

# **Adaptation to Climate Change**

**Aspects of vulnerability, exposure & risk**

**Adaptation programs, concepts & tools**

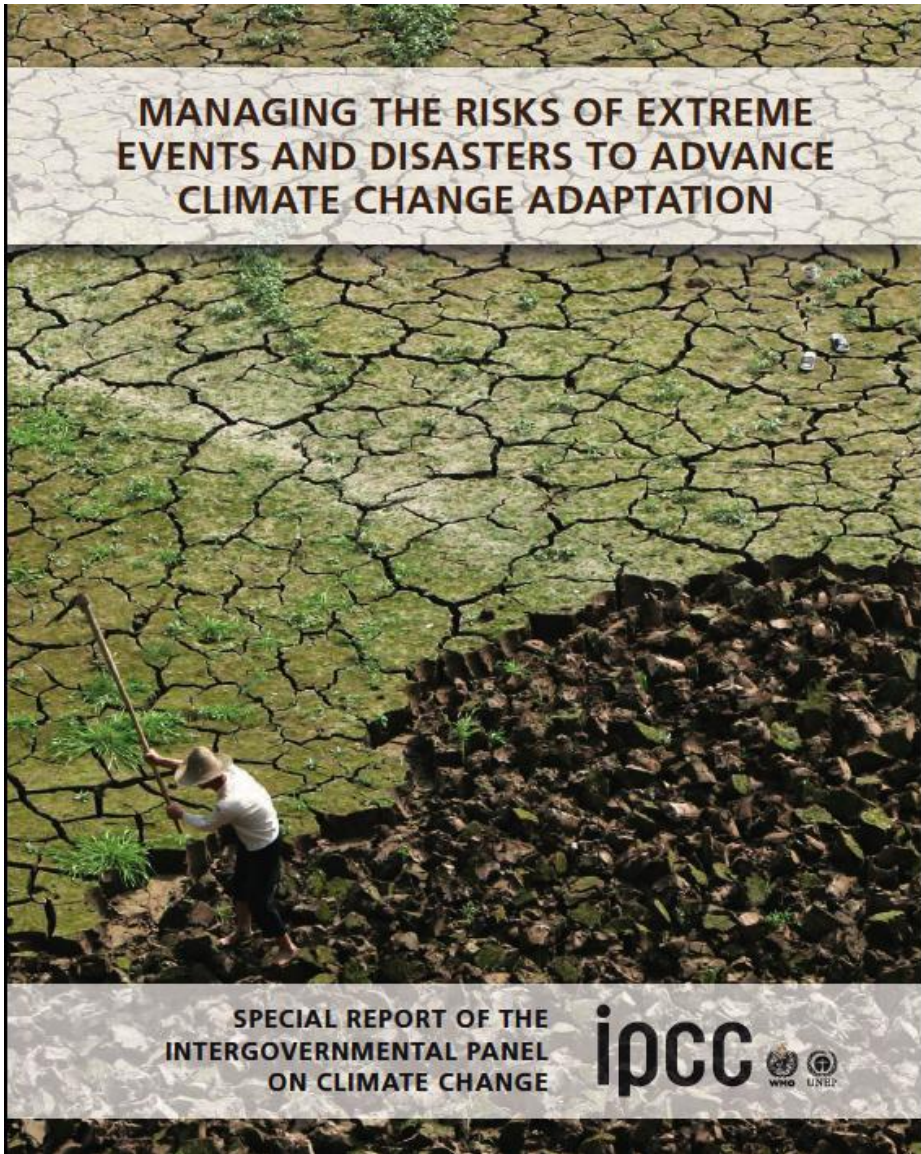
**•UK Climate Impacts program**

**•Oxfam's Climate Change Adaptation Program**

**•WeAdapt, CDKN, FAO Adapt, etc.**

**AR5 Adaptation comments**

**Participants thoughts & comments**



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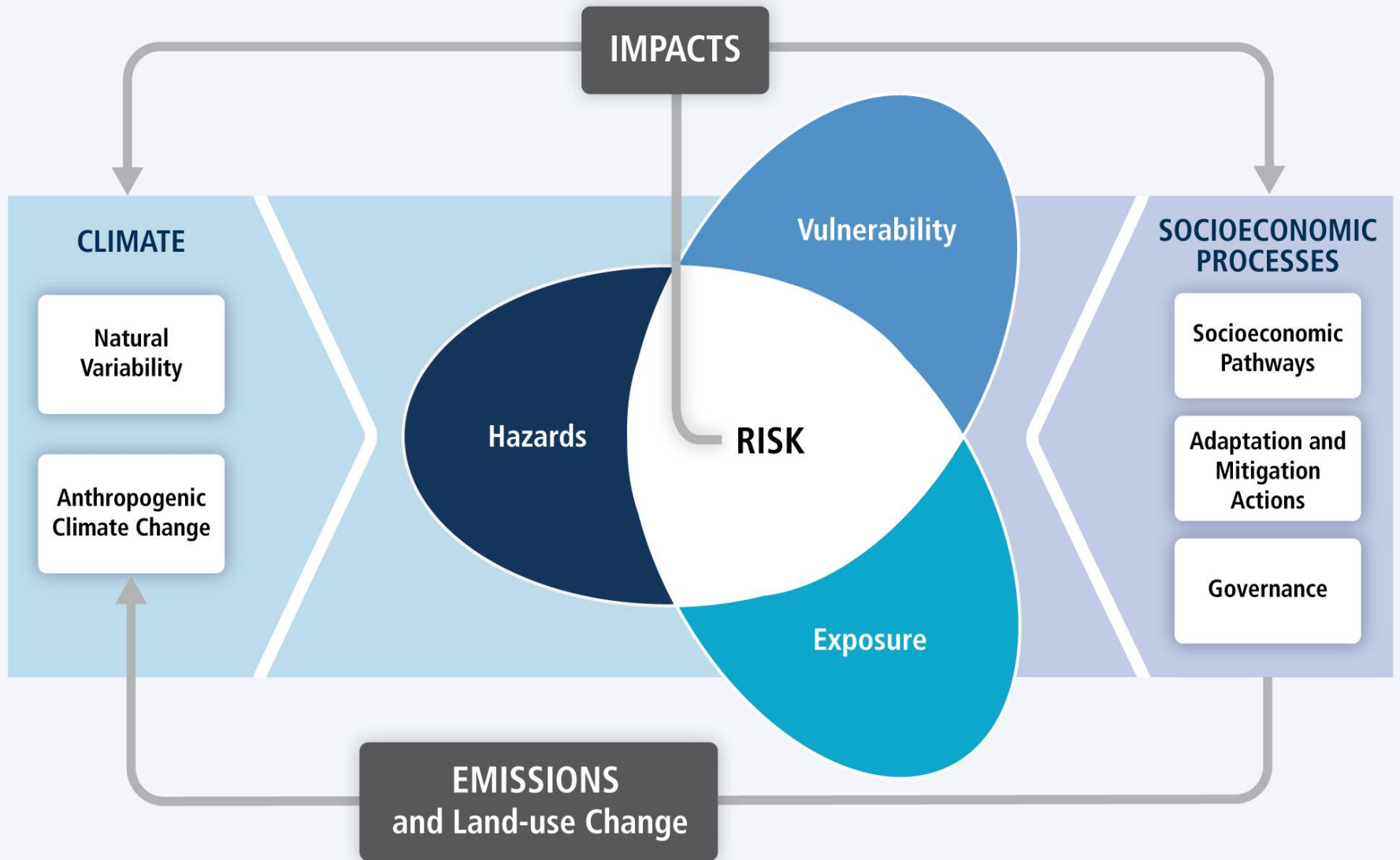


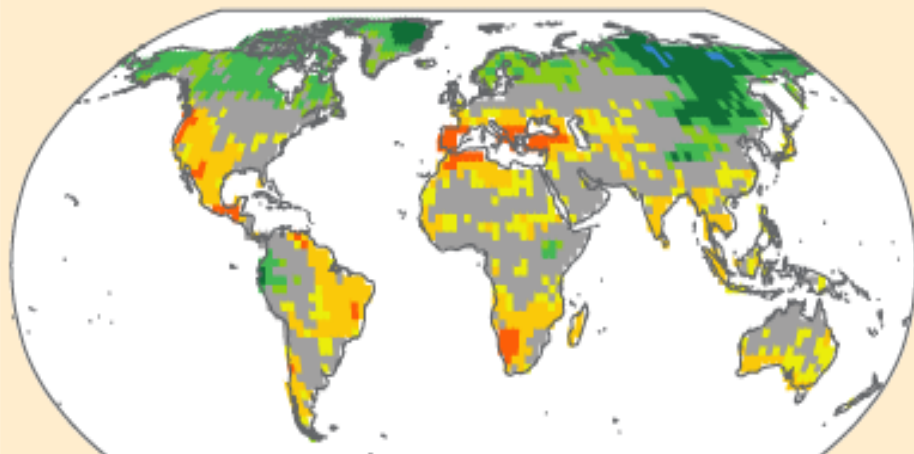
Figure SPM.1 | Illustration of the core concepts of the WGII AR5. Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems. Changes in both the climate system (left) and socioeconomic processes including adaptation and mitigation (right) are drivers of hazards, exposure, and vulnerability.

# Exposure & Vulnerability

- Extreme impacts on human, ecological, or physical systems can result from individual extreme weather or climate events.
- Extreme impacts can also result from nonextreme events where exposure and vulnerability are high or from a compounding of events or their impacts. For example, drought, coupled with extreme heat and low humidity, can increase the risk of wildfire.
- Extreme and non-extreme weather or climate events affect vulnerability to future extreme events by modifying resilience, coping capacity, and adaptive capacity.
- A changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events.. Many extreme weather and climate events continue to be the result of natural climate variability. Natural variability will be an important factor in shaping future extremes in addition to the effect of anthropogenic changes in climate.

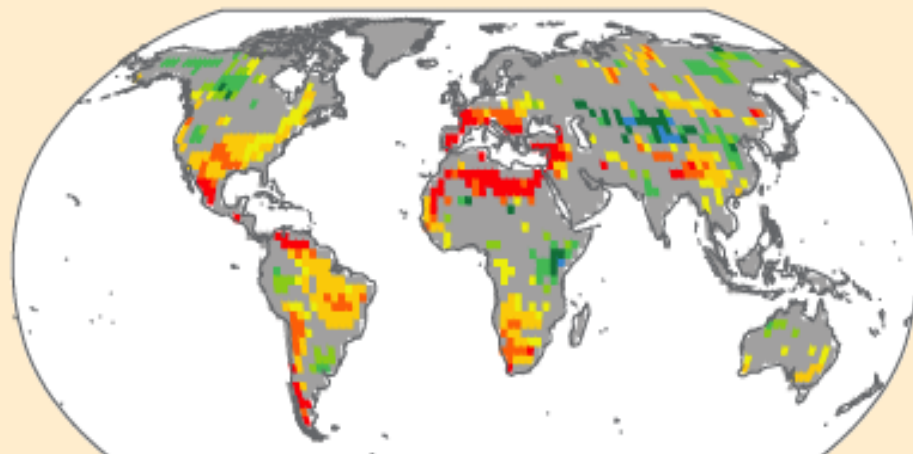
### Change in consecutive dry days (CDD)

2046-2065

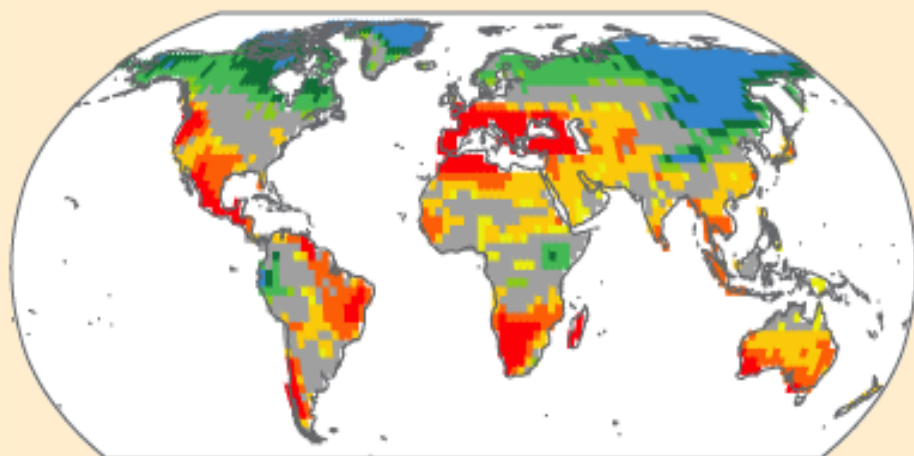


### Soil moisture anomalies (SMA)

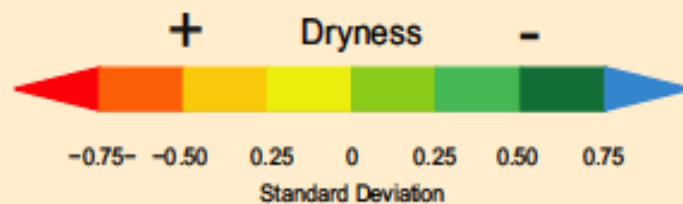
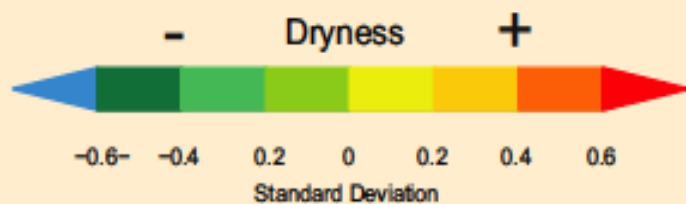
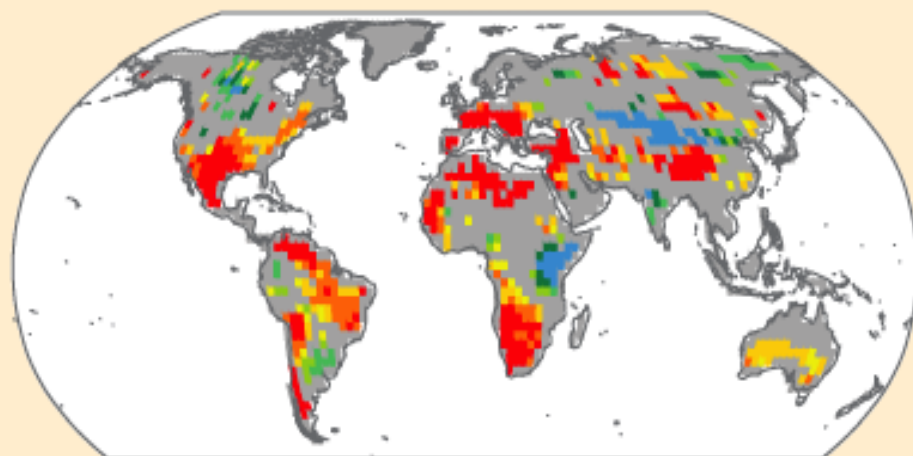
2046-2065



2081-2100



2081-2100



# Exposure & Vulnerability

- Exposure and vulnerability are dynamic, varying across temporal and spatial scales, and depend on economic, social, geographic, demographic, cultural, institutional, governance, and environmental factors.
- Settlement patterns, urbanization, and changes in socioeconomic conditions have all influenced observed trends in exposure and vulnerability to climate extremes.
  - ...mountain settlements are exposed and vulnerable to climate extremes in both developed and developing countries, but with differences among regions and countries.
  - Rapid urbanization and the growth of megacities, especially in developing countries, have led to the emergence of highly vulnerable urban communities, particularly through informal settlements and inadequate land management.
  - Vulnerable populations also include refugees, internally displaced people, and those living in marginal areas.

