# WRDMAP
# Other Climate Change Adaptation Requirements in the Water Sector

## (15th April 2010)

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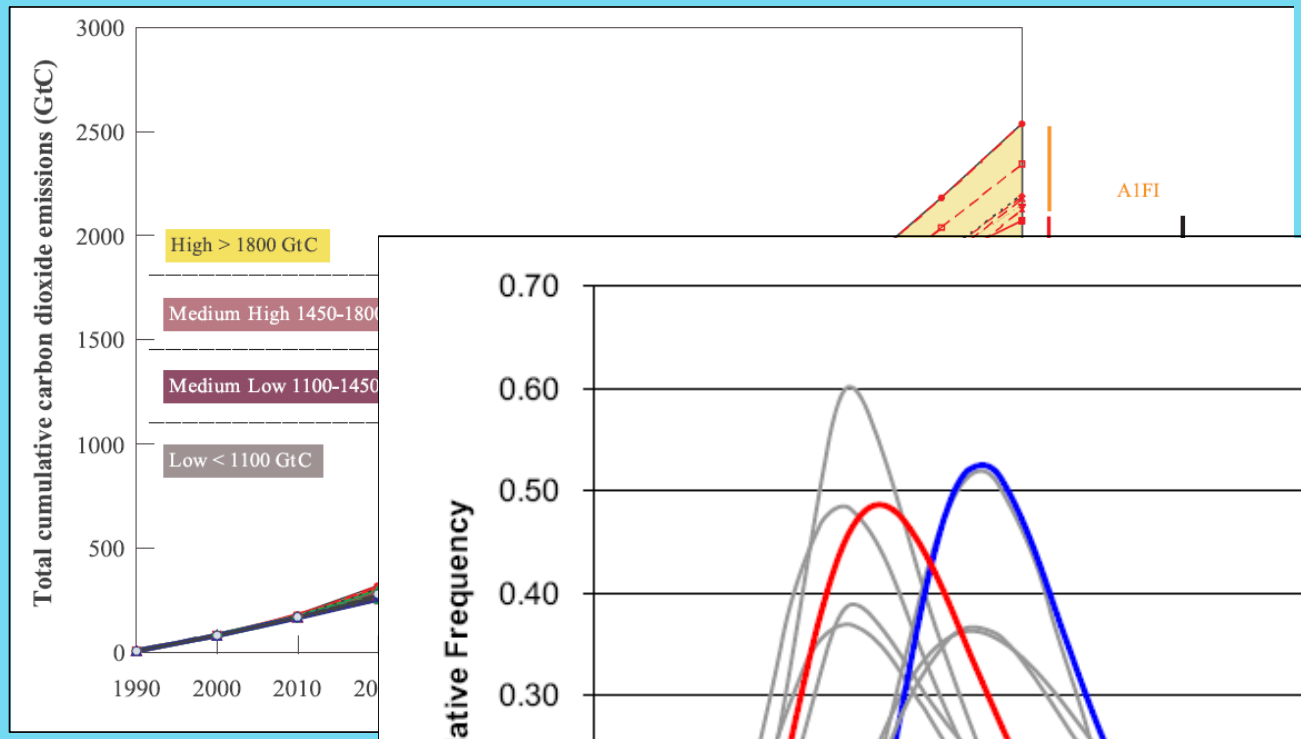
# Summary of Observed changes in extreme events in China (Extracted from IPCC, AR4, WG2, 2007)

