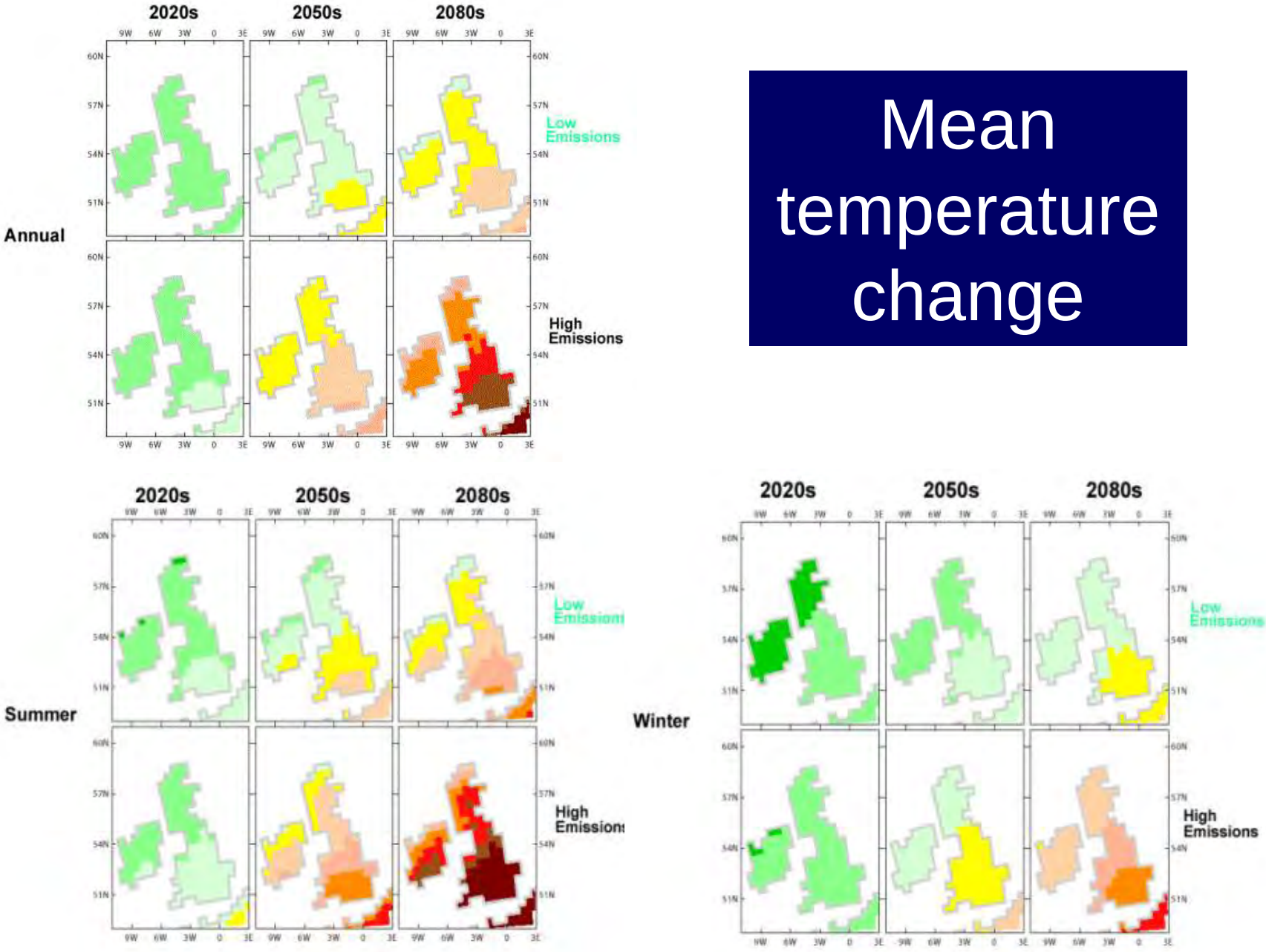
- UKCIP02
  - 4 emissions scenarios
  - 3 time slices
  - 50 km outputs (some 5 km)
- UKCIPnext
  - Probabilistic scenarios
  - 25 km output
  - Due 2008

# Downscaling the global model to a regional scale for the UKCIP02 scenarios



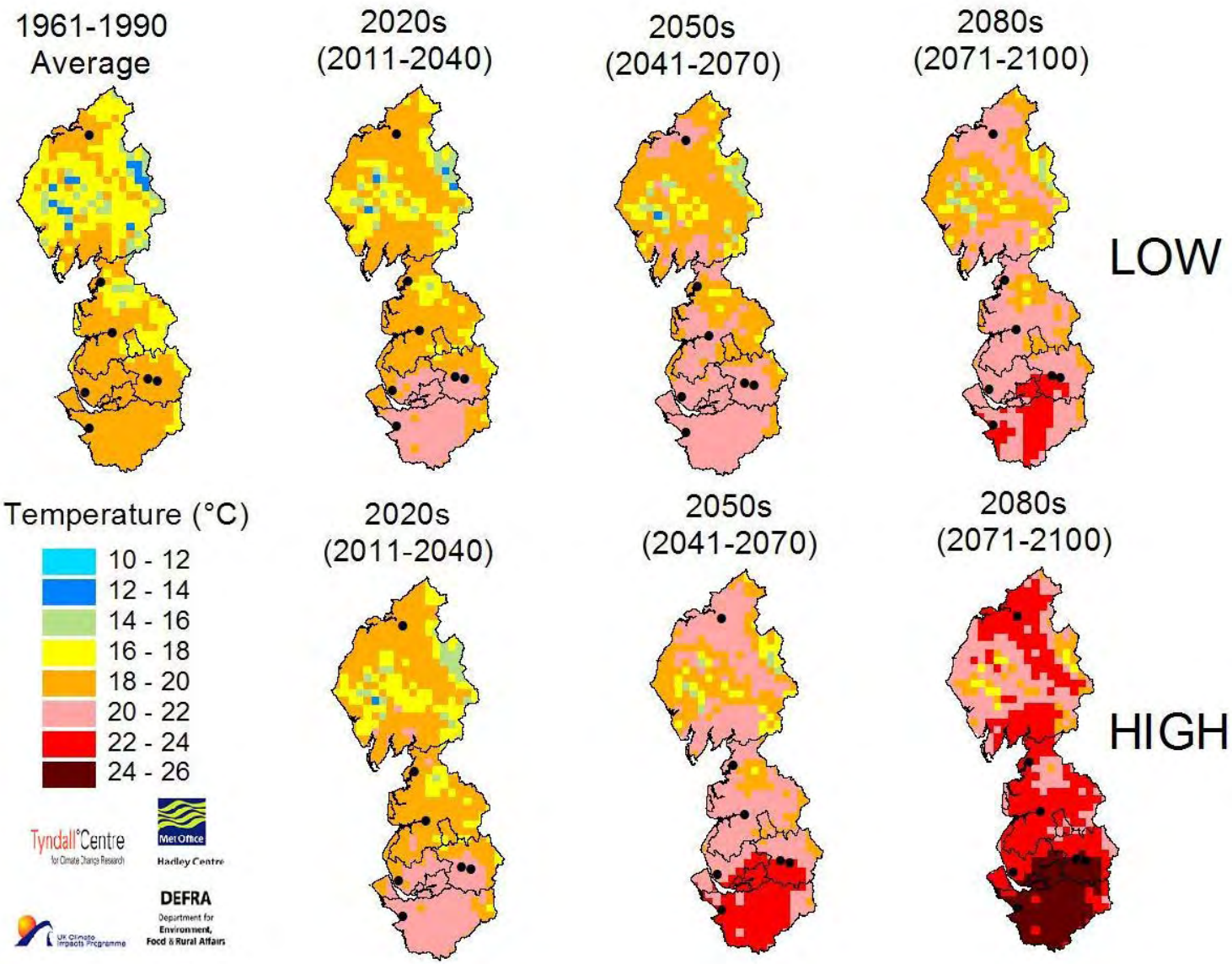

(UKCIP, 2002)