# Disaster Losses

- Economic losses from weather- and climate-related disasters have increased, but with large spatial and interannual variability.
- Economic, including insured, disaster losses associated with weather, climate, and geophysical events are higher in developed countries.
- Fatality rates and economic losses expressed as a proportion of gross domestic product (GDP) are higher in developing countries.
- Increasing exposure of people and economic assets has been the major cause of long-term increases in economic losses from weather- and climate-related disasters.
- Long-term trends in economic disaster losses adjusted for wealth and population increases have not been attributed to climate change, but a role for climate change has not been excluded.

# Increased exposure to Tropical cyclones without CC

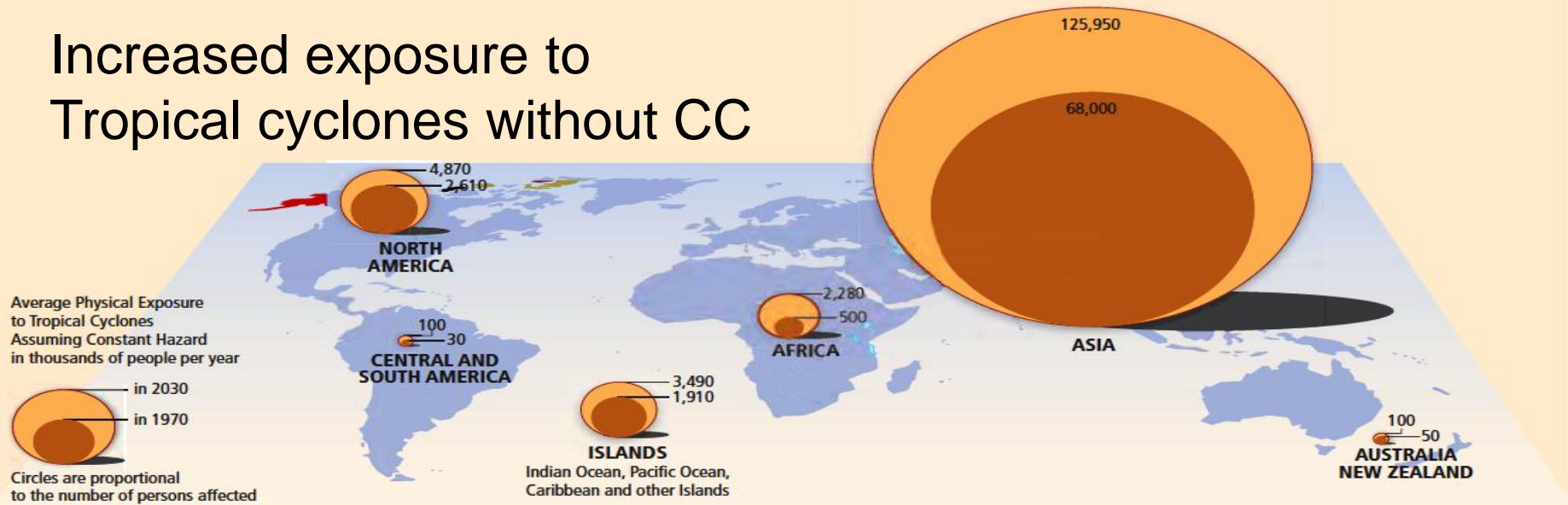


Figure 4-1 | Average physical exposure to tropical cyclones assuming constant hazard (in thousands of people per year). Data from Peduzzi et al., 2011.

# Floods

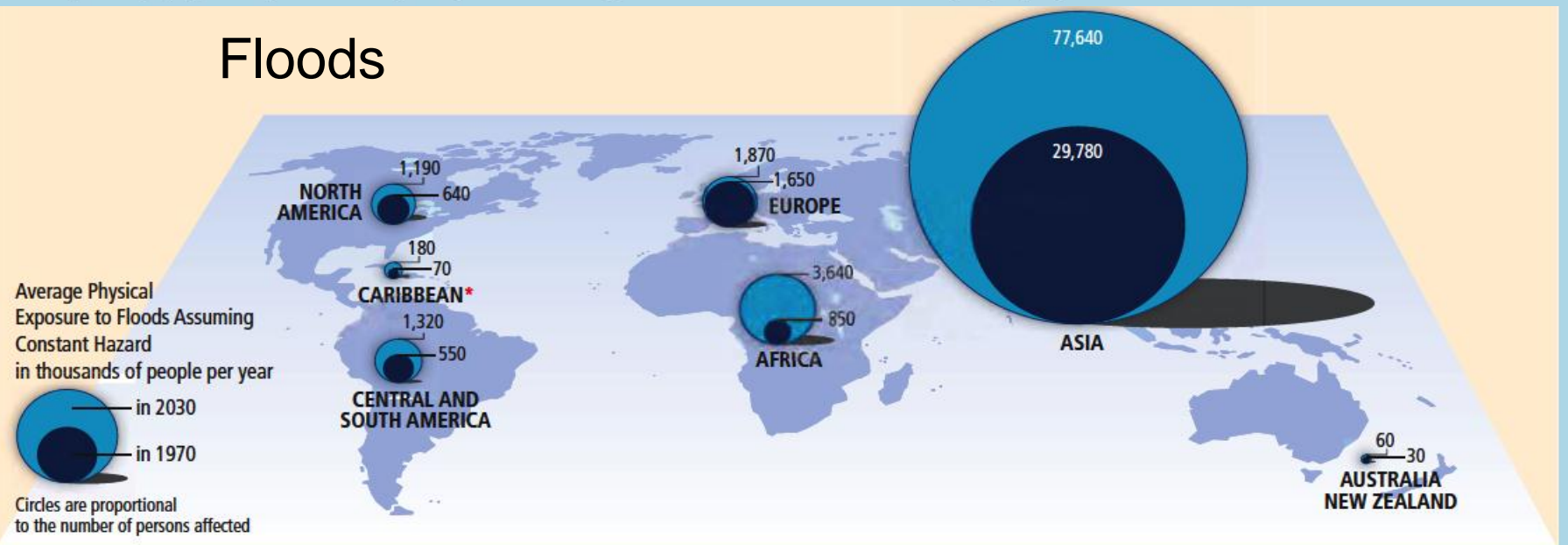
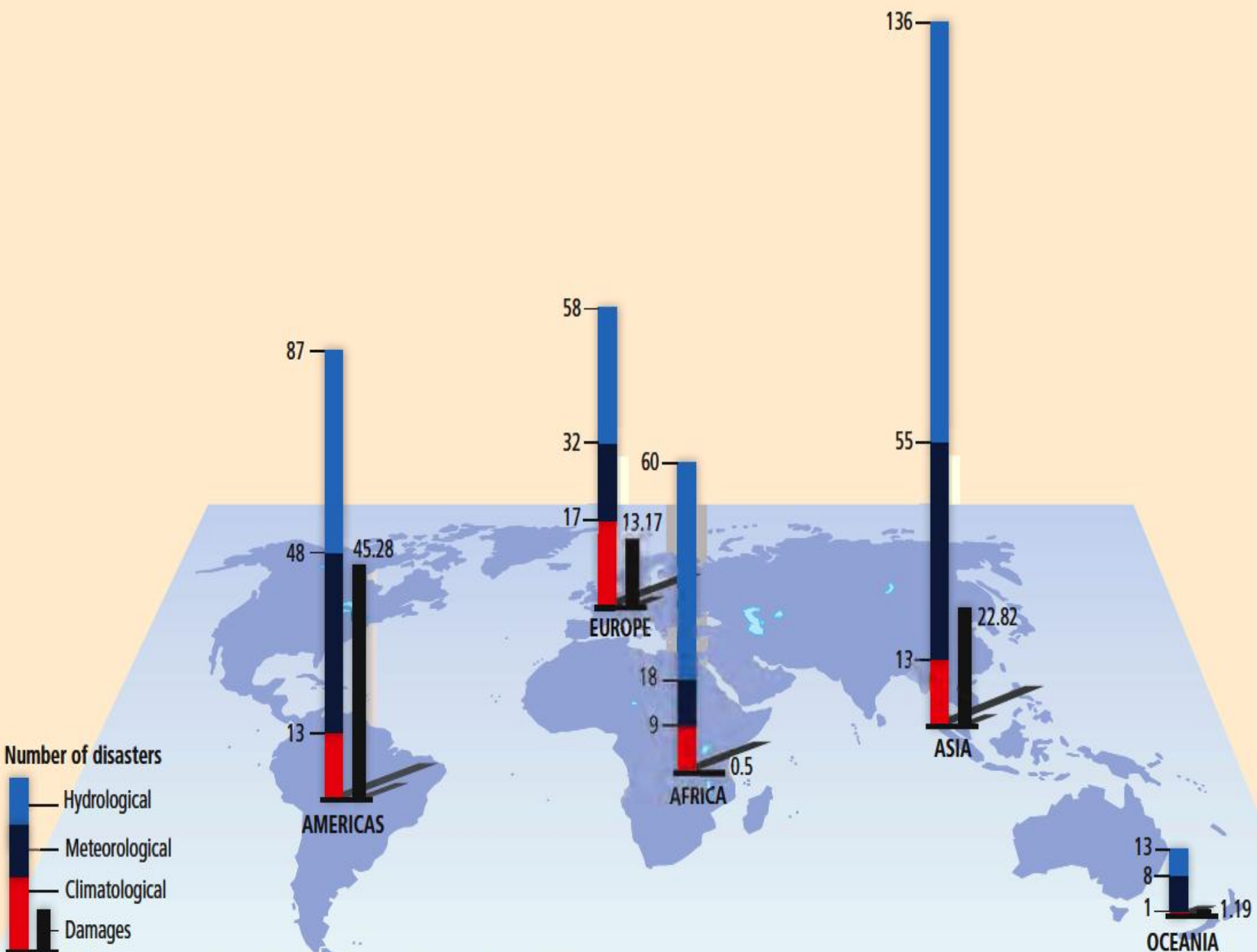


Figure 4-2 | Average physical exposure to floods assuming constant hazard (in thousands of people per year). Data from Peduzzi et al., 2011.





**Number of disasters**

- Hydrological
- Meteorological
- Climatological
- Damages

Height of columns represents the number of disasters or damages in billion dollars.

# Disaster Risk Management and Adaptation

- Trends in exposure and vulnerability are major drivers of changes in disaster risk. Vulnerability reduction is a core common element of adaptation and disaster risk management.
- Inequalities influence local coping and adaptive capacity, and pose disaster risk management and adaptation challenges from the local to national levels.
- Humanitarian relief is often required when disaster risk reduction measures are absent or inadequate.
- Post-disaster recovery and reconstruction provide an opportunity for reducing weather- and climate-related disaster risk and for improving adaptive capacity.
- Closer integration of disaster risk management and climate change adaptation, along with the incorporation of both into local, sub-national, national, and international development policies and practices, could provide benefits at all scales

# We know with certainty, AR5

## Future Pathways for Adaptation, Mitigation & Sustainable Development:

1. Effective decision-making to limit climate change and its effects can be informed by a wide range of analytical approaches for evaluating expected risks and benefits, recognizing the importance of governance, ethical dimensions, equity, value judgments, economic assessments and diverse perceptions and responses to risk and uncertainty.

1. Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread and irreversible impacts globally (*high confidence*)

1. Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness, especially with greater magnitudes and rates of climate change. Taking a longer-term perspective, in the context of sustainable development, increases the likelihood that more immediate adaptation actions will also enhance future options and preparedness.

1. Climate change is a threat to equitable and sustainable development. Adaptation, mitigation and sustainable development are closely related, with potential for synergies and trade-offs.