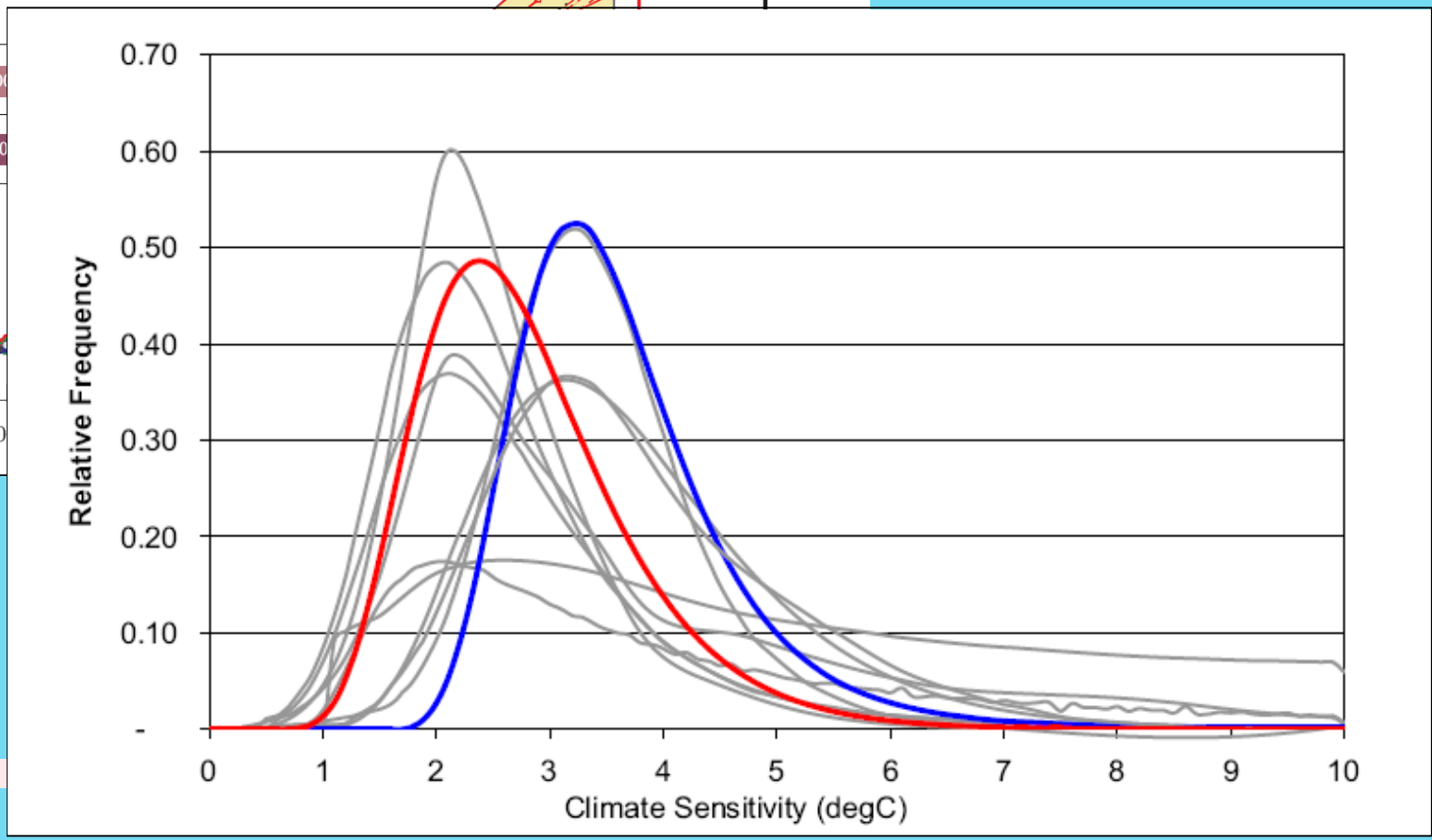
| Event | Trend | References |
|---|---|---|
| Heatwaves | Increase in frequency of short duration heatwaves in recent decade, increasing warmer days and nights in recent decades. | Zhai et al., 1999; Zhai and Pan, 2003 |
| Intense Rains and Floods | Increasing frequency of extreme rains in western and southern parts including Changjiang river, and decrease in northern regions; more floods in Changjiang river in past decade; more frequent floods in North-East China since 1990s; more intense summer rains in East China; severe flood in 1999; seven-fold increase in frequency of floods since 1950s. | Zhai et al., 1999; Ding and Pan, 2002; Zhai and Pan, 2003; Zhai, 2004 |
| Droughts | Increase in area affected by drought has exceeded 6.7 Mha since 2000 in Beijing, Hebei Province, Shanxi Province, Inner Mongolia and North China; increase in dust storm affected area. | Chen et al., 2001; Yoshino, 2000, 2002; Zhou, 2003 |
| Cyclones / Typhoons | Number and intensity of strong cyclones increased since 1950s; 21 extreme storm surges in 1950 to 2004 of which 14 occurred during 1986 to 2004. | Fan and Li, 2005 |