# Mean temperature change

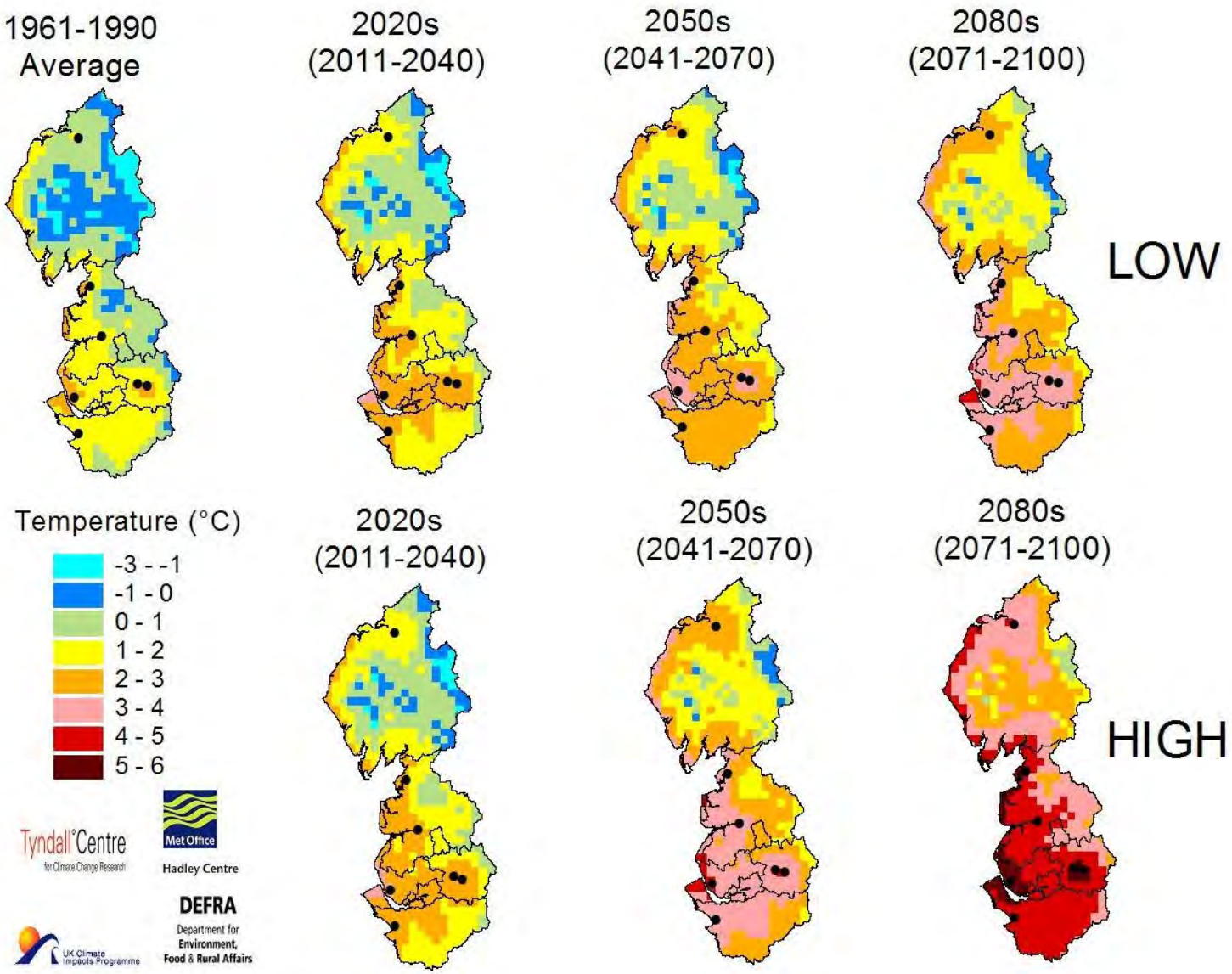



(Source: UKCIP02)

# Average Summer Maximum Temperature Scenarios for the North West



# Average Winter Minimum Temperature Scenarios for the North West



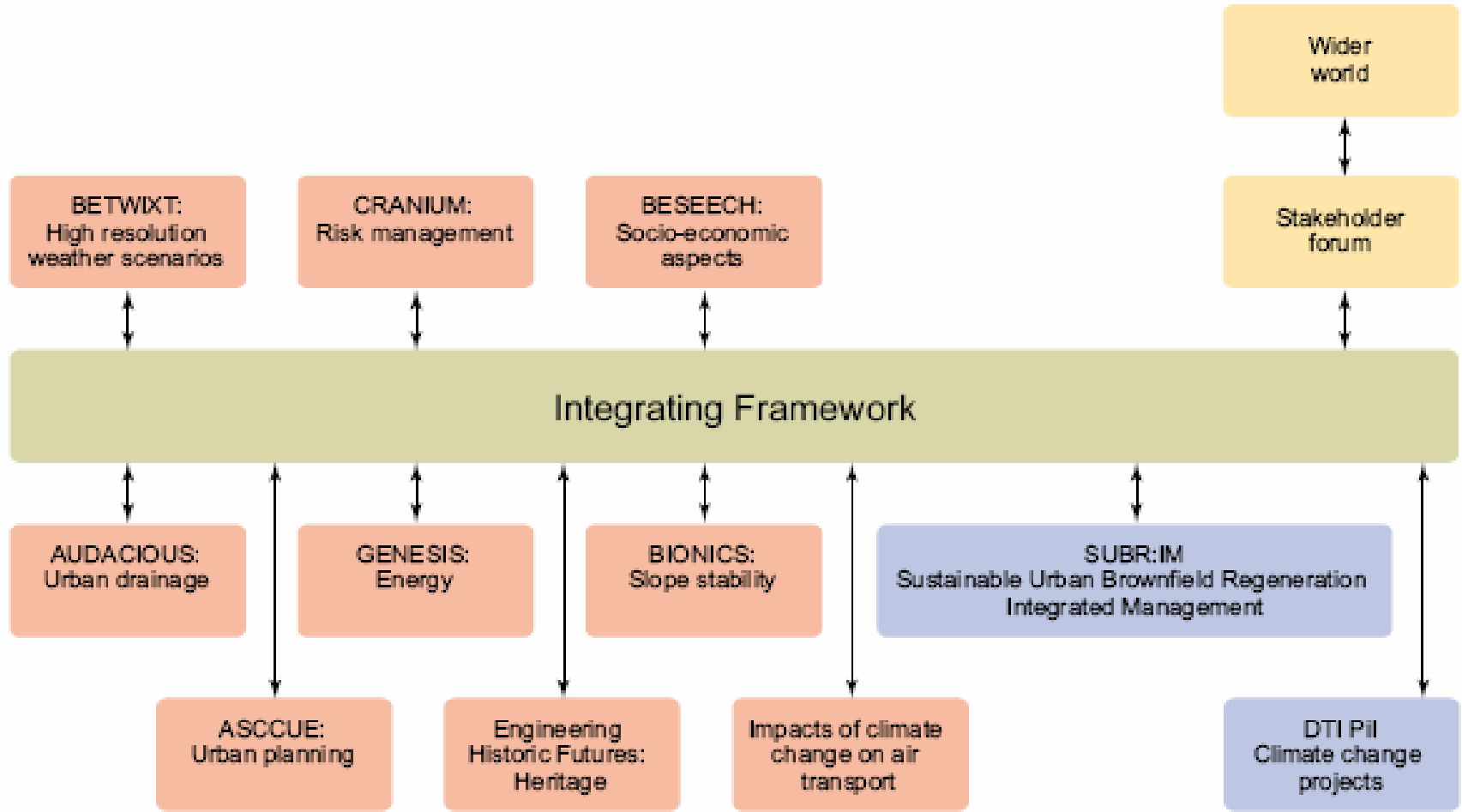
# Confidence in Climate Information

- CO2 concentration
- Global mean sea level
- Global mean temperature
- Regional temperatures
- Regional temperature extremes
- Regional precipitation
- Cloud cover
- Climatic variability / extremes