# We know with certainty, AR5

## Adaptation and Mitigation:

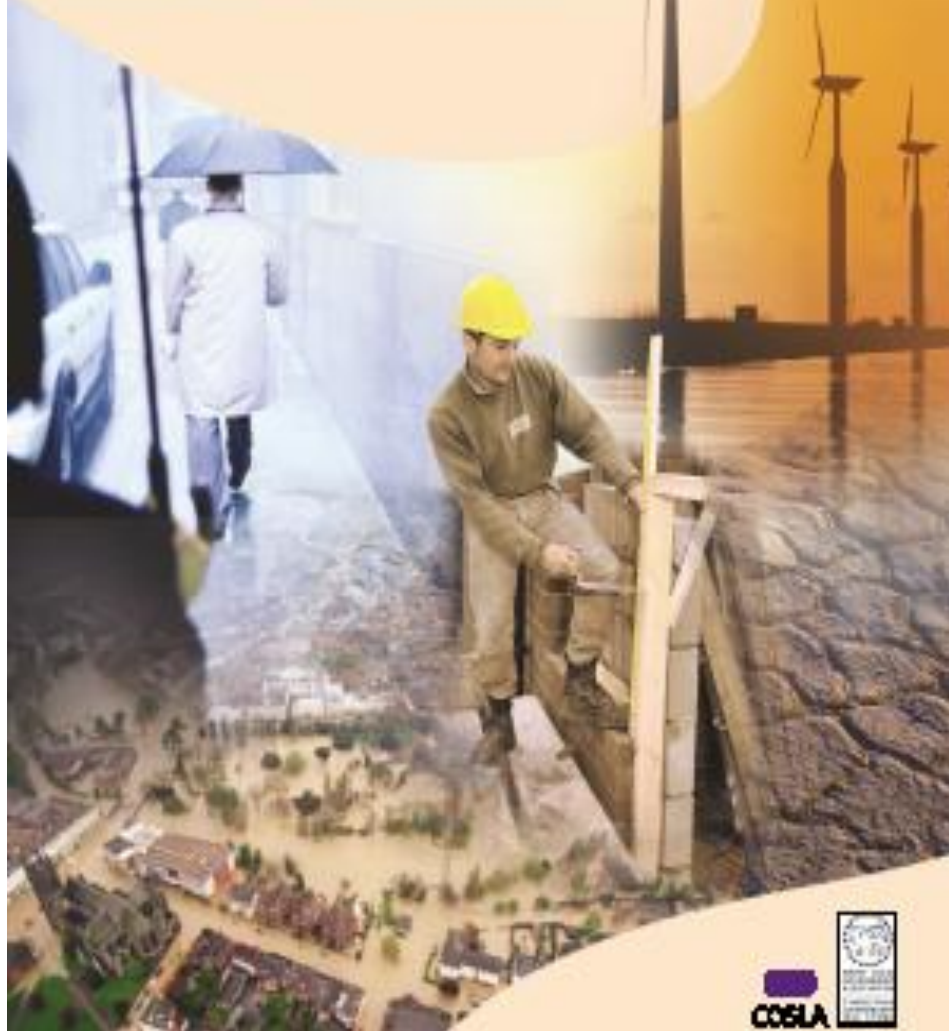
1. Adaptation responses are underpinned by common enabling factors. These include effective institutions and governance, innovation and investments in environmentally sound technologies and infrastructure, sustainable livelihoods and behavioural and lifestyle choices.
2. Adaptation options exist in all sectors, but their context for implementation and potential to reduce climate-related risks differs across sectors and regions.
3. Effective adaptation responses depend on policies and measures across multiple scales: international, regional, national and sub-national. Policies across all scales supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation.
4. There are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses (*high confidence*). Successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond (*medium confidence*).

# Principles for Effective Adaptation, AR5

1. Adaptation is place- and context-specific, with no single approach for reducing risks appropriate across all settings (high confidence).
2. Adaptation planning and implementation can be enhanced through complementary actions across levels, from individuals to governments (high confidence).
3. A first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability (high confidence).
4. Adaptation planning and implementation at all levels of governance are contingent on societal values, objectives, and risk perceptions (high confidence). Recognition of diverse interests, circumstances, social-cultural contexts, and expectations can benefit decision-making processes. (Indigenous, local, and traditional knowledge systems and practices, including indigenous peoples' holistic view of community and environment, are a major resource for adapting to climate change).
5. Poor planning, overemphasizing short-term outcomes, or failing to sufficiently anticipate consequences can result in maladaptation (medium evidence, high agreement).

# Climate change and local communities - How prepared are you?

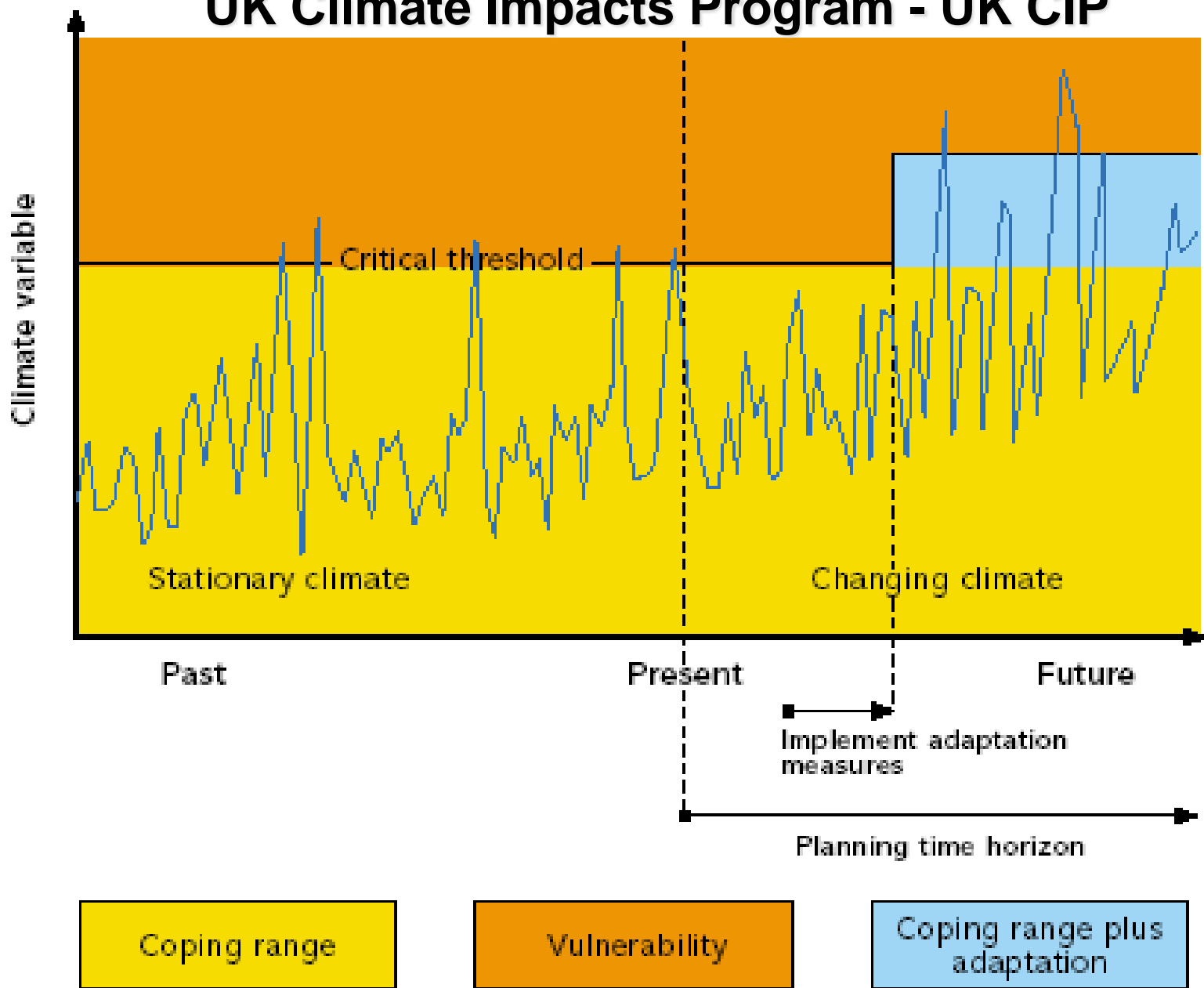
An adaptation guide for local authorities in the UK

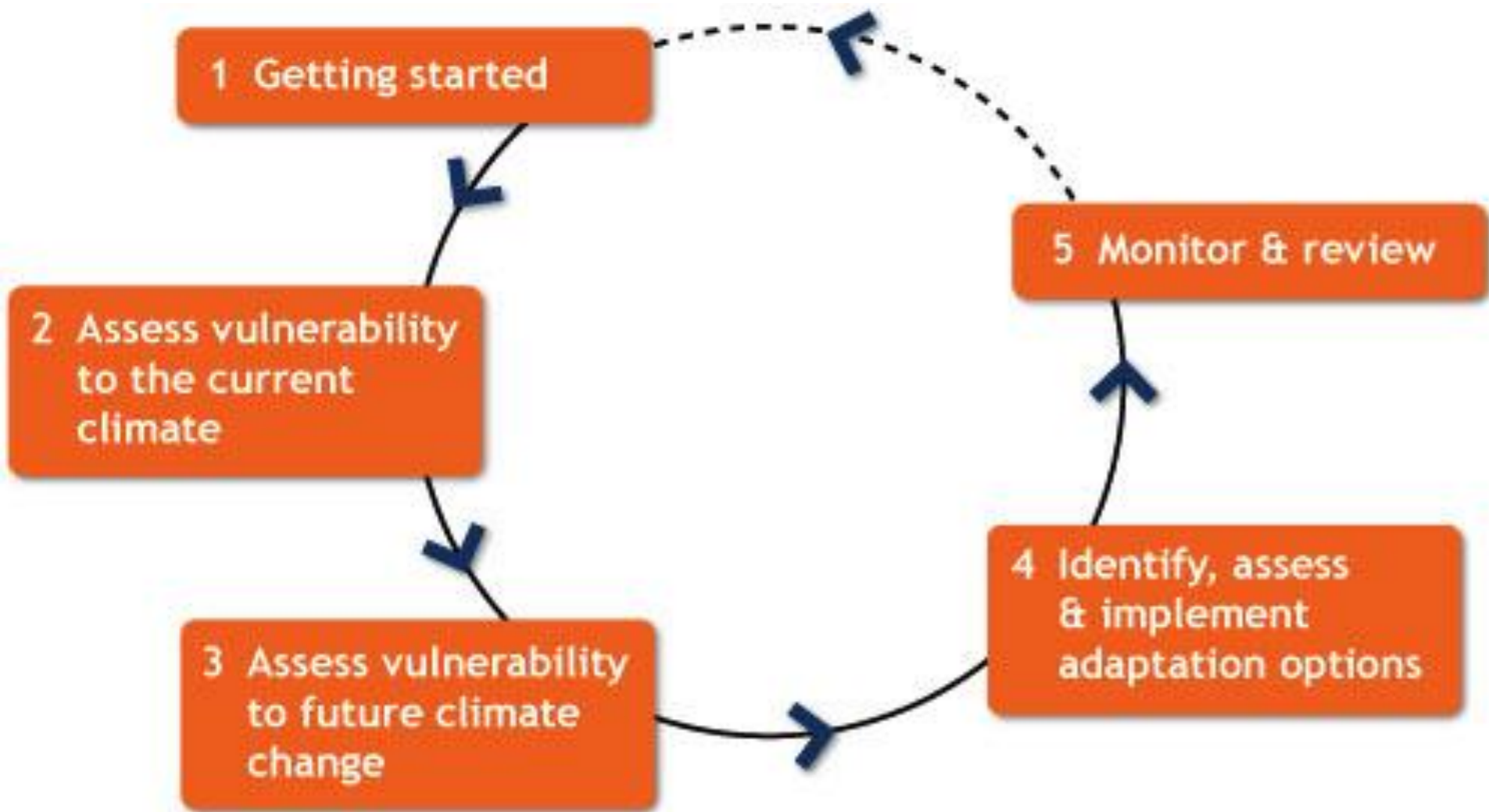


## Ask yourself

- Do you know what impact climate change could have on your area?
- Do your current policies, strategies and plans include provision for the impacts of climate change?
- Can you identify and assess the risks from climate change to your services?
- Are developments with a lifetime of more than 20 years required to factor in climate change?
- Does your Emergency Planning service take into account climate change?
- Are you addressing climate change in your local Community Strategy or Community Plan?
- Have you briefed your elected members on any key risks arising from climate variability and long-term climate change?

# UK Climate Impacts Program - UK CIP

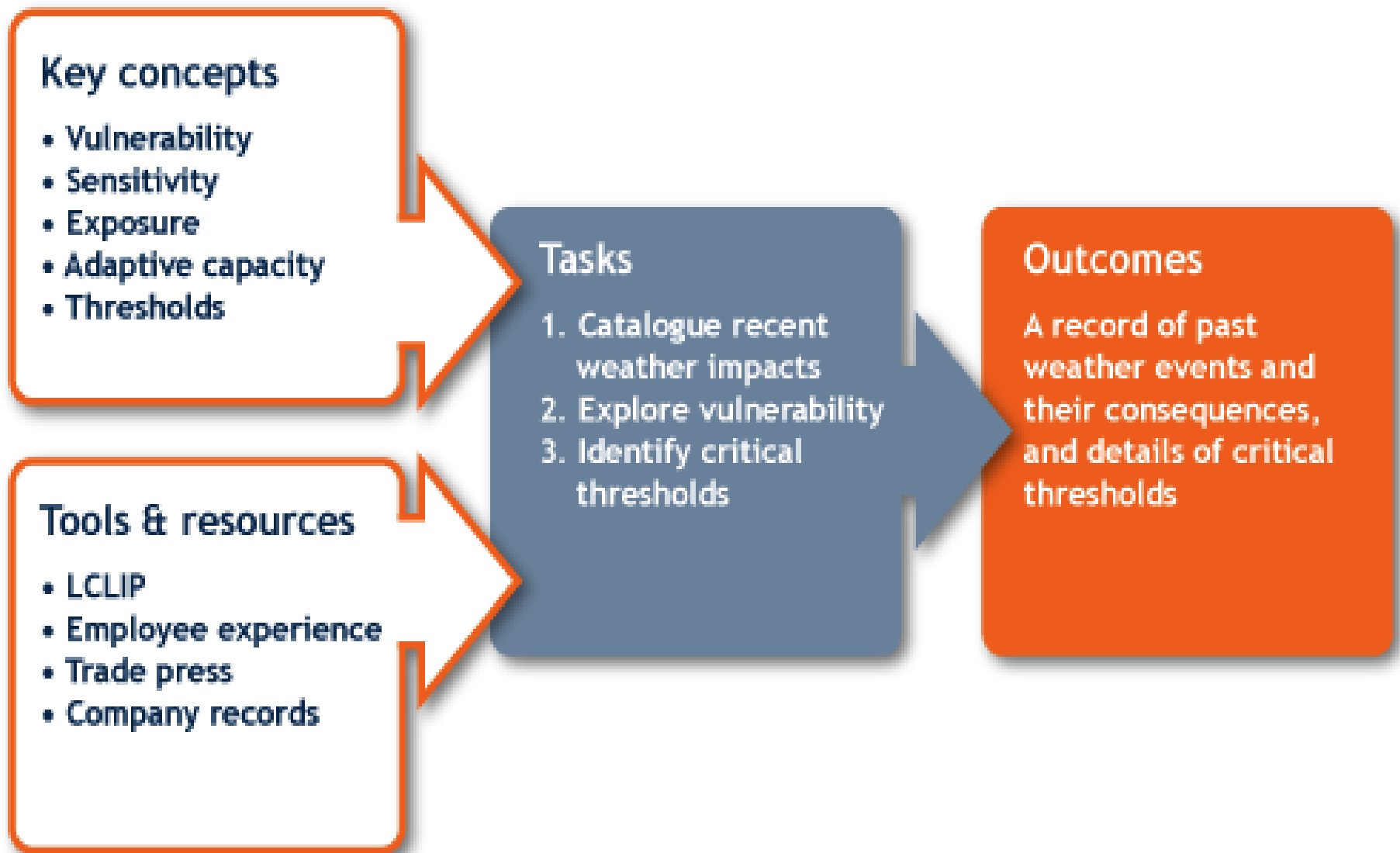




**The UKCIP Adaptation Wizard is a tool to help organisations adapt to climate change.**

<http://www.ukcip.org.uk/wizard/>





## **2 Assess your vulnerability to the current climate**

## Key concepts

- Climate projections
- Socio-economic context
- Risk
- Exposure units & receptors