# Climate Change and Engineering Design

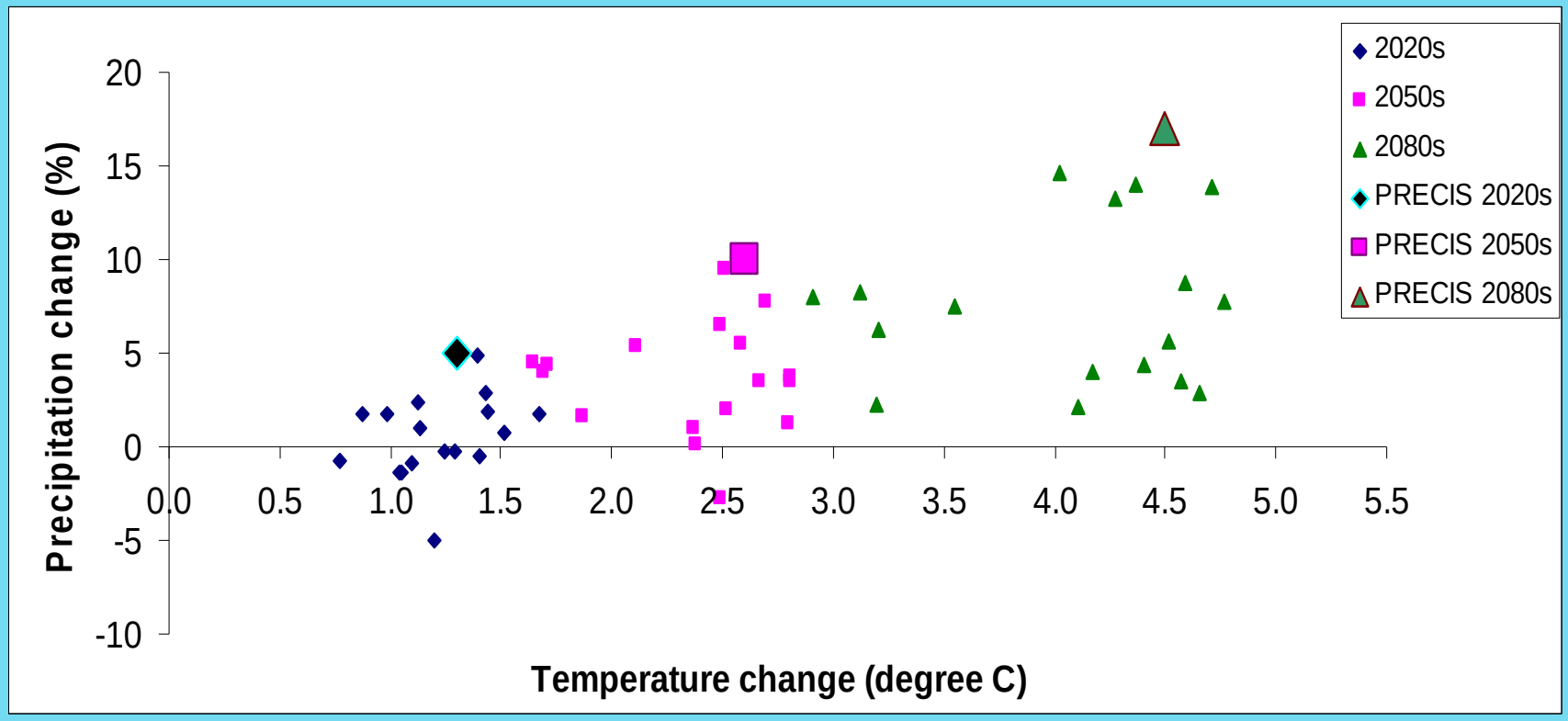
- Urban drainage
- Fluvial flood mitigation works
- Transportation cross drainage routes
- Agricultural field drainage rates
- Water resources reliability (surface and groundwater)
- Saline intrusion in coastal aquifers and estuaries
- Drainage in coastal areas with tidal outfalls
- Coastal flood defence

# Sources of Uncertainty



# Inter-model Variability




Changes in temperature and precipitation averaged for the whole of China by the 2020s, 2050s, and 2080s simulated by 17 GCMs from IPCC AR4 and PRECIS (all simulations under A2 scenario)