High Confidence

Low Confidence

# Building Knowledge for a Changing Climate Programme



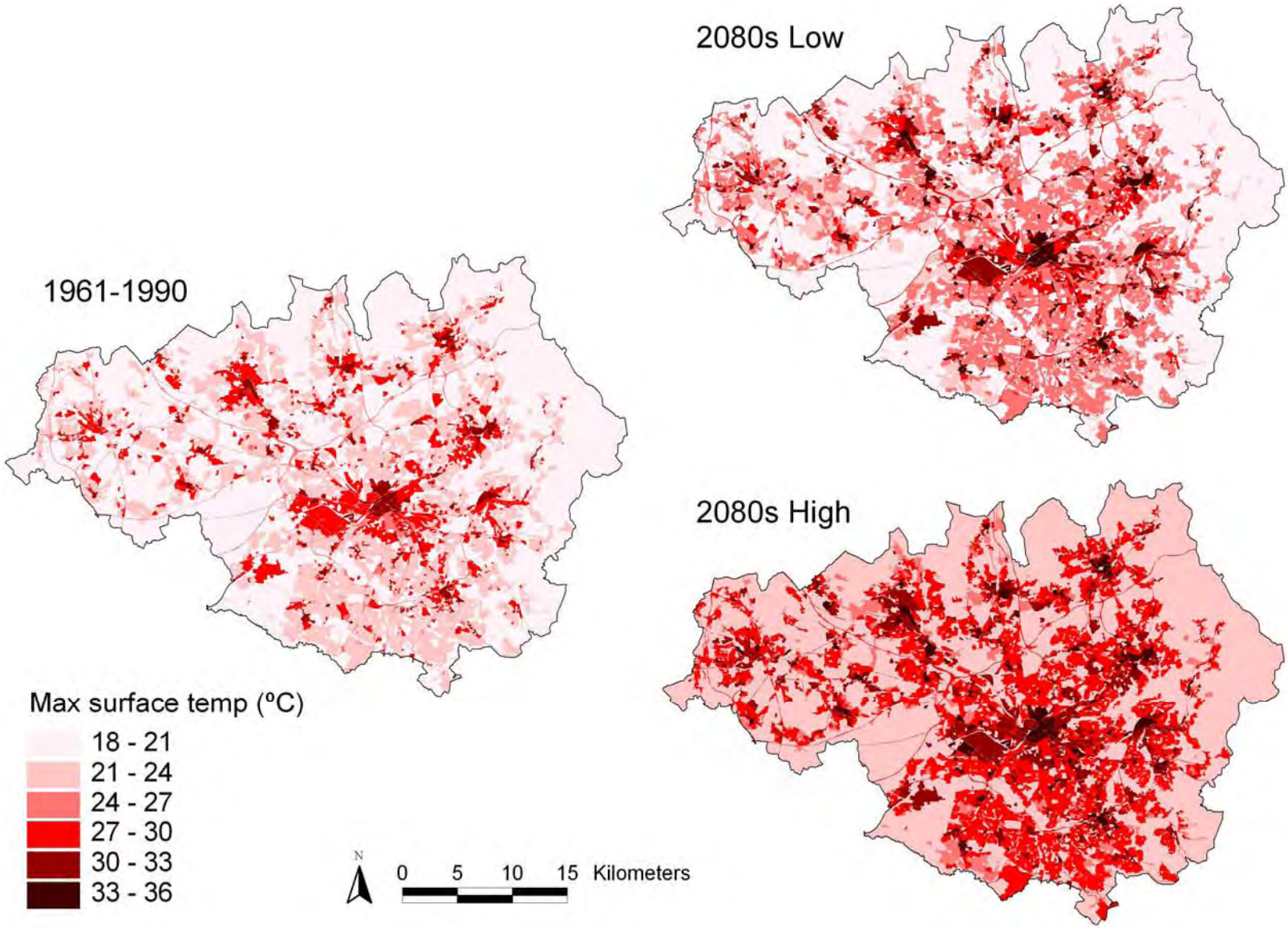
# Built Environment: Weather scenarios for investigation of impacts & extremes (BETWIXT)

- Climatic Research Unit (CRU) weather generator:
  - Constructs self-consistent daily time series for the present day and future time periods for 8 variables
- Rainclim software package:
  - Generates rainfall time series for the present day and future time periods up to 2100 for 18 sites in the UK, with time resolutions of 5 minutes and 1 hour
- EA Rainfall and Weather Impacts Generator:
  - Further development of CRU weather generator and Rainclim

# Climate Change Impacts in the Built Environment

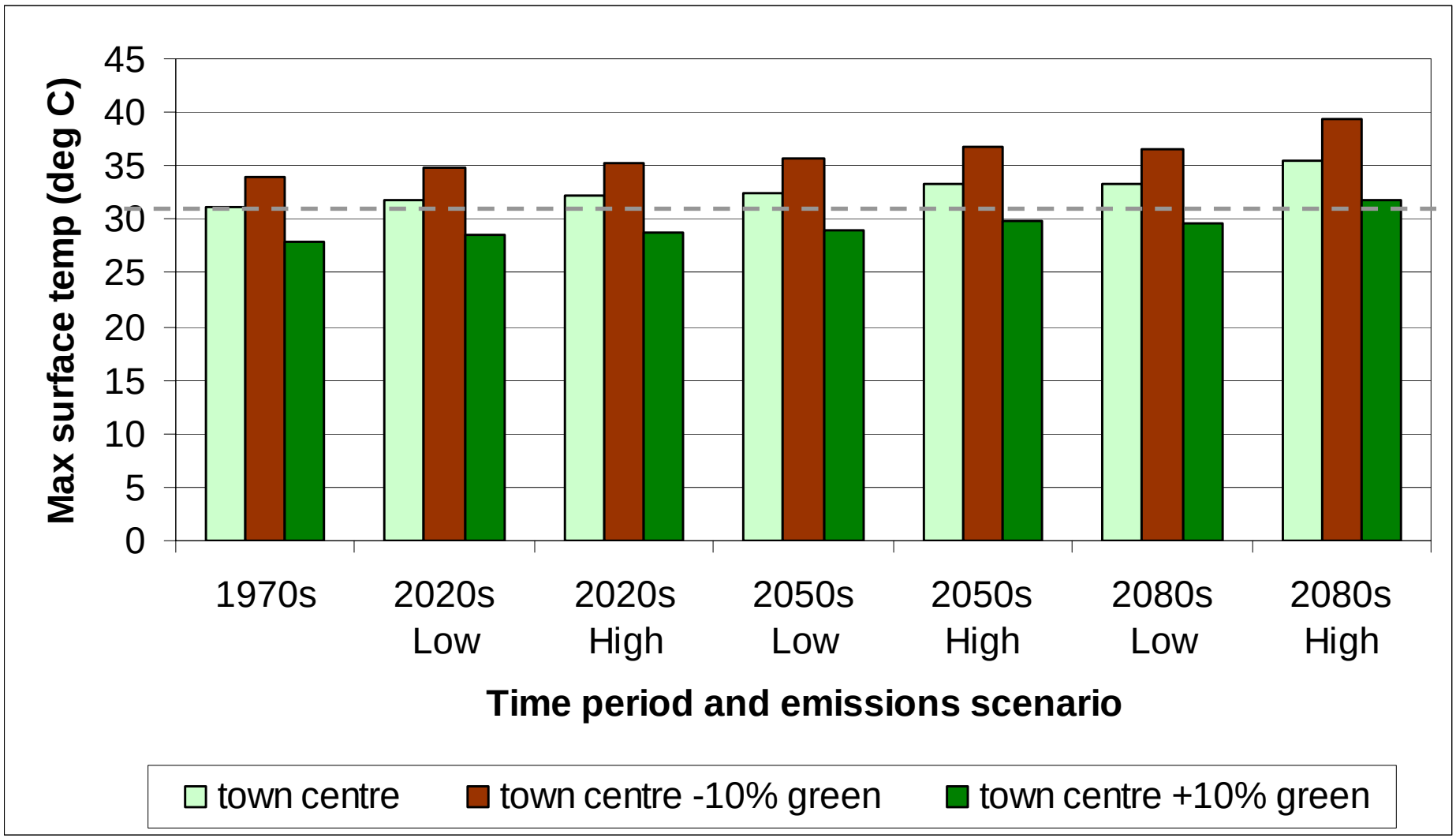
- The built environment is distinctive
  - High building mass increases thermal capacity
  - Surface sealing increases rainfall run-off
- Climate change strengthens the urban heat island and accelerates run-off