## Tools & resources

- UKCP09
- Socio-economic scenarios
- Regional/sectoral studies
- Costings report
- Risk management

## Tasks

1. Scope the impacts climate change
2. Assess risks of impacts
3. Prioritise key risks

## Outcomes

A list of priority climate change risks

# 3 Assess your vulnerability to future climate change

## Key concepts

- BAC & DAA
- Attitude to risk
- Sensitivity to uncertainty
- Evaluation criteria
- Adaptive management
- Maladaptation

## Tools & resources

- UKCP09
- AdOpt
- Costings report
- Existing systems

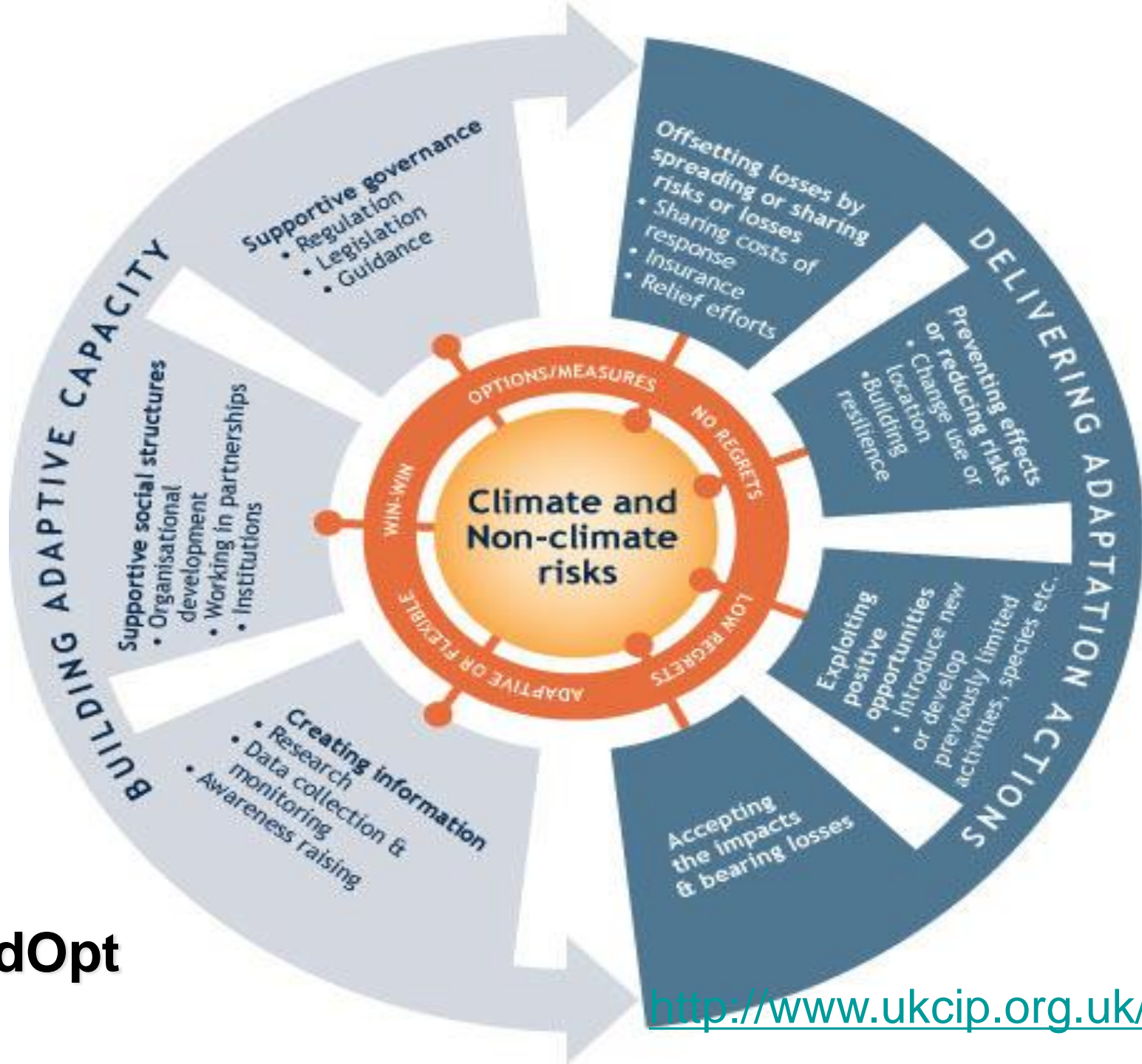
## Tasks

1. Identify options
2. Evaluate options
3. Implement preferred options

## Outcomes

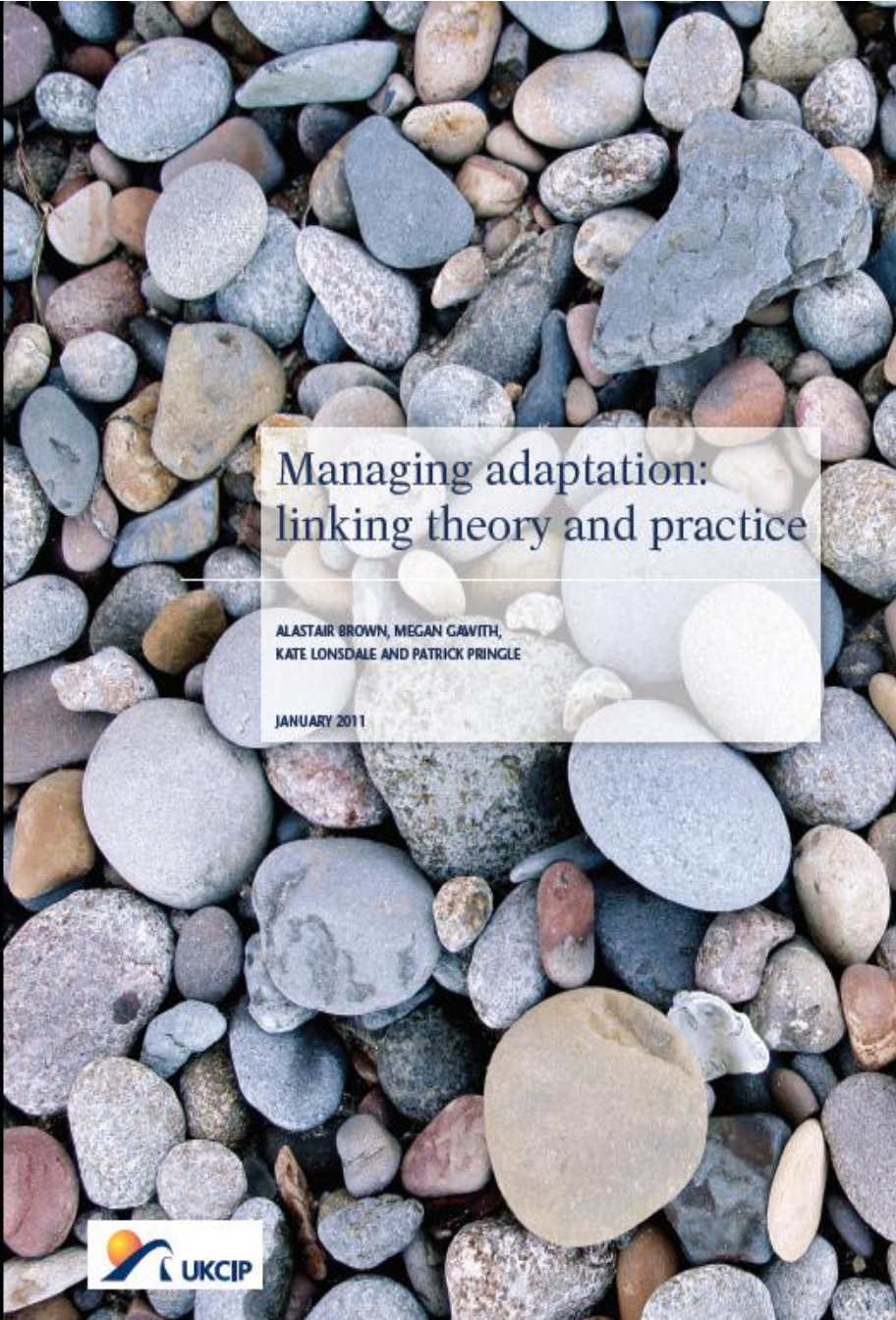
A 'Well adapted' plan, project, strategy, building etc.

# 4 Identify, assess and implement adaptation options



**AdOpt**

<http://www.ukcip.org.uk/adopt/>



# Managing adaptation: linking theory and practice

ALASTAIR BROWN, MEGAN GAWTH,  
KATE LONSDALE AND PATRICK PRINGLE

JANUARY 2011

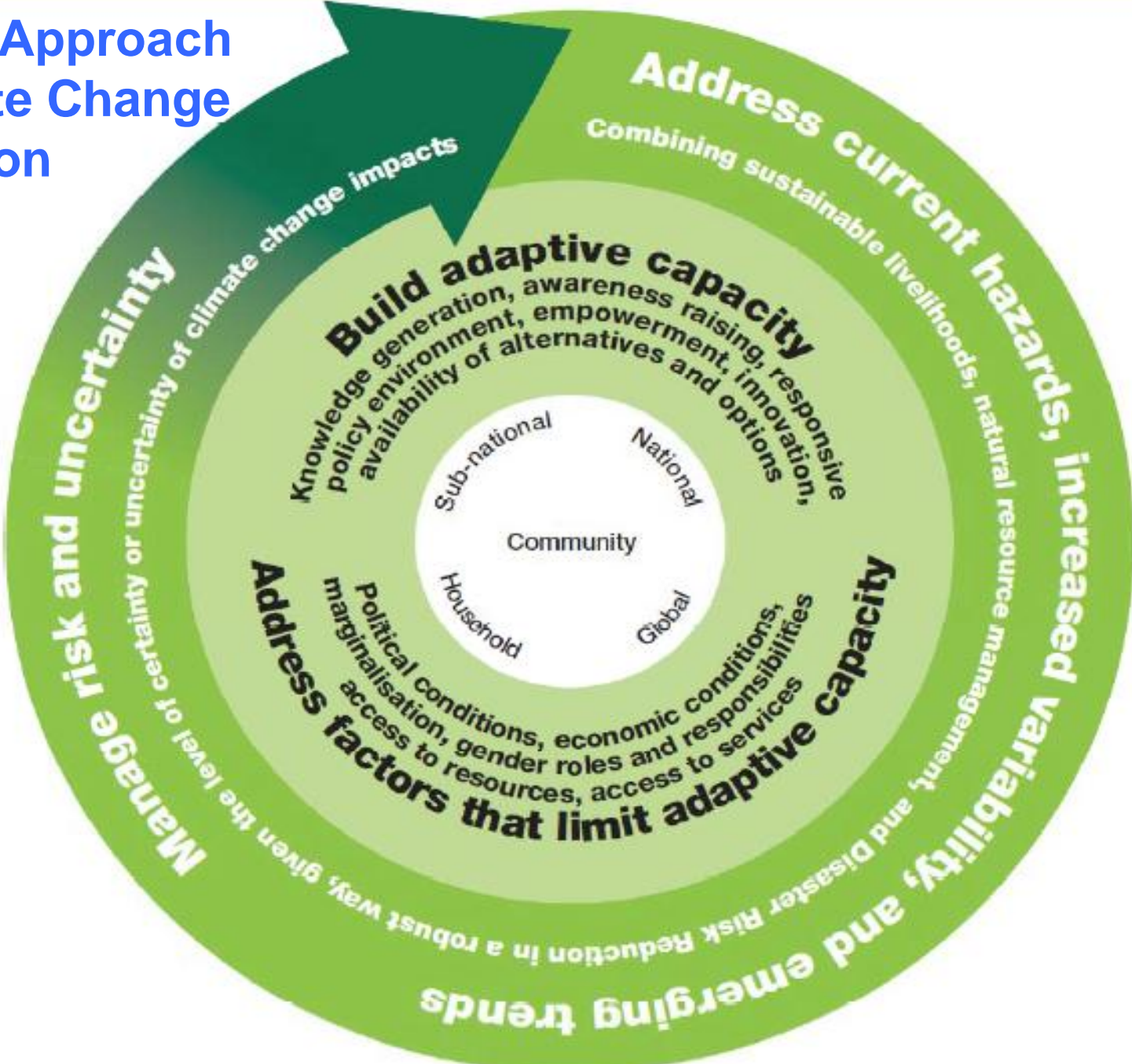


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# Oxfam's Approach to Climate Change Adaptation



Community	Local government	National government
<p style="text-align: center;">Capacity</p> <p style="text-align: center;">Resources</p> <p style="text-align: center;">Participatory decision making</p> <p style="text-align: center;">Access to information</p> <p style="text-align: center;">Innovation and learning</p> <p style="text-align: center;">Flexible planning</p> <p style="text-align: center;">Robust decision making</p> <p style="text-align: center;">Addressing factors that limit adaptive capacity</p>		
<ul style="list-style-type: none"> <li>• Bottom-up vulnerability assessment</li> <li>• Local design and implementation</li> <li>• Participatory monitoring and evaluation</li> </ul>	<ul style="list-style-type: none"> <li>• Devolved decision making and resources</li> <li>• Bridge bottom-up and top-down processes</li> <li>• Platform for engagement with stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>• Political will</li> <li>• Supportive policy environment</li> <li>• Knowledge generation</li> <li>• Co-ordination</li> <li>• Integration</li> </ul>

## 1 What is the climate context?

- What current climate hazards and emerging trends affect the area?
- What are the impacts of these?
- What are the likely impacts of climate change in the area over the short-, medium- and longer-term?
- What is uncertain?
- What strategies are employed to protect against climate hazards or change in response?