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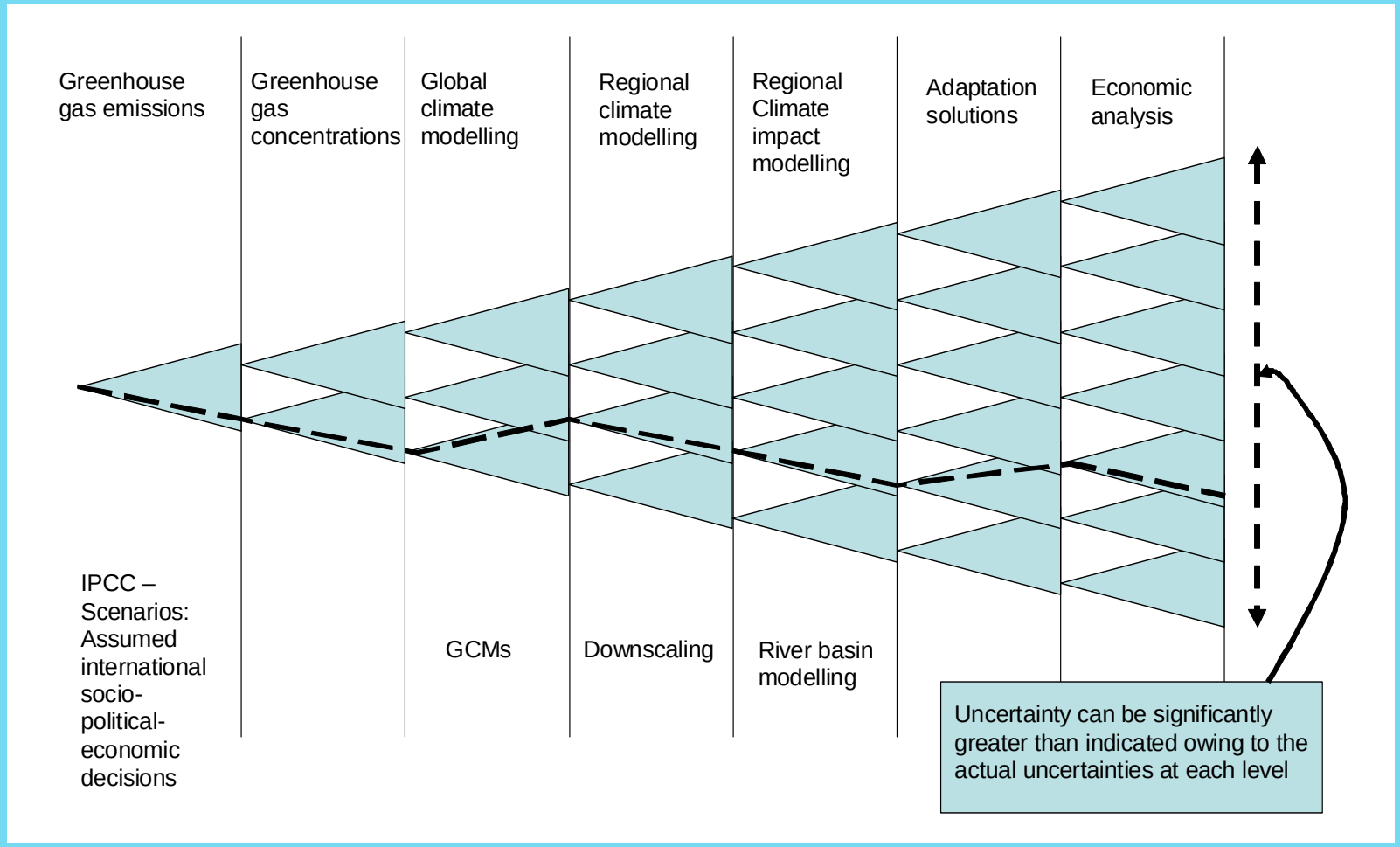
# Consideration of Uncertainties