# Surface temperature

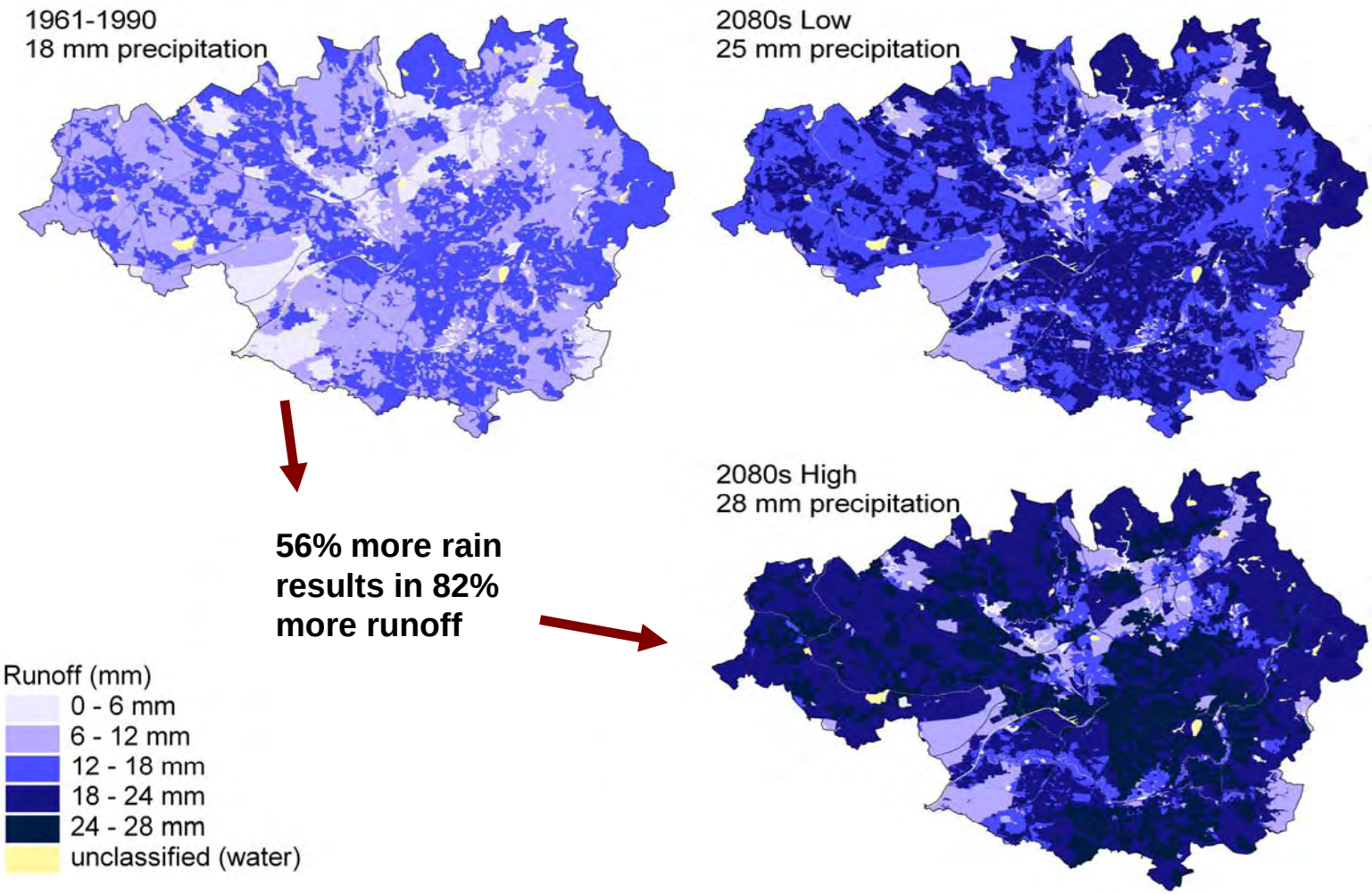


# Importance of the public realm

# Effect of adding/subtracting greenspace on surface temperature



# Surface run-off



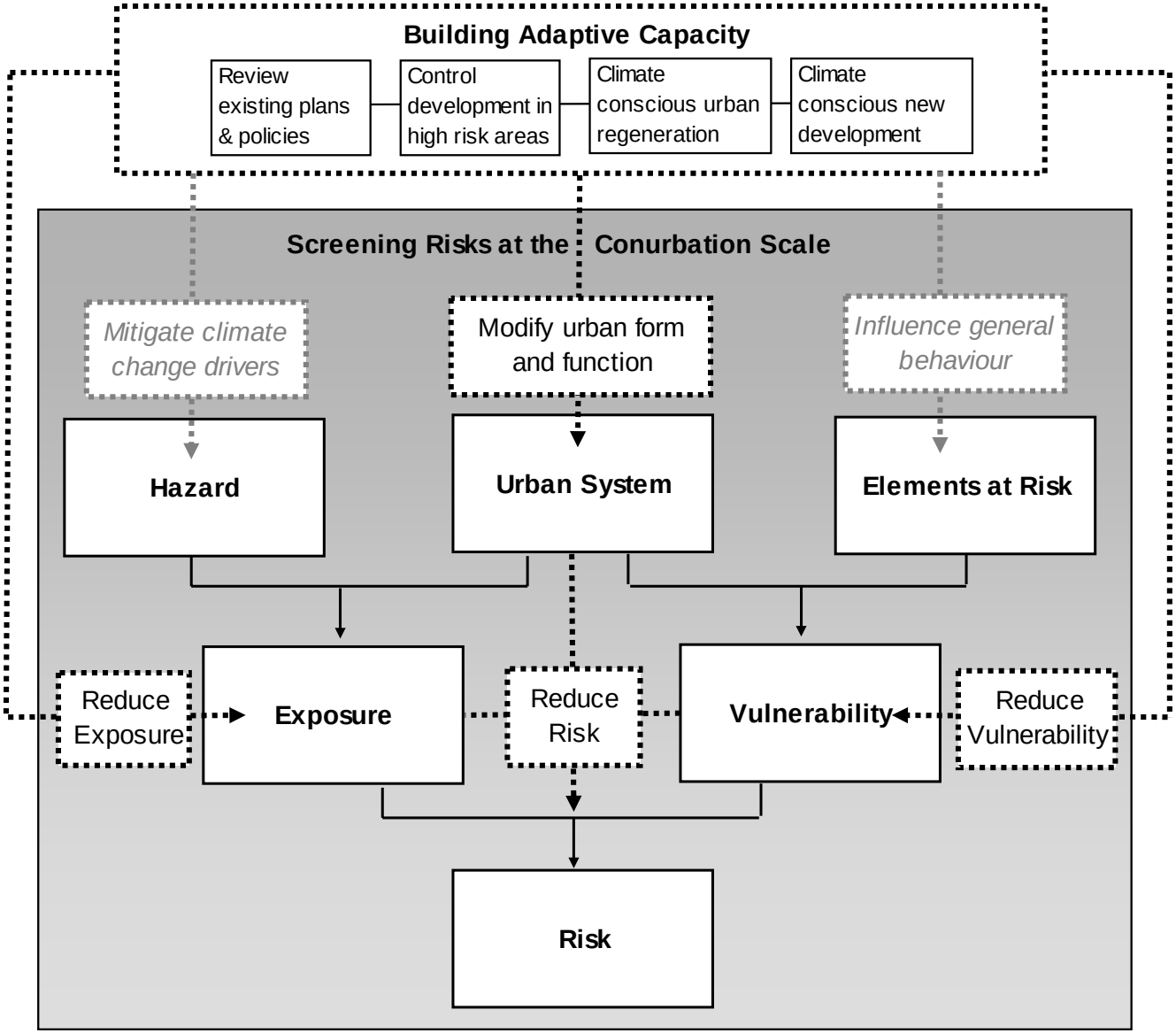

For a precipitation event occurring on average one day per winter, with normal antecedent moisture conditions

# Problems of pluvial flooding

# Priority themes for risk assessment

| **Exposure Unit** | **Hazard** | **Elements at Risk** |
|---|---|---|
| Built environment | Flooding, geohazards (e.g. landslides, shrink-swell clays) | Built environment, key infrastructure and services |
| Urban greenspace | Drought (available water content), runoff, temperature | Key greenspace infrastructure including parks, gardens and trees |
| Human comfort | Temperature (day and night maxima), precipitation | Receptive environments e.g. for shoppers and commuters |
| Human health | Temperature (day and night maxima) | Population density and characteristics |

# Pathways to climate change adaptation

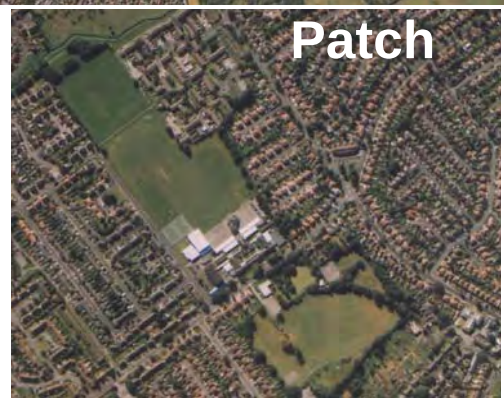


# Strategic Planning Works to Reduce Risk and Realise Opportunity

- Characterise the urban environment
- Scope out climate impacts at conurbation level
- Do not increase exposure; seek to reduce it
- Increase resilience through urban design and capacity building
- Adaptation and mitigation should complement each other, not conflict
- Develop complementary strategies e.g. green infrastructure

# Climate Adaptation via the Green Infrastructure

| | Corridor | Patch | Matrix |
|---|---|---|---|
| Flood storage | • • • | • • | • |
| Infiltration capacity | • | • • | • • • |
| Evaporative cooling | • | • • • | • • |
| Shading | • | • • | • • • |



**Functional importance of urban greenspace needs to be reflected in RSS and LDFs**

# Impacts of climate change on species

- All species are adapted to specific bioclimatic conditions or ‘climate space’ which are shifting polewards as the climate warms
- Models of likely changes in species climate space reveal that species’ responses are likely to be individualistic
- Whilst upland species are likely to lose climate space, lowland species will have the potential to expand their distributions northward