## 2 What is the local context?

- Are livelihoods climate-sensitive, and in what ways?
- Whose livelihoods are most vulnerable to climate change? What are the climate- and non-climate-related factors?
- What are the available livelihood opportunities, and what are the limiting factors?
- What resources are available? Who has access? How are they managed?
- What information is available? How is it communicated? How is it used?
- How is risk reduced and managed?



### 3 What interventions and policies are feasible and appropriate to address 1 and 2?

- What interventions and policies would reduce risk from and enable adaptation to address current hazards, variability, and emerging trends?
- What interventions and policies would manage risk and uncertainty?
- What interventions and policies would build adaptive capacity?

### 4 Which of these, or which combination of these, are most robust, given 1 and 2?

- Considering the level and types of likely changes and uncertainty, which of the options are preferable?
- Considering the local context, which options are needed to build adaptive capacity?

Change	Impact	Intervention examples
Temperature increase on land and water	Heat stress on crops	Access to heat tolerant crops
	Increased crop water demand and/or reduced water availability	Access to drought-tolerant and fast maturing crops and varieties
		Increase soil organic content
		Water-conserving crop management practices (e.g. ridge planting)
		Maximize water capture and storage
		Advocacy on securing rights of access to water supplies for small-scale farmers
	Heat stress on livestock	Tree planting (shade and fodder)
		Change to more heat tolerant livestock (e.g. shift from cattle to goats)
	Worsening availability of fish stocks	Conservation of coastal mangroves and other vegetation
		Sustainable aquaculture, such as fish farming in ponds
Glacial melt flooding	Early warning systems	
Glacial melt reducing summer river water	Maximize water capture and storage	
Sea-level rise	Saline intrusion	Provision of water for households and productive use
		Access to saline tolerant crops
	Coastal erosion	Sea defences built
	Increased frequency/severity of storm surges	Early warning systems
		Protected/raised food, water and sanitation
	Mangrove rehabilitation	

Changed seasonality	Farmers uncertain about when to cultivate, sow, and harvest	Appropriate, accessible, and reliable seasonal and weather forecasts
		Crop diversification and crop mixing
		Livelihood diversification
	Crops damaged by dry spells within growing season	Appropriate, accessible, and reliable weather forecasts
		Crop diversification and crop mixing
		Water capture and storage
		Access to fast maturing/drought tolerant crops
		Soil and crop management to conserve water
	Crops damaged by unseasonal heavy downpours	Appropriate, accessible and reliable weather forecasts
		Flood-tolerant varieties
		Crop diversification and crop mixing
		Sustainable agricultural techniques to improve drainage
		Crop insurance/social protection measures
Reduced agricultural seasons	Livelihood diversification	
	Access to fast maturing/drought tolerant crops	
	Appropriate, accessible, and reliable seasonal and weather forecasts	
Increase in intense rainfall or large increase in annual rainfall	Increased frequency/severity of floods	Improved drainage
		Protected/raised food, water and sanitation
Decrease in annual rainfall in arid/semi-arid areas	Increased frequency/severity of drought	Rainwater harvesting
		Community water management committees
		Access to more drought-tolerant crops

## NAC adaptation functions summary

<b>Assessment</b>	Assessment is the process of examining available information to guide decision making. Adaptation is likely to require iterative assessments over time, including assessments of vulnerability, climate change impacts, adaptation practices, and the climate sensitivity of development activities.
<b>Prioritization</b>	Prioritization means assigning special importance to particular issues, areas, sectors, or populations. For adaptation, prioritization at the national level usually takes into account projected geographic distribution of climate change impacts, as well as differential vulnerability to the impacts of climate change among a country's population. Effective processes for prioritization will engage a wide range of stakeholders, will be made transparent to the public, and will enable review and adjustment of priorities as circumstances change.
<b>Coordination</b>	Adaptation requires action by disparate actors at multiple levels, both within and outside of government. Co-ordination of their activities helps to avoid duplication or gaps, and can create economies of scale in responding to challenges. Co-ordination may be horizontal (e.g., among ministries), vertical (e.g., among national, global, and sub-national actors), or inter-sectoral (e.g., between government and business).

Source: World Resources Institute (WRI) (November 2009) 'The National Adaptive Capacity Framework: Key Institutional Functions for a Changing Climate'.

<b>Information management</b>	Information management consists of collecting, analysing, and disseminating knowledge in support of adaptive activities. Relevant information will vary, but at a minimum, typically covers climate variables, the status of natural and human systems, and existing coping strategies. Good information management will ensure that information is useful and accessible to stakeholders. It may also involve general awareness raising, or building the capacity of stakeholders to use information for adaptation.
<b>Climate risk reduction</b>	Different development priorities will face different risks from climate change. Addressing these risks depends on the above adaptation functions, but also requires a distinct process of identifying specific risks to a given priority, evaluating the full range of options for addressing the risks, and then selecting and implementing risk reduction measures. Many risk-reduction measures will entail changing practices in the areas of infrastructure, natural resources management, or social protection. For some countries, it may be useful to treat these three sets of activities as adaptation functions in their own right.

*Source:* World Resources Institute (WRI) (November 2009) 'The National Adaptive Capacity Framework: Key Institutional Functions for a Changing Climate'.

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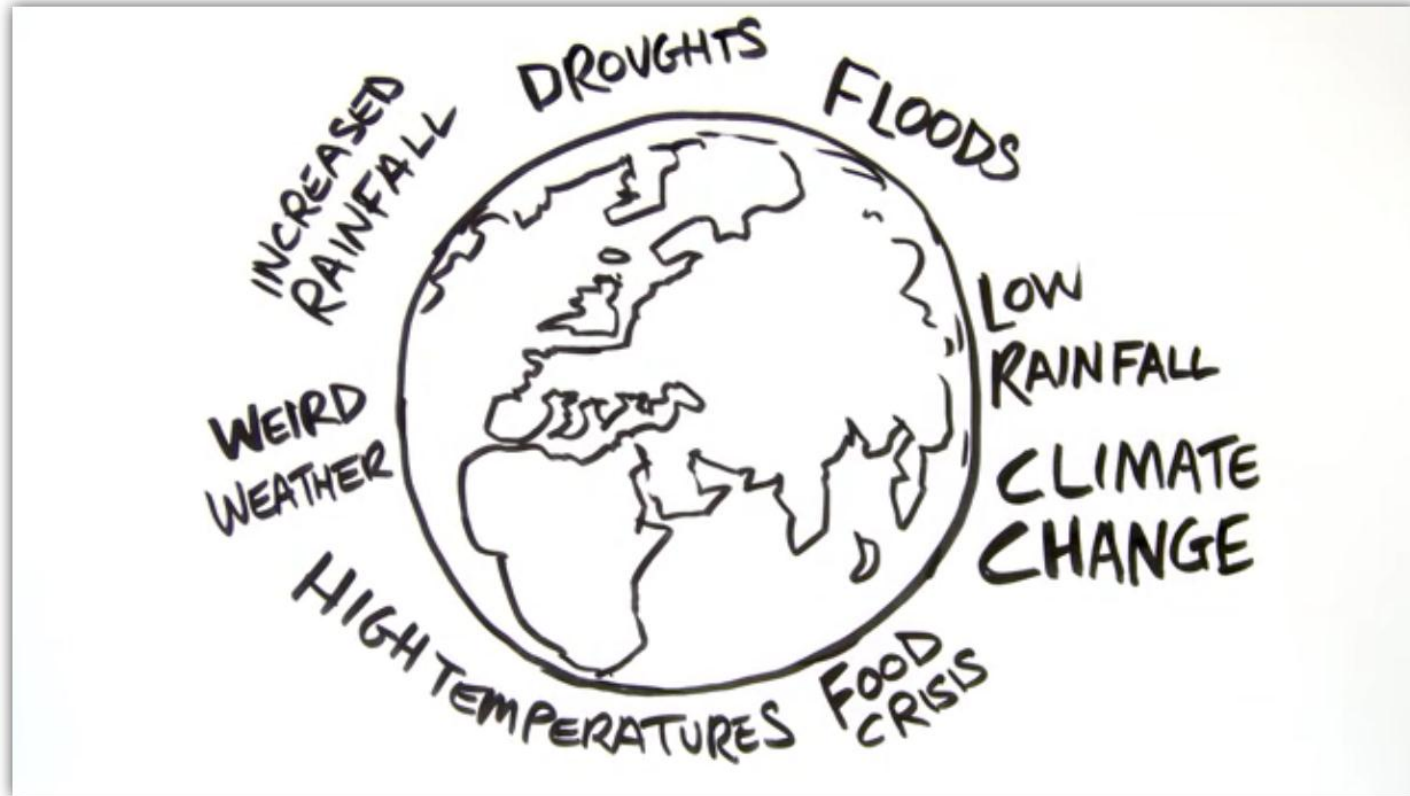
Find out who is doing what, and where, alongside climate station data through the Adaptation Layer.

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# What is weADAPT?

# What is weADAPT?



weADAPT is an online 'open space' on climate adaptation issues and synergies with mitigation which allows practitioners, researchers and policy makers to access credible, high quality information and to share experiences and lessons learnt.

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## About weADAPT

weADAPT is developed and maintained by the Stockholm Environment Institute (SEI). Content is curated both [by SEI and the weADAPT team](#), a dynamic [network of Knowledge Partners](#), using an [innovative suite of technologies](#).

weADAPT started life as 'wikiADAPT' and has grown into a collection of over 1000 articles and case studies. The technical development of weADAPT is based on extensive consultation with [Knowledge Partners](#) by the Stockholm Environment Institute. It has been the result of collaborations over several years between SEI and many Knowledge Partners including IIED, IDS (CBAX), CSAG (UCT), UNEP RRCAP, SENSEA, Oxfam GB, CIFOR, UNITAR, Google.org, ENDA and START. To become a Knowledge Partner, see [here](#).

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weADAPT is an online 'open space' on climate adaptation issues (including the synergies between adaptation and mitigation) which allows practitioners, researchers and policy makers to access credible, high quality information and to share experiences and lessons learnt with the weADAPT community. It is designed to facilitate learning, exchange, collaboration and knowledge integration to build a professional community of research and practice on adaptation issues while developing policy-relevant tools and guidance for adaptation planning and decision-making.

# Climate and Development Knowledge Network

Helping developing countries to design and deliver climate compatible development

[cdkn.org](http://cdkn.org)



## *Strategic Themes:*

- Climate compatible development strategies and plans;
- Improving developing countries' access to climate finance;
- Strengthening resilience through climate-related disaster risk management;
- Supporting climate negotiators from the least developed and most vulnerable countries.
- CDKN is managed by an alliance of organisations led by PricewaterhouseCoopers LLP (PwC), and others including Overseas Development Institute, Fundación Futuro Latinoamericano, etc..
- Supported by UKAID & Netherlands Foreign Affairs.



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**The Climate and Development Knowledge Network (CDKN)** aims to help decision-makers in developing countries design and deliver climate compatible development.



Tue 16/06/15

### FEATURE: Scaling-up climate smart agriculture in Nepal

Hammad Raza Khan, CDKN's Country Programme Manager for Nepal discusses the climate challenges faced by agriculture in Nepal and CDKN's work to help the government and farmers overcome these.

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Small Island Developing States Toolkit

Africa Toolkit South Asia Toolkit

Latin America Toolkit

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PROVIA aims to meet a growing demand for knowledge on climate change vulnerability, impacts and adaptation by providing clear technical guidance that combines robust science with explicit consideration of user needs at the local, national and international levels, in both developed and developing countries. This document updates and improves existing guidance, discussing key issues at each stage of the adaptation cycle and covering the wide array of approaches, methods and tools available to address them. The resulting guidance should be useful to researchers, adaptation practitioners, planners and policy-makers alike.

# US AID COMPENDIUM OF LESSONS LEARNED FROM ARCC CLIMATE CHANGE VULNERABILITY ASSESSMENTS

AFRICAN AND LATIN AMERICAN RESILIENCE TO CLIMATE CHANGE (ARCC)

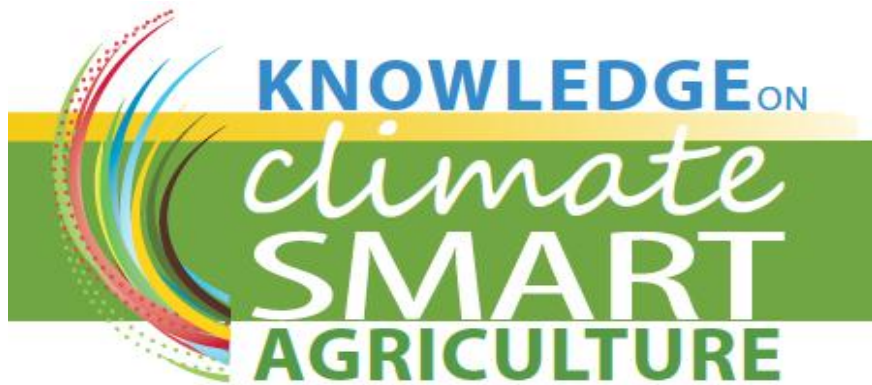
***[www.usaid.gov](http://www.usaid.gov)***

OCTOBER 2014

**TABLE 3.3: EXAMPLES OF VULNERABILITY DIMENSION INDICATORS**

<b>Vulnerability Dimension</b>	<b>Uganda CCVA</b>	<b>Dominican Republic CCVA</b>	<b>Senegal CCVA</b>
<b>Exposure</b>	Precipitation; temperature	Precipitation; temperature; wind; sea-level rise	Cropping systems: rainfall and temperature; livestock systems: quality and quantity of rangeland vegetation; surface water availability, and availability of field crop residue; markets: rates of road deterioration; frequency of commodity price shocks
<b>Sensitivity</b>	Phenology; crop diversification; value chains; household crop sales; off-farm income; household assets	Livelihoods; poverty; coastal infrastructure; mangroves and coral reefs; fish stocks; tourism	Off-farm and on-farm income; livestock and crops farmed; large/small ruminants; vulnerability of crops; market engagement
<b>Adaptive Capacity</b>	New technology; on-farm investment; diversification of revenue; access to loans	Institutional analysis	Assets in five forms of capital: human, natural, physical, social, and financial





**Food and Agriculture  
Organization of the  
United Nations**



RESEARCH PROGRAM ON  
**Climate Change,  
Agriculture and  
Food Security**



**CCAFS**



### *Why do we need climate-smart agriculture?*

FAO estimates that feeding the world population will require a 60 percent increase in total agricultural production. With many of the resources needed for sustainable food security already stretched, the food security challenges are huge. At the same time climate change is already negatively impacting agricultural production globally and locally. Climate risks to cropping, livestock and fisheries are expected to increase in coming decades, particularly in low-income countries where adaptive capacity is weaker. Impacts on agriculture threaten both food security and agriculture's pivotal role in rural livelihoods and broad-based development. Also the agricultural sector, if emissions from land use change are also included, generates about one-quarter of global greenhouse gas emissions.