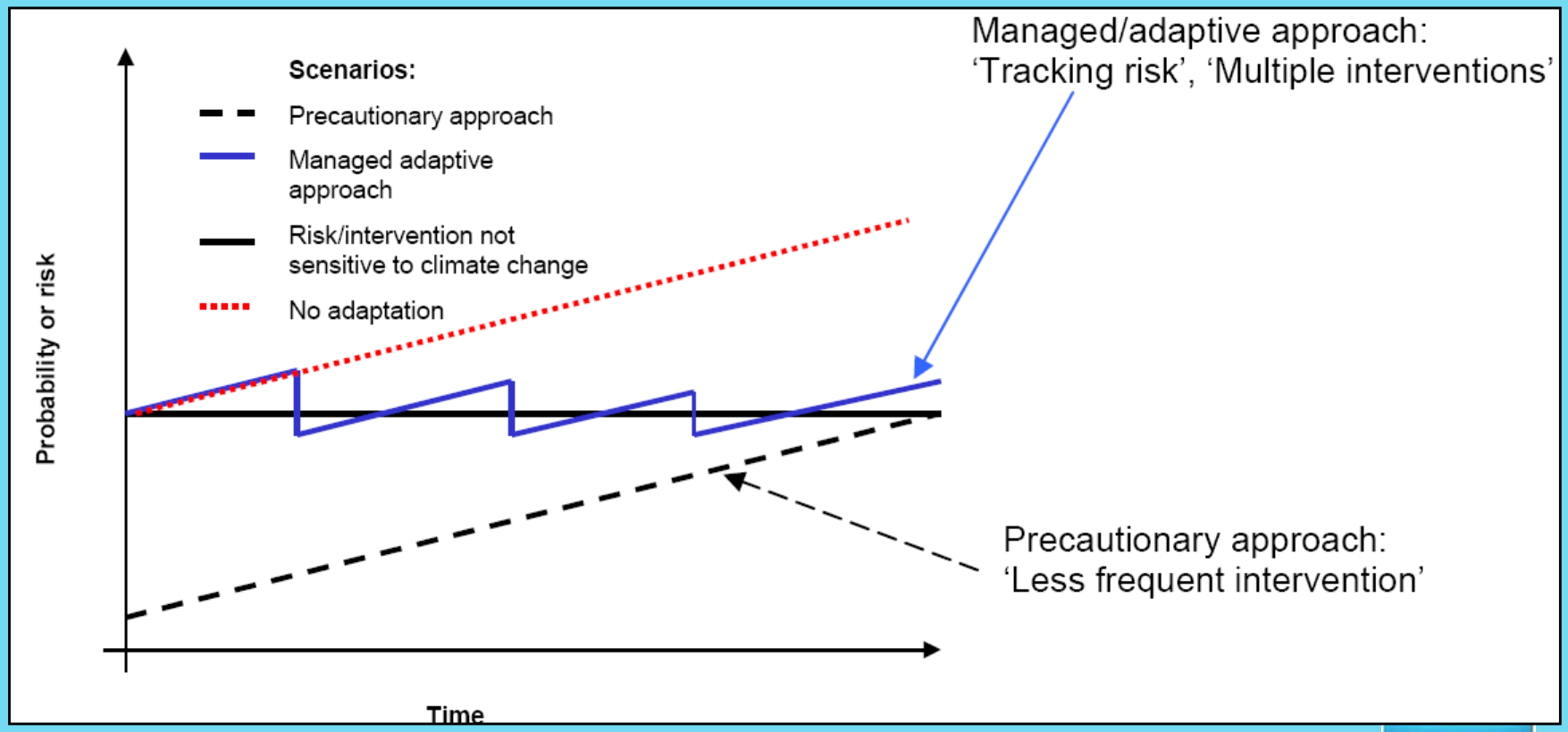

# Pragmatic adjustments to design parameters currently used in the UK

| ***Parameter*** | ***1990-2025*** | ***2025-2055*** | ***2055-2085*** | ***2085-2115*** |
|---|---|---|---|---|
| Peak rainfall intensity (preferably for small catchments) | *+5%* | **+10%** | *+20%* | *+30%* |
| Peak river flow volume (preferably for larger catchments) | +10% | **+20%** | | |
| Offshore wind speed | *+5%* | | **+10%** | *+10%* |
| Extreme wave height | *+5%* | | **+10%** | *+10%* |

# Regional net sea level rise allowance for design in the UK

| *Administrative or Devolved Region* | *Assumed Vertical Land Movement (mm/yr)* | *Net Sea-Level Rise (mm/yr)* | | | | *Previous allowances* |
|---|---|---|---|---|---|---|
| | | *1990-2025* | *2025-2055* | *2055-2085* | *2085-2115* | |
| East of England, East Midlands, London, SE England (south of Flamborough Head) | -0.8 | 4.0 | 8.5 | 12.0 | 15.0 | 6mm/yr* constant |
| South West and Wales | -0.5 | 3.5 | 8.0 | 11.5 | 14.5 | 5 mm/yr* constant |
| NW England, NE England, Scotland (north of Flamborough Head) | +0.8 | 2.5 | 7.0 | 10.0 | 13.0 | 4 mm/yr* constant |