# Changes to Species' Climate Space

## Lowland Species

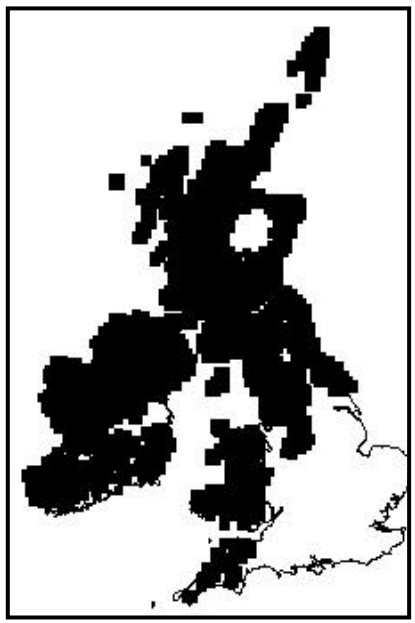
Climate space for *Ochlodes venata* (Large skipper butterfly)

Current climate

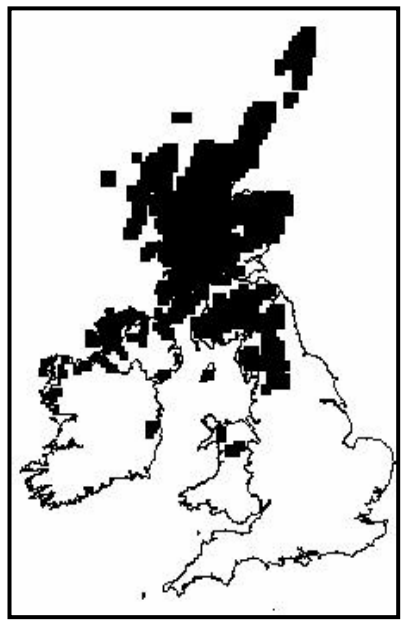
2050s High emissions scenario

## Upland Species

Climate space for *Coenonympha tullia* (Large heath butterfly)



Current climate

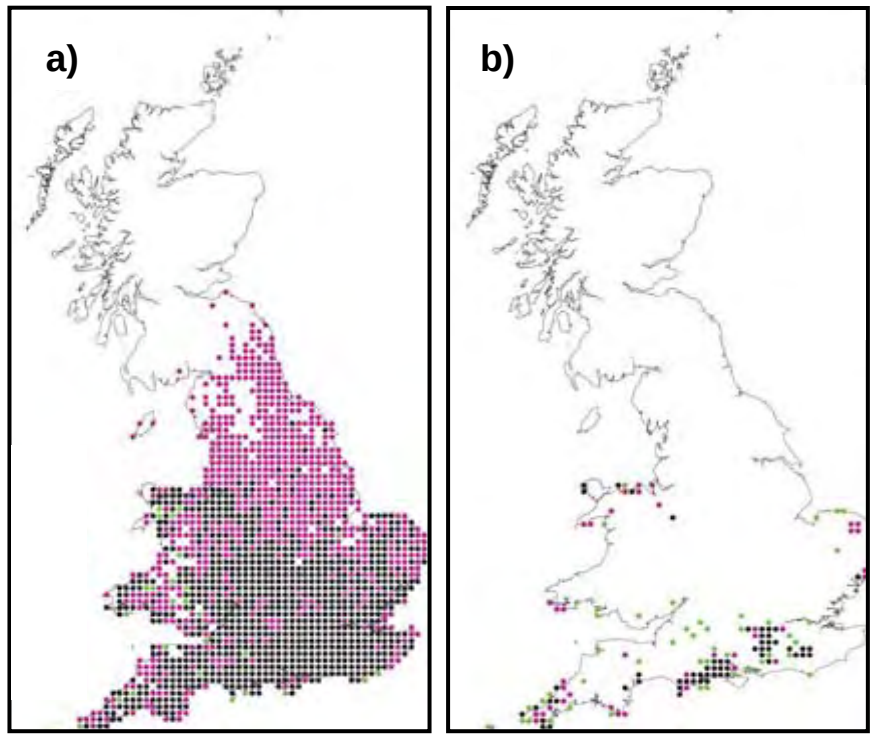


2050s High emissions scenario

Source: Harrison *et al* , 2001 (MONARCH)

# Exploiting Changes in Climate Space

- Many lowland species may be unable to exploit opportunities of increased climate space due to Britain's modified and fragmented landscapes
- Whilst wider countryside species are already shifting their distribution northwards, species adapted to specific habitats are not able to access new climate space




a) Current distribution of *Polygonia c-album* (Comma butterfly)

b) Current distribution of *Plebejus argus* (Silver-studded blue butterfly)

Source: Warren *et al* , 2001

# The Role of Green Infrastructure for Species Range Expansion

- To facilitate species range expansions, the barriers to their movement need to be identified so that they can adapt to they changing climatic conditions
- Current plans for implementing green infrastructure in the NW may help species to track their climate space polewards
- This will allow species to adapt to anthropogenic climate change without direct intervention e.g. translocation

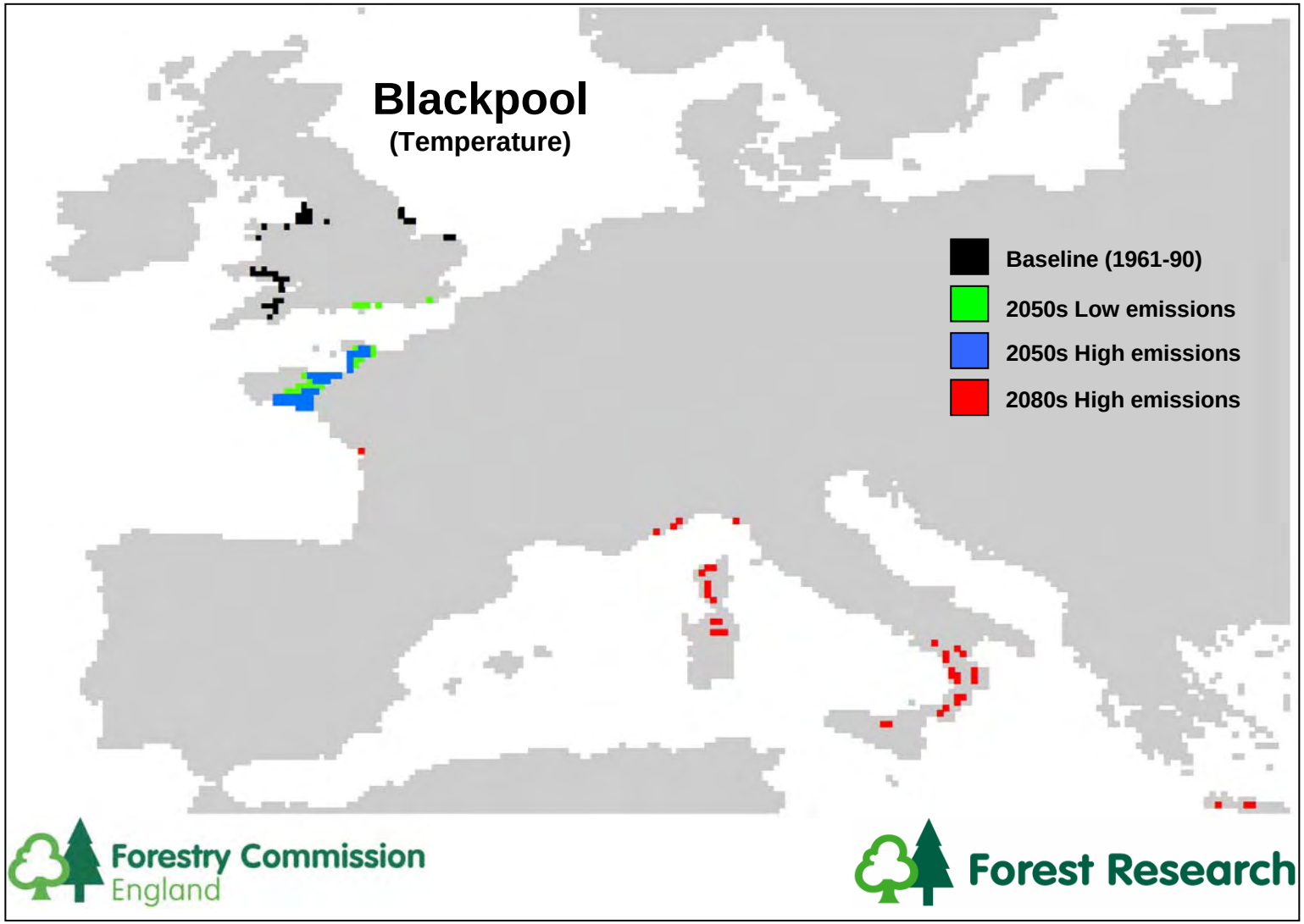
Source: Highways Agency Photo Gallery

# Climate Change and the Visitor Economy


"there are potential benefits resulting from climate change in some economic sectors, especially tourism and recreation, but we can be less certain about the scale of such benefits and they are unlikely to be distributed evenly across the sector"