## FAO's definition of climate-smart agriculture

Climate-smart agriculture is an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. It contributes to the achievement of national food security and development goals with three objectives:

1. Sustainably increase agricultural productivity and incomes
2. Adapt and build resilience to climate change
3. Reduce and/or remove greenhouse gas emissions where possible

Climate-smart agriculture ...

- addresses adaptation and builds resilience to shocks;
- considers climate change mitigation as a potential co-benefit;
- is a location-specific and knowledge-intensive approach;
- identifies integrated options that create synergies and reduce trade-offs;
- identifies barriers to adoption and provides appropriate solutions;
- strengthens livelihoods by improving access to services, knowledge and resources;
- integrates climate financing with traditional sources of agricultural investment.

Source: [3]

Main livelihood	Options for managing climate risks
Subsistence and smallholder farming	<p>Reduce post-harvest losses</p> <p>Improve efficiency of water use to address increasing rainfall variability</p> <p>Ensure access to extension services for climate change adaptation (drought-tolerant seeds etc.)</p>
Medium- to large-scale farming	<p>Strengthen early warning system for floods, drought, heat waves and cold spells</p>
Unskilled labour (rural)	<p>Establish national social safety nets for coping with climate-related shocks by improving effective delivery of post-disaster assistance</p> <p>Support home gardening to enhance access to diverse food</p>
Unskilled labour (urban)	<p>Stabilize food prices (early price warning etc.)</p> <p>Support home gardening to enhance access to diverse food</p>
Remittances	<p>Ensure women's access to agricultural services for climate change adaptation (drought-tolerant seeds etc.)</p>
Social allowances	<p>Build resilience to climate-related risks and shocks through public works and social safety nets</p>

# Planning for an Uncertain Future

Promoting adaptation to climate change through Flexible and Forward-looking Decision Making

## Executive summary

Lindsey Jones, Eva Ludi, Elizabeth Carabine, Natasha Grist

Aklilu Amsalu, Luis Artur, Carina Bachofen, Patrick Beautement, Christine Broenner, Matthew Bunce, Janot Mendler de Suarez, William Muhumuza, Pablo Suarez and Daniel Zacarias



March 2014

ACCRA – the Africa Climate Change Resilience Alliance – is a research, advocacy and capacity building consortium of Oxfam GB, the Overseas Development Institute (ODI), Care International, Save the Children and World Vision International. It works in Mozambique, Uganda and Ethiopia.

ACCRA is funded by the UK Department for International Development (DFID).

# Overview of climate change adaptation platforms in Europe

ISSN 1725-2237



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E-Communiqué

The Adaptation Knowledge Platform is a response to the demand for effective mechanisms for sharing information on climate change adaptation, and for developing adaptive capacities in Asian countries. The initiative supports research and capacity building, policy making and information assimilation, generation, management and sharing. It will also facilitate climate change adaptation at local, national and regional levels, while working with existing and emerging networks and initiatives.

[More information](#)

[www.climateadapt.asia](http://www.climateadapt.asia)

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### E-Communiqué: Issue 16, March 2012

The E-communiqué is part of the efforts by the Regional Climate Change Adaptation Knowledge Platform for Asia and Asia Pacific Adaptation Network to share and inform about its activities

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### E-Communiqué: Issue 14, January 2012

The E-communiqué is part of the efforts by the Regional Climate Change Adaptation Knowledge Platform for Asia and Asia Pacific Adaptation Network to share and inform about its activities

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### E-Communiqué: Issue 13 November - December 2011

The E-communiqué is part of the efforts by the Regional Climate Change Adaptation Knowledge Platform for Asia and Asia Pacific Adaptation Network to share and inform about its activities

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CIRCLE-2

# Climate Change and Mountain Areas

Climate Change Impacts and Response Options in Mountainous Areas



An overview of the CIRCLE-Mountain  
Research Projects (2010-2013)





# CIRCLE 2

## ADAPTATION FRONTIERS

Conference on European Climate Change Adaptation  
Research and Practice

10 > 12 March 2014 Lisboa > Portugal





# Climate Change Adaptations in Mountain Areas

<http://www.circle-era.eu>

More research is needed on Climate Change impacts (natural and anthropogenic factors) and response options in mountainous areas including effects on, water resources, infrastructure, slope stability, agriculture, tourism, public health and biodiversity, e.g.:

- Consequences of Climate Change impacts (natural and anthropogenic) on biophysical, social, cultural and economic aspects of mountainous areas (e.g. economic competitiveness, environment protection and risk prevention);
- Climate Change response strategies and adaptation policies (with emphasis on transnational cooperation) for mountainous areas;
- Trade-offs and synergies between Climate Change adaptation and mitigation policies and their relevance for national, transnational and European strategies;
- Mountainous areas (cross-border and transnational) needs regarding climate policy development:
- Stakeholder involvement on Climate Change response adaptation strategies.



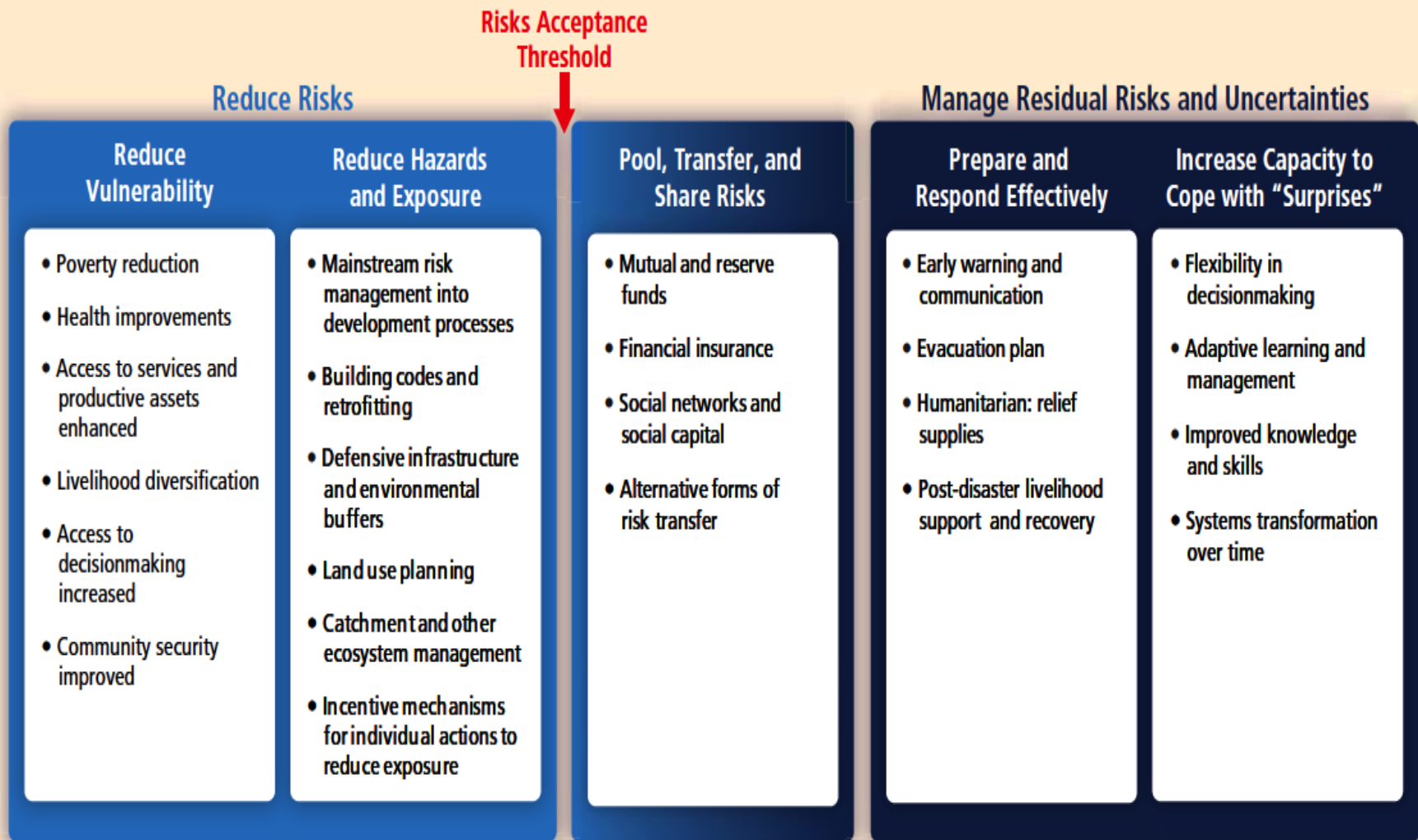


Figure 6-3 characterizes the range of risk management and adaptation options open to stakeholders involved in national systems for managing disaster risk.

Category	Examples
Human development	Improved access to education, nutrition, health facilities, energy, safe housing & settlement structures, & social support structures; Reduced gender inequality & marginalization in other forms.
Poverty alleviation	Improved access to & control of local resources; Land tenure; Disaster risk reduction; Social safety nets & social protection; Insurance schemes.
Livelihood security	Income, asset, & livelihood diversification; Improved infrastructure; Access to technology & decision-making fora; Increased decision-making power; Changed cropping, livestock, & aquaculture practices; Reliance on social networks.
Disaster risk management	Early warning systems; Hazard & vulnerability mapping; Diversifying water resources; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements.
Ecosystem management	Maintaining wetlands & urban green spaces; Coastal afforestation; Watershed & reservoir management; Reduction of other stressors on ecosystems & of habitat fragmentation; Maintenance of genetic diversity; Manipulation of disturbance regimes; Community-based natural resource management.
Spatial or land-use planning	Provisioning of adequate housing, infrastructure, & services; Managing development in flood prone & other high risk areas; Urban planning & upgrading programs; Land zoning laws; Easements; Protected areas.

AR5 WGII SPM1 Approaches for managing the risks of Climate Change. Including reducing vulnerability & exposure, adaptation and transformation. 1 of 3

Structural/physical	<b>Engineered &amp; built-environment options:</b> Sea walls & coastal protection structures; Flood levees; Water storage; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements; Floating houses; Power plant & electricity grid adjustments.
	<b>Technological options:</b> New crop & animal varieties; Indigenous, traditional, & local knowledge, technologies, & methods; Efficient irrigation; Water-saving technologies; Desalinization; Conservation agriculture; Food storage & preservation facilities; Hazard & vulnerability mapping & monitoring; Early warning systems; Building insulation; Mechanical & passive cooling; Technology development, transfer, & diffusion.
	<b>Ecosystem-based options:</b> Ecological restoration; Soil conservation; Afforestation & reforestation; Mangrove conservation & replanting; Green infrastructure (e.g., shade trees, green roofs); Controlling overfishing; Fisheries co-management; Assisted species migration & dispersal; Ecological corridors; Seed banks, gene banks, & other <i>ex situ</i> conservation; Community-based natural resource management.
	<b>Services:</b> Social safety nets & social protection; Food banks & distribution of food surplus; Municipal services including water & sanitation; Vaccination programs; Essential public health services; Enhanced emergency medical services.

AR5 WGII SPM1 Approaches for managing the risks of Climate Change. Including reducing vulnerability & exposure, adaptation and transformation. 2 of 3

Institutional	<b>Economic options:</b> Financial incentives; Insurance; Catastrophe bonds; Payments for ecosystem services; Pricing water to encourage universal provision and careful use; Microfinance; Disaster contingency funds; Cash transfers; Public-private partnerships.
	<b>Laws &amp; regulations:</b> Land zoning laws; Building standards & practices; Easements; Water regulations & agreements; Laws to support disaster risk reduction; Laws to encourage insurance purchasing; Defined property rights & land tenure security; Protected areas; Fishing quotas; Patent pools & technology transfer.
	<b>National &amp; government policies &amp; programs:</b> National & regional adaptation plans including mainstreaming; Sub-national & local adaptation plans; Economic diversification; Urban upgrading programs; Municipal water management programs; Disaster planning & preparedness; Integrated water resource management; Integrated coastal zone management; Ecosystem-based management; Community-based adaptation.
Social	<b>Educational options:</b> Awareness raising & integrating into education; Gender equity in education; Extension services; Sharing indigenous, traditional, & local knowledge; Participatory action research & social learning; Knowledge-sharing & learning platforms.
	<b>Informational options:</b> Hazard & vulnerability mapping; Early warning & response systems; Systematic monitoring & remote sensing; Climate services; Use of indigenous climate observations; Participatory scenario development; Integrated assessments.
	<b>Behavioral options:</b> Household preparation & evacuation planning; Migration; Soil & water conservation; Storm drain clearance; Livelihood diversification; Changed cropping, livestock, & aquaculture practices; Reliance on social networks.