# Comparison of approaches to managing climate change impacts (Source: Defra, 2006)

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# Adaptation:

- Changing our behaviour to respond to the impacts of climate change
- Making decisions that are sustainable, made at the right time, maximising benefits and minimising costs
- Needs to be built into the planning and risk management now to ensure continued and improved success of business, Government and social operations

Source: DEFRA, UK

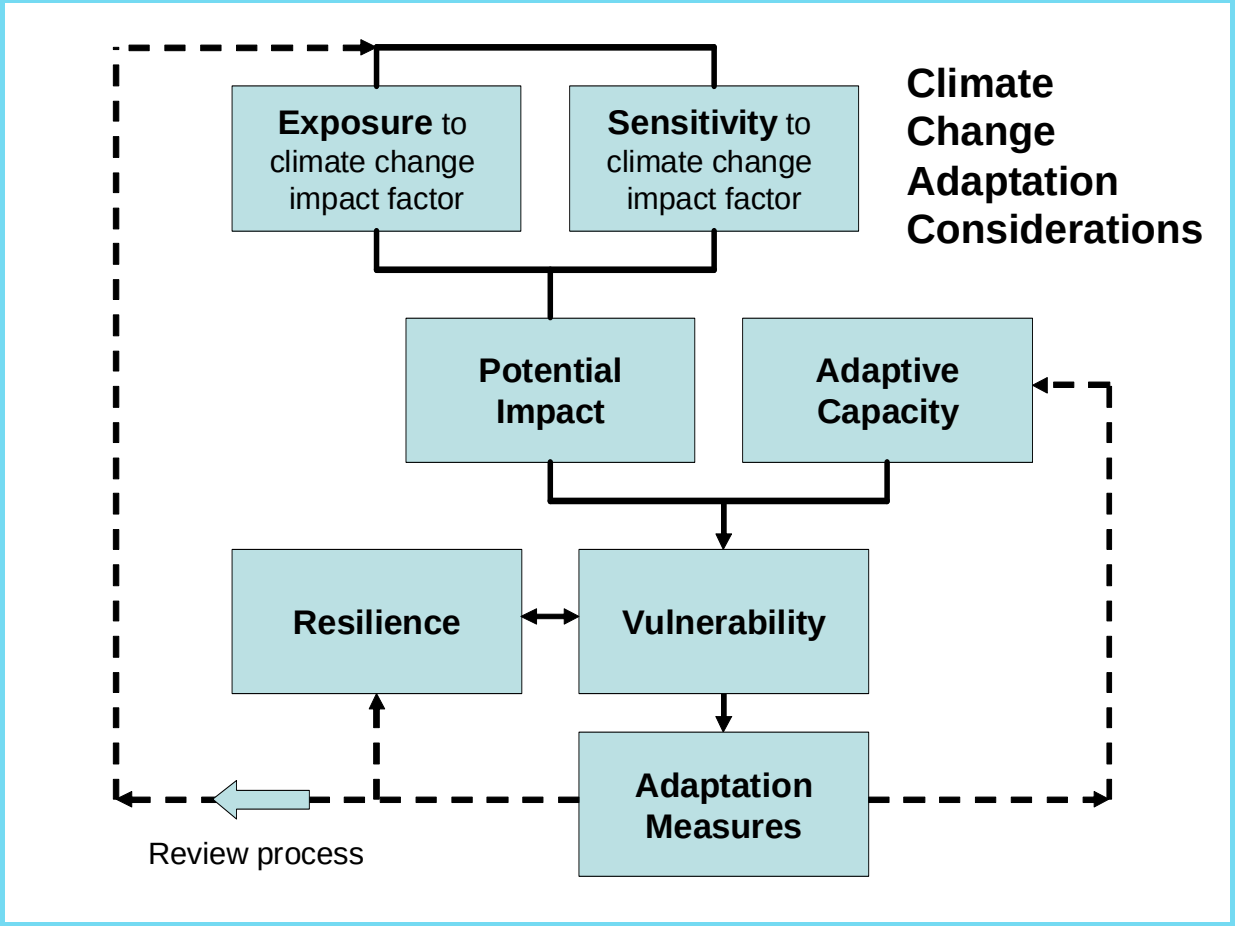
# Types of Adaptation

- Autonomous:  reaction or response of individuals
- Planned adaptation:  conscious policy options or response strategies