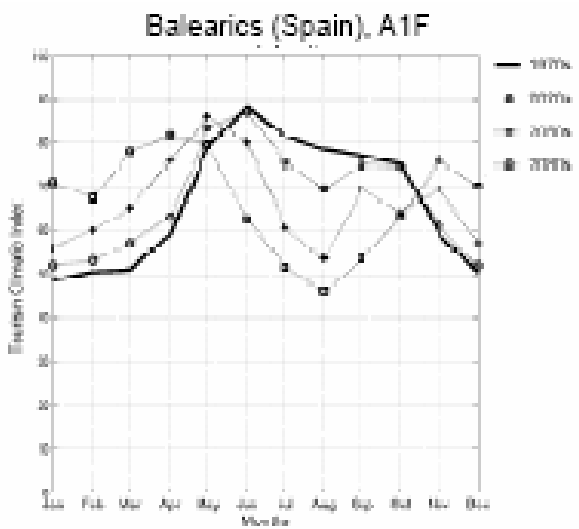
Source: North West Regional Scoping Study, 1998

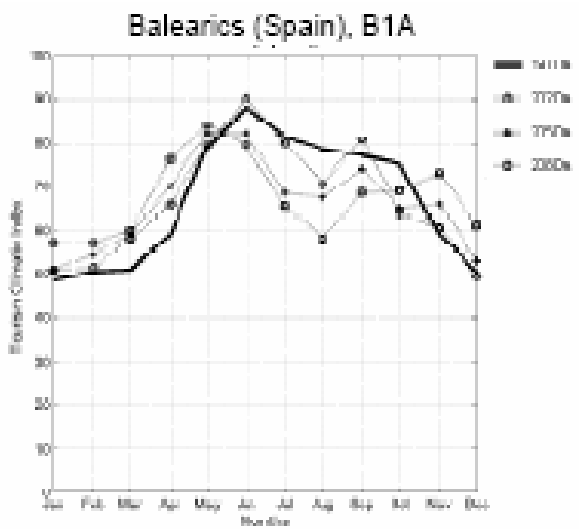
# Analogues for Blackpool's future climate