AR5 WGII SPM1 Approaches for managing the risks of Climate Change. Including reducing vulnerability & exposure, adaptation and transformation. 3 of 3

## AR5 Adaptation Experiences

- Adaptation is becoming embedded in some planning processes... (high confidence).
- Engineered and technological options are commonly implemented adaptive responses, often integrated within existing programs such as disaster risk management and water management. There is increasing recognition of the value of social, institutional, and ecosystem-based measures and of the extent of constraints to adaptation. Adaptation options adopted to date continue to emphasize incremental adjustments and co-benefits and are starting to emphasize flexibility and learning (medium evidence, medium agreement)

## AR5 Adaptation Experiences

- Adaptation experience is accumulating across regions in the public and private sector and within communities (high confidence).
  - In **Africa**, most national governments are initiating governance systems for adaptation. Disaster risk management, adjustments in technologies and infrastructure, ecosystem-based approaches, basic public health measures, and livelihood diversification are reducing vulnerability, although efforts to date tend to be isolated.
  - In **Asia**, adaptation is being facilitated in some areas through mainstreaming climate adaptation action into subnational development planning, early warning systems, integrated water resources management, agroforestry, and coastal reforestation of mangroves..



## AR5 Adaptation Experiences

- Adaptation experience is accumulating across regions in the public and private sector and within communities (high confidence).
  - In **Central and South America**, ecosystem-based adaptation including protected areas, conservation agreements, and community management of natural areas is occurring. Resilient crop varieties, climate forecasts, and integrated water resources management are being adopted within the agricultural sector in some areas.
  - In **small islands**, which have diverse physical and human attributes, community-based adaptation has been shown to generate larger benefits when delivered in conjunction with other development activities.

# **Adapting to climate change & food security in Mountain Areas**

- Maintaining and enhancing agro-biodiversity and cultural diversity in mountain areas which offer significant adaptation potential to respond to the challenges of climate change;
- Providing education and training in the nutritional value of locally grown and gathered food to mountain families and the providers of health and education services in mountain communities;
- Promoting a supportive environment for the development of high-quality products and services from mountain areas as a means to improve livelihoods and protect mountain environments and encourage more active involvement by the private sector in all parts of the value chain for high-quality mountain products;

# Adapting to climate change & food security in Mountain Areas

- Integrating local and indigenous environmental knowledge and practices in climate change adaptation and food security strategies. Diversity of cultures and knowledge systems must be recognized and enhanced through public policy and investment;
- Fostering capacity building for all stakeholders in climate change processes and trends, mitigation and adaptation measures, and food security options in mountain regions, along with the establishment of appropriate extension services;
- Improving economic conditions and facilitating access to resources for mountain communities through mechanisms such as payment for environmental services.

# Adapting to climate change & food security in mountains

- Review of land use plans and zoning, as floods, landslides and avalanches are likely to become more severe and affect livelihood systems in areas so far considered safe;
- Adoption of a conservation-by-use philosophy and better integration of agriculture, livestock, forestry, aquaculture and local processing in order to help diversify income sources and make mountain food systems more resilient to climate change;
- Promotion of multifunctional, biodiverse and organic farming systems as well as localised, diversified food systems to improve food security in mountain areas facing climate change. Ecological and organic farming also reduce the demand for intensive irrigation while enhancing soil capacity in order to retain water and improve water quality. Finally, ecological and organic farming mitigate climate change by reducing greenhouse gas emissions and increasing carbon sequestration in plants and soils;

# We know with certainty, AR5

1. Adaptation and mitigation responses are underpinned by common enabling factors. These include:
  - a. effective institutions and governance,
  - b. innovation and investments in environmentally sound technologies and infrastructure,
  - c. sustainable livelihoods and
  - d. behavioural and lifestyle choices.
  
2. Adaptation options exist in all sectors, but their context for implementation and potential to reduce climate-related risks differs across sectors and regions.

# We know with certainty, AR5

3. Effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and sub-national. Policies across all scales supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation.
4. There are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses (*high confidence*). Successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond (*medium confidence*).

# AR5 SPM Synthesis

- **Observed Changes and their Causes:**

Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems.

- **Future Climate Changes, Risks and Impacts:**

Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.

- **Future Pathways for Adaptation, Mitigation and Sustainable Development:**

Adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. Substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the longer term, and contribute to climate-resilient pathways for sustainable development.

- **Adaptation and Mitigation:**

Many adaptation and mitigation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales, and can be enhanced through integrated responses that link adaptation and mitigation with other societal objectives.

# Small Group Discussion

## ***1. Is the climate changing in your area?***

- In what ways: means, variance, extremes, other?
- What are some of the effects?

## ***2. Are adaptation options available?***

- Identify any adaptation options that can help reduce exposure, vulnerability and/or risk.

## ***3. Can you identify opportunities to take actions that will help adapt to climate change?***

- *What are they?*
- *Are there any barriers to implementing actions?*
- *Are you aware of any studies or actions in your area addressing climate change adaptation?*





**Questions**

**[dgfox@comcast.net](mailto:dgfox@comcast.net)**



# AR4 2007 Adaptation summary

Sector	Adaptation option/strategy	Underlying policy framework	Key constraints and opportunities to implementation (Normal font = constraints; <i>italics</i> = opportunities)
<b>Water</b> {WGII, 5.5, 16.4; Tables 3.5, 11.6,17.1}	Expanded rainwater harvesting; water storage and conservation techniques; water reuse; desalination; water-use and irrigation efficiency	National water policies and integrated water resources management; water-related hazards management	Financial, human resources and physical barriers; <i>integrated water resources management; synergies with other sectors</i>
<b>Agriculture</b> {WGII 10.5, 13.5; Table 10.8}	Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection through tree planting	R&D policies; institutional reform; land tenure and land reform; training; capacity building; crop insurance; financial incentives, e.g. subsidies and tax credits	Technological and financial constraints; access to new varieties; markets; <i>longer growing season in higher latitudes; revenues from 'new' products</i>
<b>Infrastructure/ settlement (including coastal zones)</b> {WGII 3.6, 11.4; Tables 6.11, 17.1}	Relocation; seawalls and storm surge barriers; dune reinforcement; land acquisition and creation of marshlands/wetlands as buffer against sea level rise and flooding; protection of existing natural barriers	Standards and regulations that integrate climate change considerations into design; land-use policies; building codes; insurance	Financial and technological barriers; availability of relocation space; <i>integrated policies and management; synergies with sustainable development goals</i>

# Framework for risks across sectors and regions

- 1) ***Unique and threatened systems***: Some unique and threatened systems, including ecosystems and cultures, are already at risk from climate change (high confidence).
- 2) ***Extreme weather events***: Climate-change-related risks from extreme events, such as heat waves, extreme precipitation, and coastal flooding, are already at a moderate risk (high confidence) ...
- 3) ***Distribution of impacts***: Risks are unevenly distributed. Generally greater for disadvantaged people and communities in all countries. Moderate risks of impacts on crop production in some countries (medium to high confidence).
- 4) ***Global aggregate impacts***: Risks of global aggregate impacts are moderate for additional warming between 1–2° C, reflecting impacts to both Earth's biodiversity and the overall global economy (medium confidence).
- 5) ***Large-scale singular events***: With increasing warming, some physical systems or ecosystems may be at risk of abrupt and irreversible changes. Risks associated with such tipping points become moderate between 0–1° C additional warming, due to early warning signs that both warm-water coral reef and Arctic ecosystems are already experiencing irreversible regime shifts (medium confidence)

# **UK CIP Climate adaptation: Risk, uncertainty & decision-making**

## **Formal Framework:**

1. Identify problem & objectives;
2. Establish decision-making criteria;
3. Assess risk;
4. Identify option;
5. Appraise options;
6. Make decision;
7. Implement decision;
8. Monitor, evaluate & review.

# Strategic Environmental Assessment and Climate Change: Guidance for Practitioners

May 2004



CYNGOR CEFN GWLAD CYMRU  
COUNTRYSIDE COUNCIL FOR WALES



ENVIRONMENT  
AGENCY



ENGLISH  
NATURE



UK Climate  
Impacts Programme

Levett-Therivel  
sustainability  
consultants

CAG  
consultants



Environmental  
Change Institute

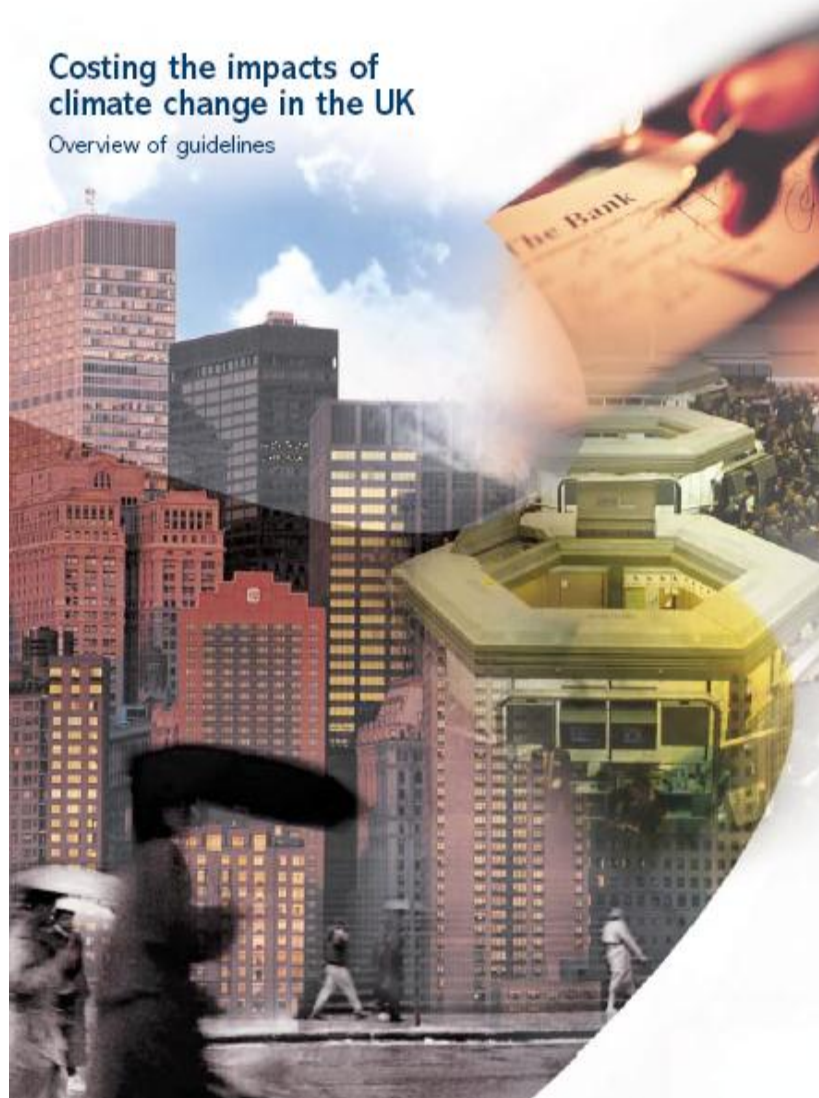
## *The Planning Response to Climate Change*