# UKCIP Adaptation: *"measures and strategies that contribute either to:*

- *Building adaptive capacity – creating the information (research, data collecting and monitoring, awareness raising), supportive social structures (organisational development, working in partnership, institutions), and supportive governance (regulations, legislations, and guidance) that are needed as a foundation for delivering adaptation actions; or*
- *Delivering adaptation actions – actions that help to reduce vulnerability to climate risks, or to exploit opportunities."*

# Process for Developing Adaptation Measures



# Hadley Centre Approach for Addressing Uncertainties

- Adapt to what we are currently confident will (or probably will) happen
- Look at historic resilience to climatic variations and predictions for the next 20 to 30 years
- Consider the options for long term adaptation measures that may be required
- Reduce the uncertainty in climate predictions

# Generic Strategies to Address Vulnerability and Climate Change Impacts

- Changing natural resource management strategies
- Building institutions
- Launching planning processes
- Raising awareness
- Promoting technology change
- Establishing monitoring / early warning systems
- Changing agricultural practices
- Empowering people
- Promoting policy change
- Improving infrastructure
- Providing insurance mechanisms

Source: World Resources Institute

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# Key Climate Changes

- Mean annual temperature increase of 2-3$^{o}$ by 2050s
- More very hot days, fewer very cold days
- Improved temperature conditions for agriculture
- Increased potential evapotranspiration
- Increased precipitation
- Increased crop yields
- Increased runoff in DRB
- Increased flood risk
- *(Confidence Levels ??)*

# Adaptations Required

- Natural Resource Management
  - Ecosystem impacts not well understood
  - Studies and monitoring of natural system response required
- Water Resources
  - Indication of no significant problem of resource availability, **BUT**
    - changes in vegetation could affect hydrology
    - ecosystem water needs may increase
  - Improved climate modelling and probabilistic assessment approach required
  - Focus on industrial water demand management and re-use
  - Assessment of existing and future flood risks
  - Review of urban drainage design approaches
  - Periodic re-assessment of irrigation norms
  - Assessment of reservoir water quality – algal blooms

# Adaptations Required

- Building Institutions
  - Creation of climate change working groups
- Planning processes incorporating climate change
  - Requirements for changing irrigation and water allocations
  - Greater flexibility conjunctive groundwater use
  - Incorporation of climate change into hydrological design – increased contingency or freeboard

# Adaptations Required

- Raising Awareness
  - Health impact
  - Agricultural extension services
  - Increased frequency of extreme events (flood)
- Promoting Technology Change
  - Flood forecasting / extreme weather forecasting
  - Industrial water saving and re-use
  - Soil moisture monitoring
  - Urban design

# Adaptations Required

- Monitoring early warning systems
  - Climate
  - Agriculture
  - Ecology /environment - e.g. land cover
  - Human health
  - General environmental change
- Changing agricultural practices (extension services)
  - Cropping practices
  - Irrigation techniques and water saving
  - Crop protection (vulnerability to disease / pest)
  - Assessment of winter irrigation value
  - Review potential impacts on livestock (grazing, animal health)

# Adaptations Required

- Empowering people
  - Targeted dissemination
  - Strengthening agricultural extension service
  - Technical support systems
  - Helping people to help themselves
- Improving infrastructure
  - Urban drainage
  - Flood mitigation
  - Cross drainage
  - Irrigation infrastructure (reduced areas but double cropping)
  - Building design (insulation, ventilation etc.)

# Adaptations Required

- Providing insurance mechanisms
  - Against flood or storm damage (household / building)
  - Against crop failure / damage



# Short Term Adaptation

- Establish climate change working groups
- Raise public awareness (agricultural extension etc.)
- Assess existing flood hazards
- Review ecological water allocations
- Improve model predictions
- Improve monitoring

# Particular Factors to Consider

- Adequacy of the existing hydrometric networks
- Modelling uncertainty
- Requirement to support the ongoing and developing science