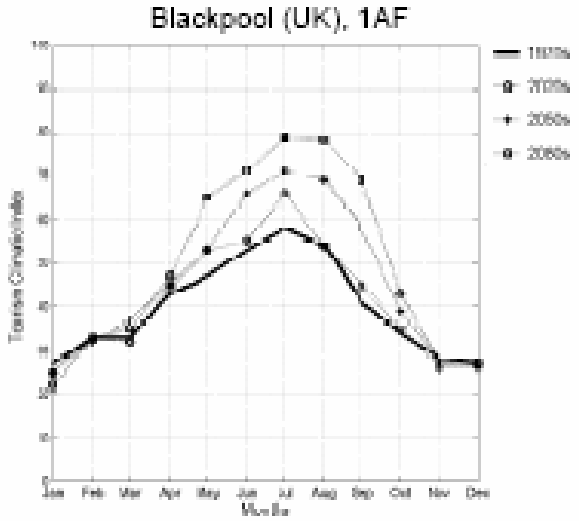


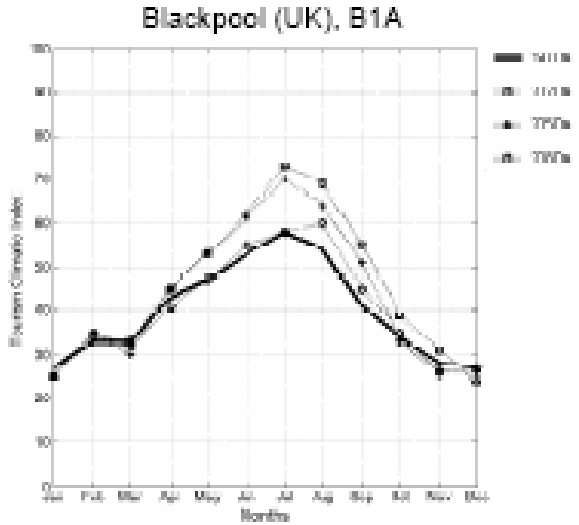

Source: Broadhurst, 2006

# Changes in Tourism Climatic Index for Blackpool and Balearics



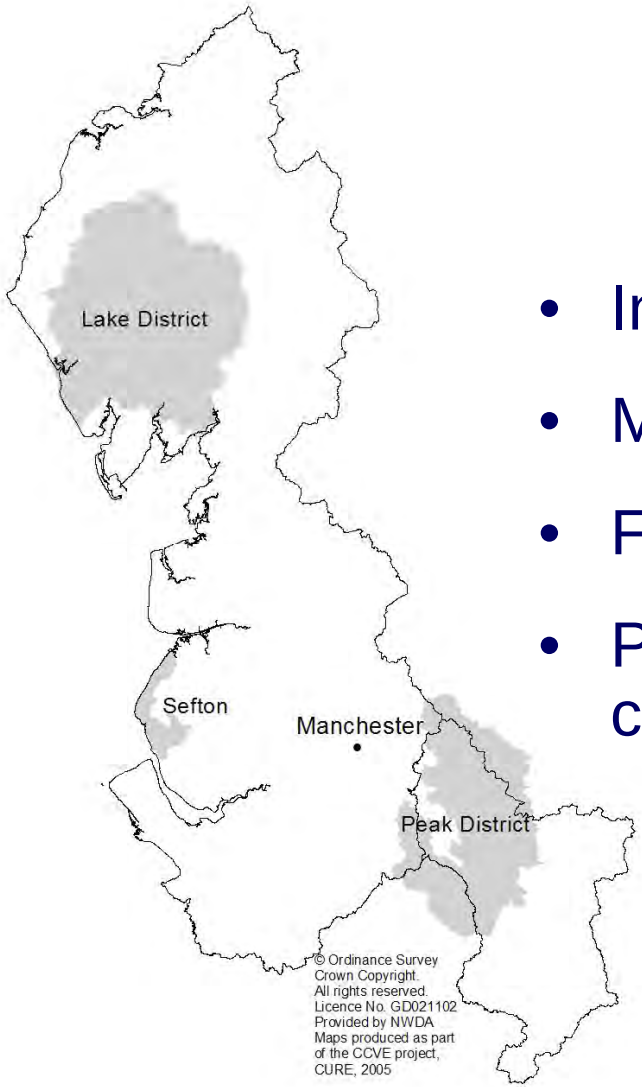




Source: Amelung & Viner, 2006

# Main Research Question

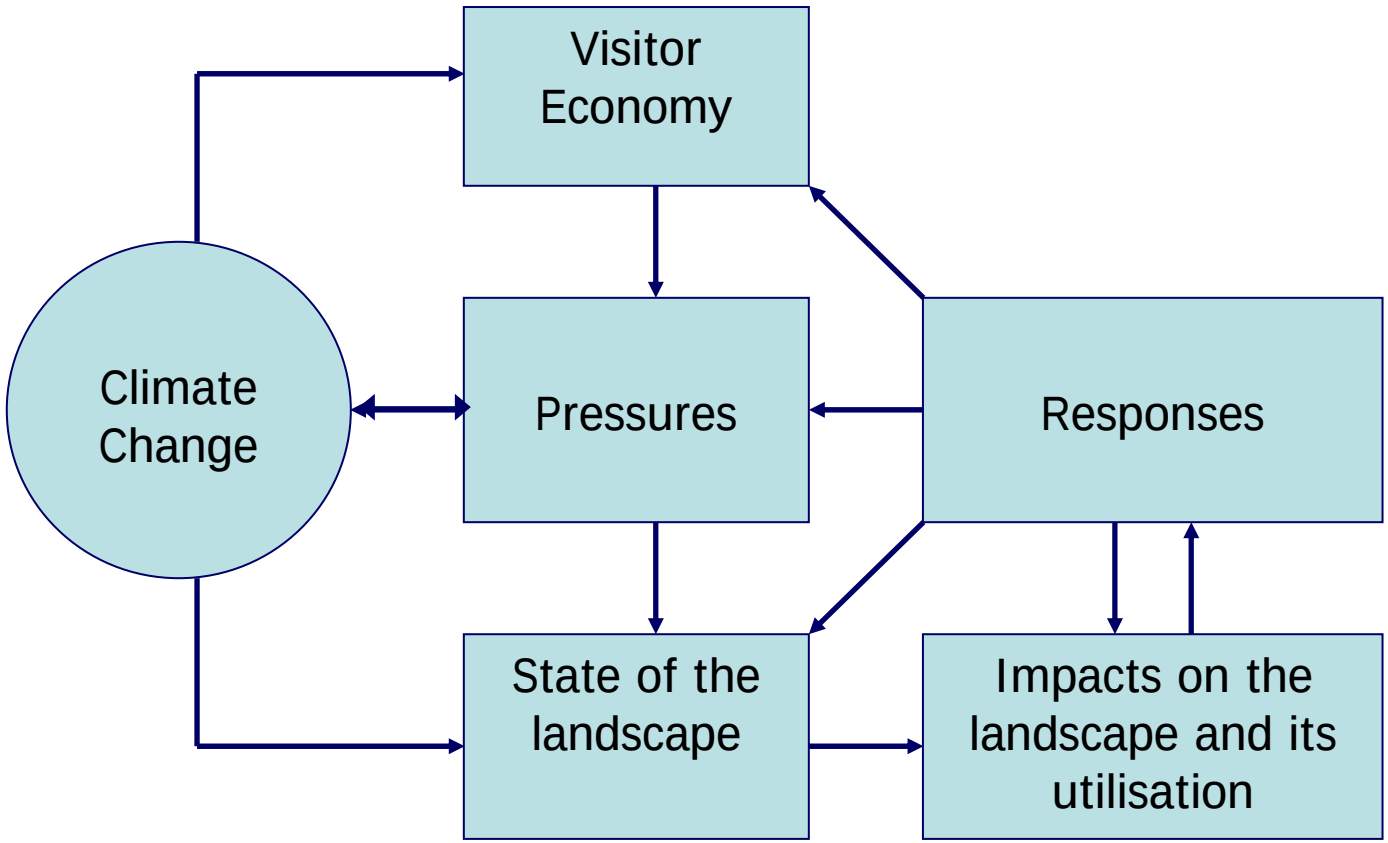
*"How can those associated with the visitor economy in the Northwest realise opportunities presented by climate change, whilst ensuring the resource base is sustained, despite growing visitor demand and climate related reductions in environmental capacity?"*

# The Case Study Landscapes



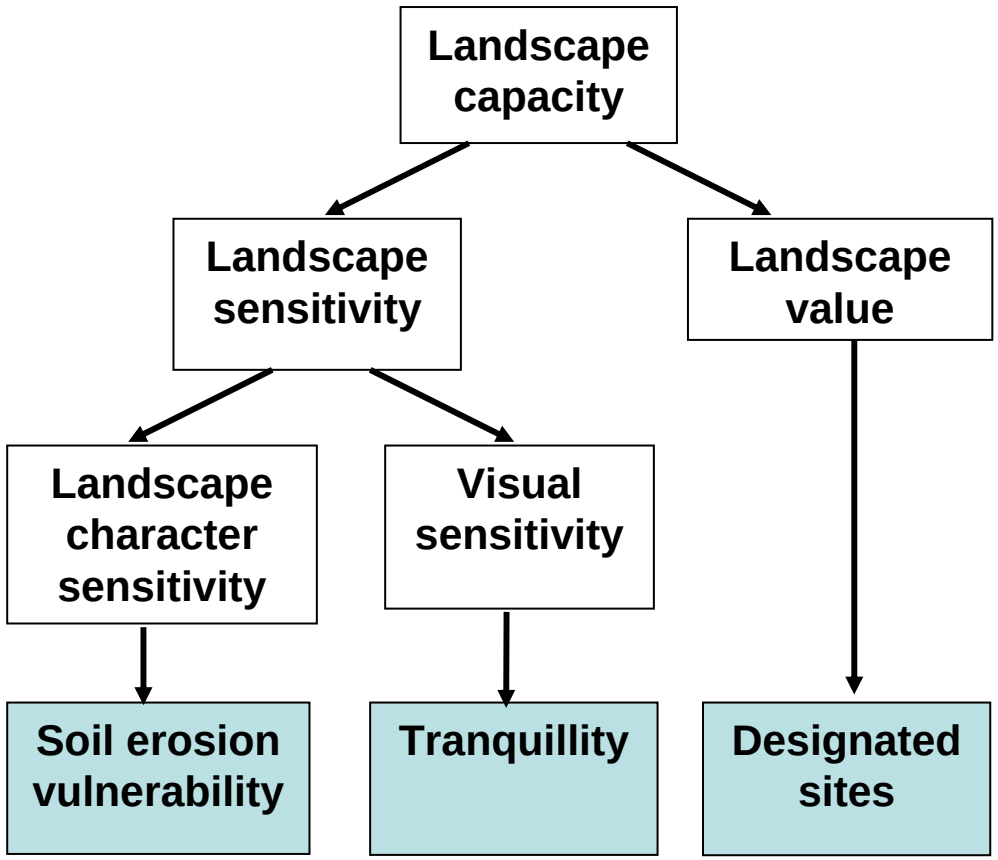

- Integrity of the Sefton Dune System
- Moorland wildfires in the Peak District
- Footpath erosion in the Lake District
- Public Spaces in Manchester city centre

# Research Framework



# State of the landscape: Current visitor capacity

- Current visitor capacity investigated through Landscape Capacity framework
- Indices that relate to use by walkers are used to represent factors in landscape capacity analysis

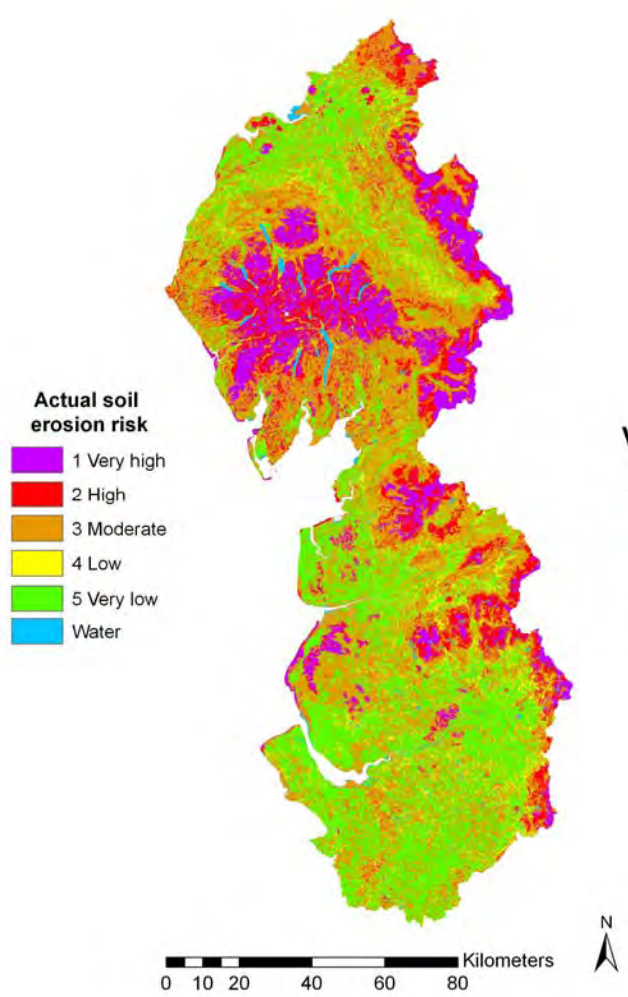


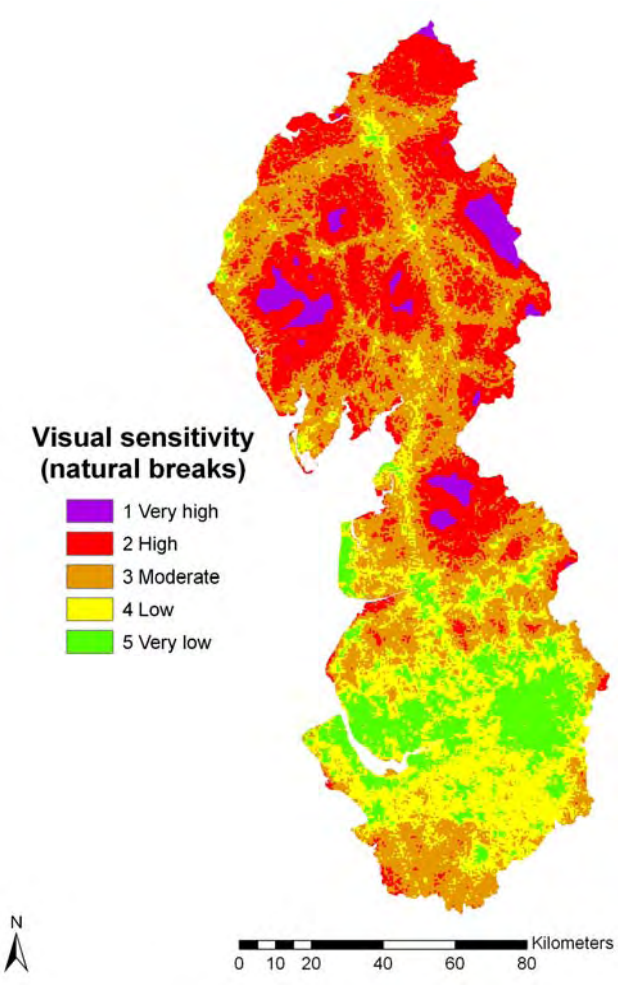
# Landscape capacity

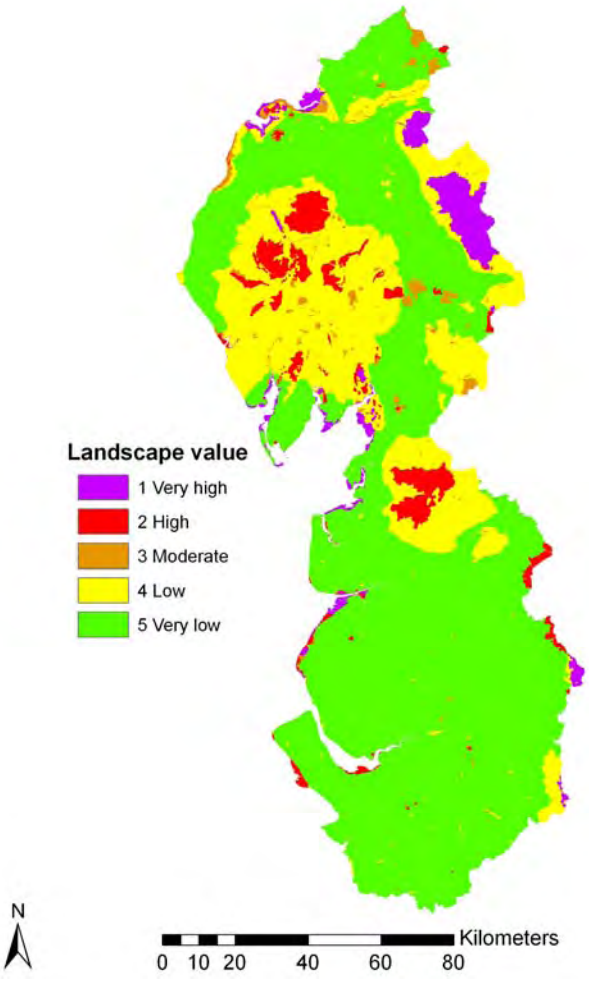
Landscape character sensitivity

Visual sensitivity

Landscape value

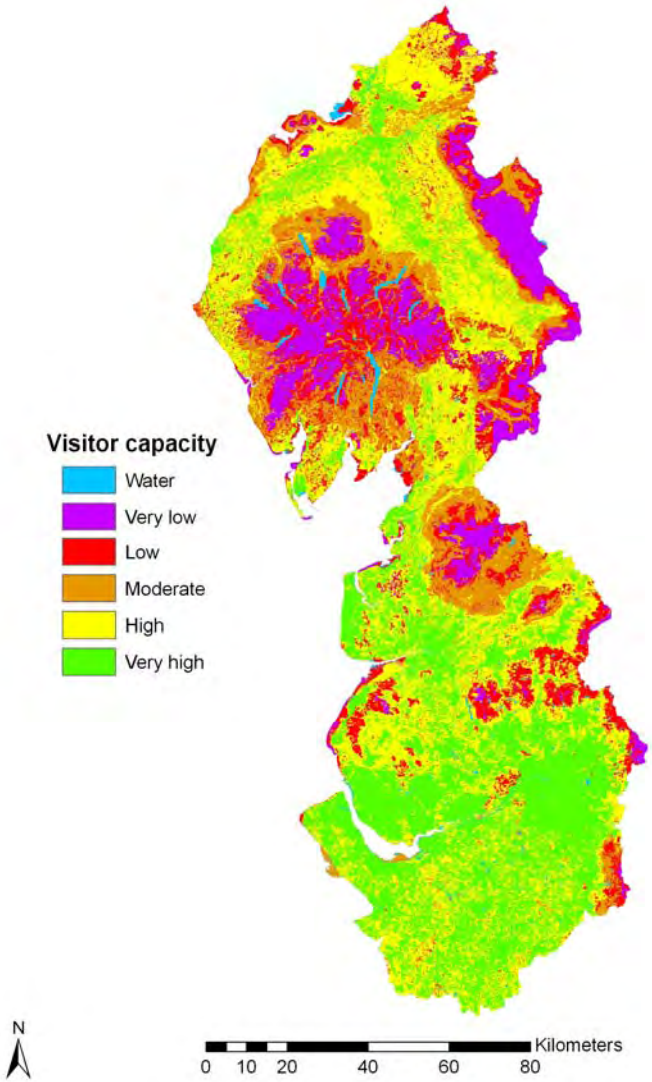


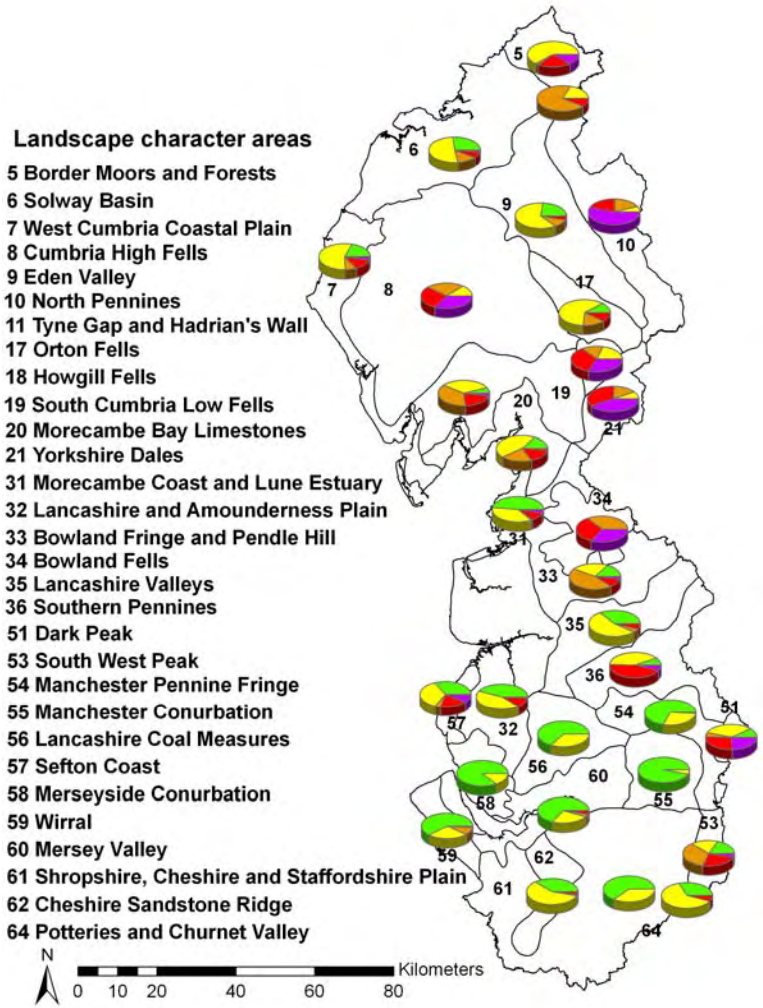



# Landscape capacity of North West England

- Capacity of the landscape to accommodate visitors varies over the NW
- Some landscape character areas are particularly sensitive to visitor use



# Regional importance of High Capacity Landscapes

e.g. Delamere and Grizedale Forests

# Sustaining Knowledge for a Changing Climate (SKCC)

Aims:

- To sustain the researcher and end user community assembled around the BKCC programme
- To synthesise and disseminate results from BKCC in order to maximise impact
- To develop a coherent user-led plan for future research into the impacts of climate change on the built environment and infrastructure and development of adaptation solutions

# SKCC Position Papers

1. Use of probabilistic climate scenarios in planning and managing the built environment and infrastructure;
2. Impacts and adaptation in existing and new building stock;
3. Integrating adaptation and solutions to mitigate greenhouse gas emissions;
4. Adaptation options that can be beneficial in a range of sectors

Website: www.k4cc.org/

# Conclusion

- Increasing confidence in the science of climate change (IPCC Fourth Assessment);
- Climate change is pervasive in physical and biological systems;
- Climate change impacts will intensify under all scenarios;
- Adaptation research is a critical area;
- New and emergent tools available for assessment of climate change impacts, at higher resolution and with probability attached.