Advice on Better Practice



## Costing the impacts of climate change in the UK

Overview of guidelines



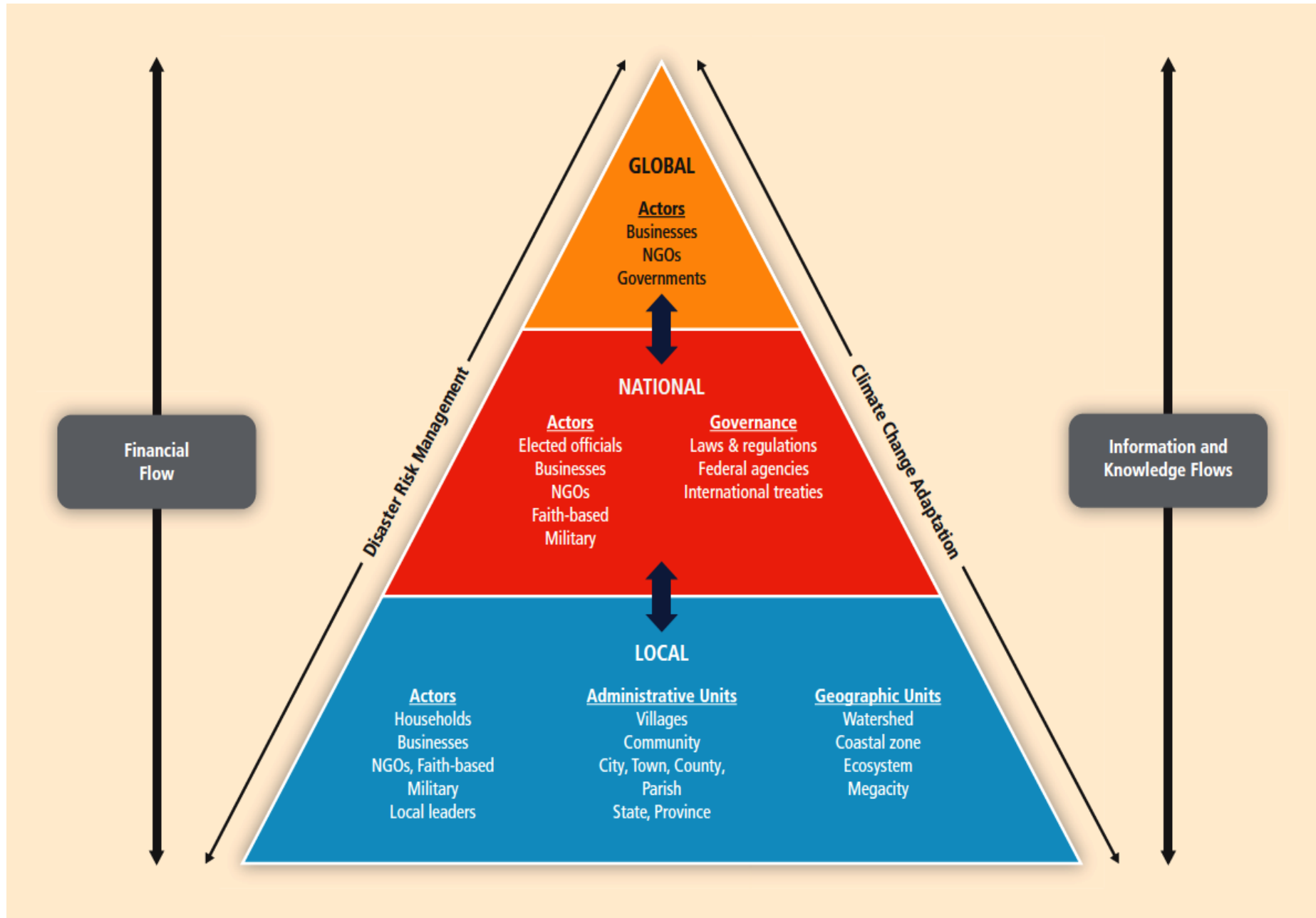
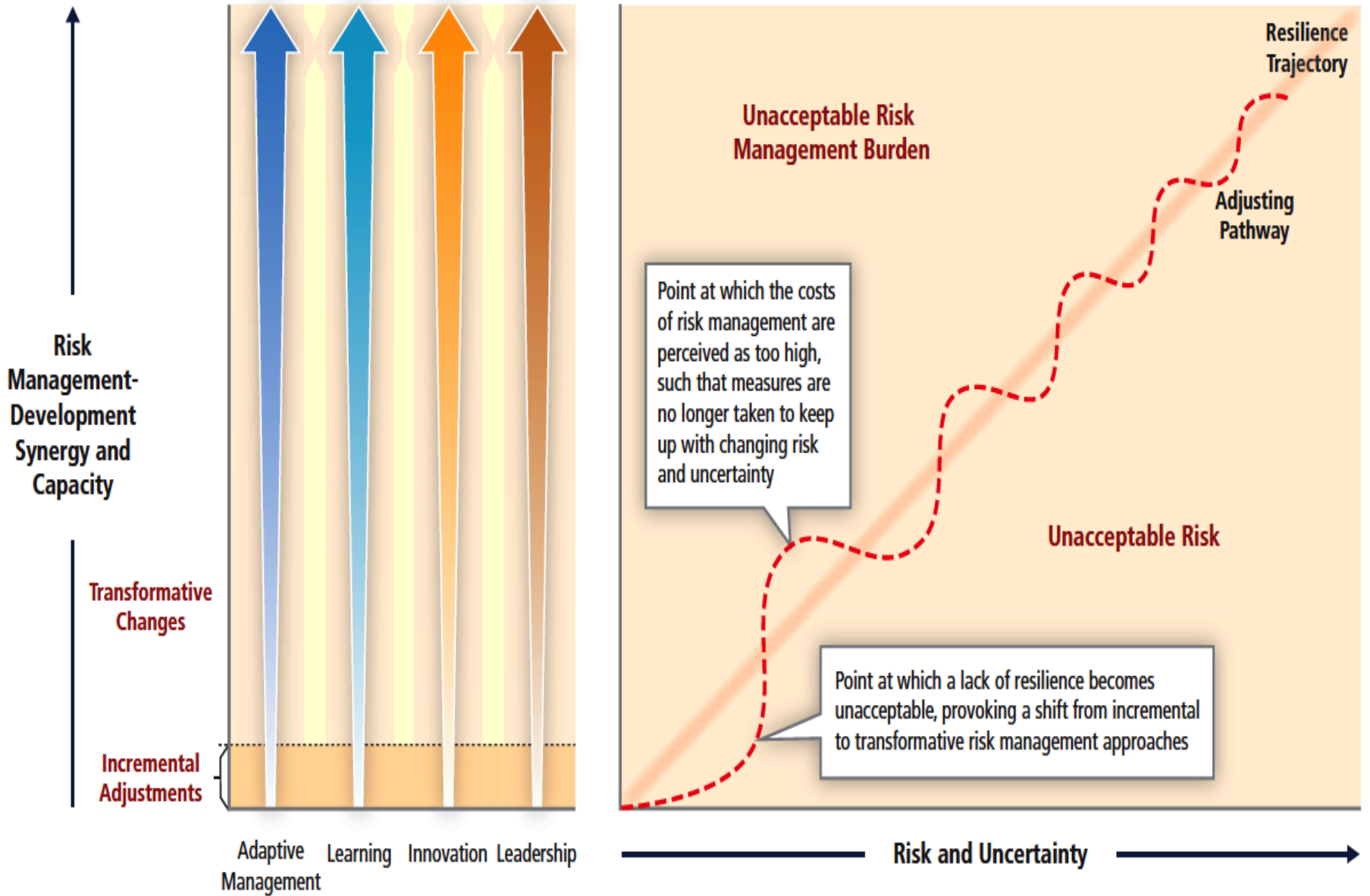


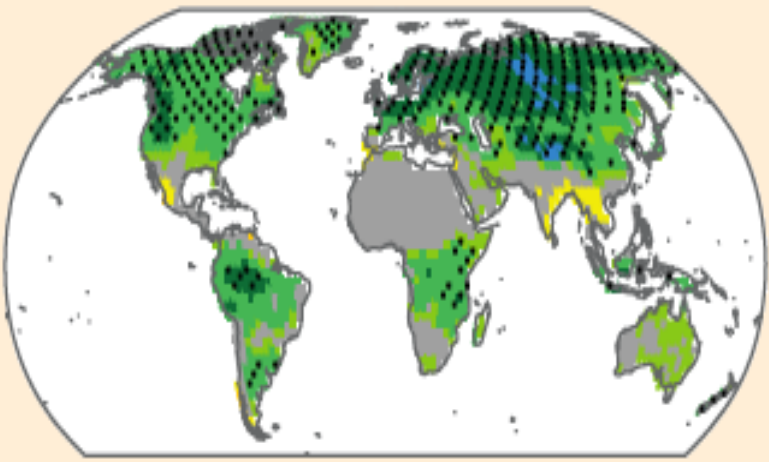
Figure 5-1 | Linking local to global actors and responsibilities.



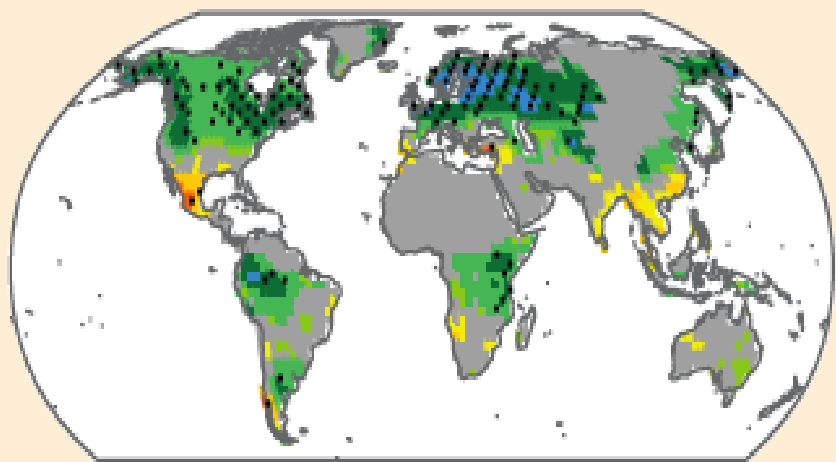


**Figure 8-1** | Incremental and transformative pathways to resilience.

DJF

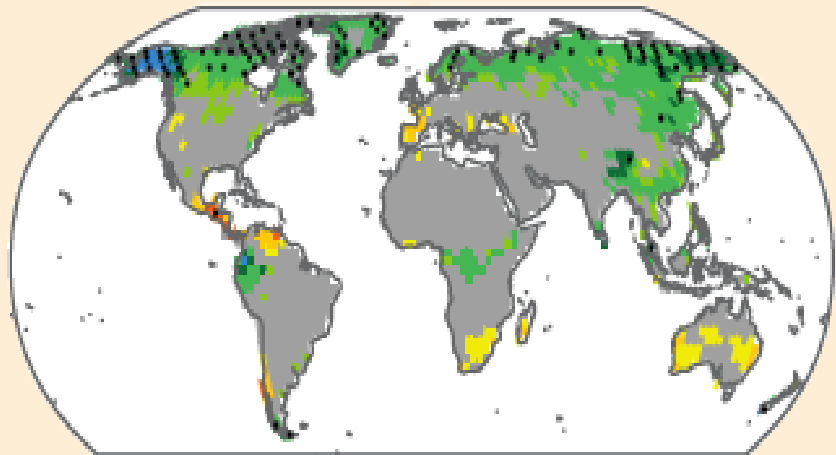
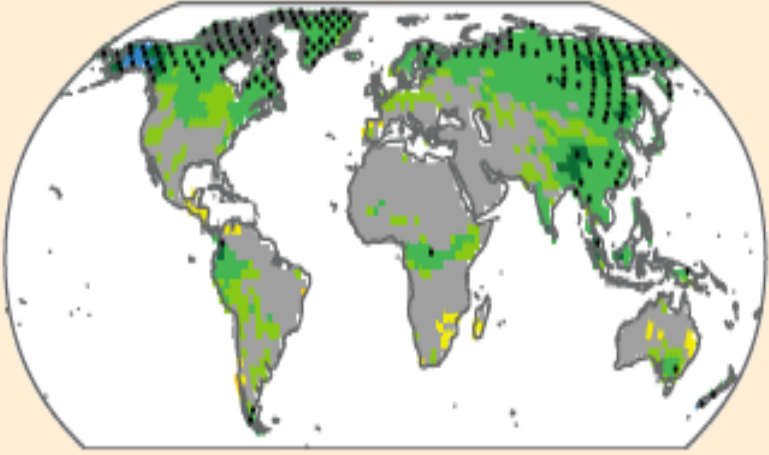


**Wet Day intensity**

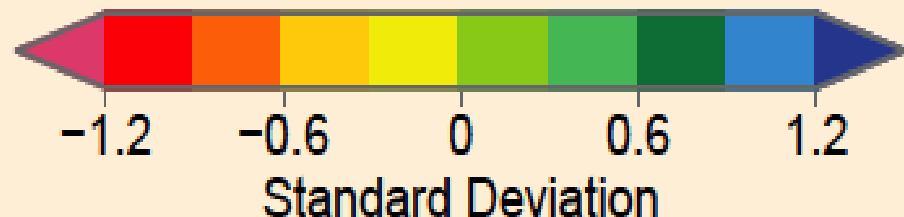
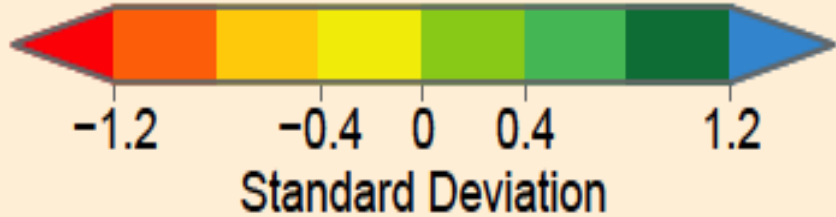


**Fraction of days > 10mm**

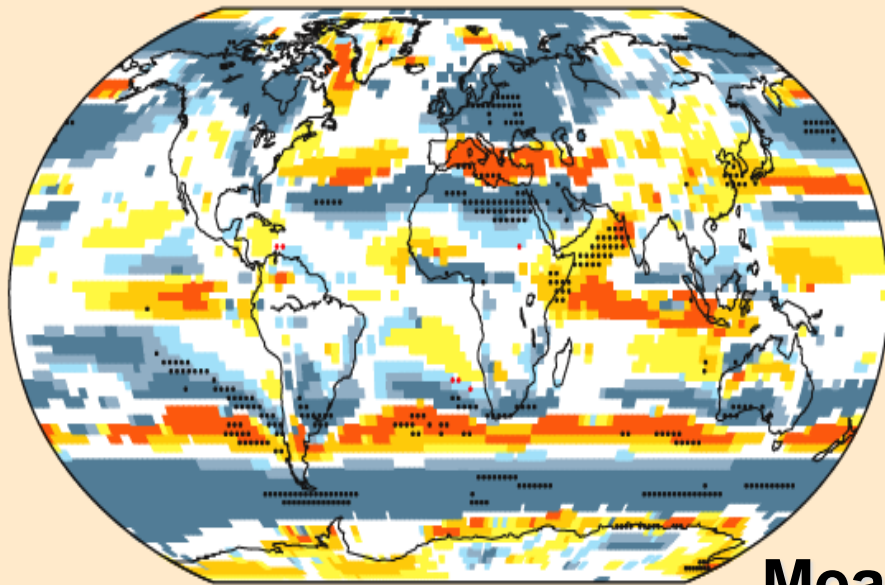
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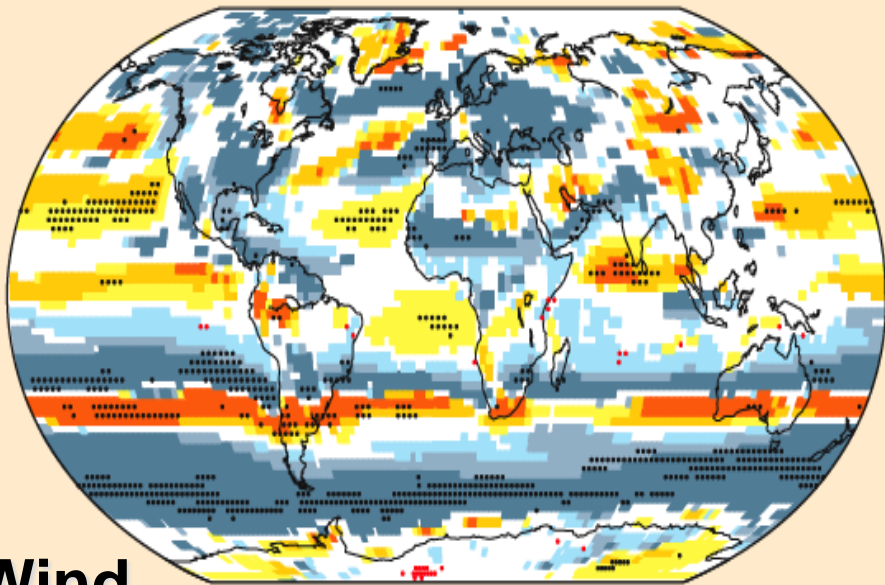
(2081-2100) – (1980-1999)



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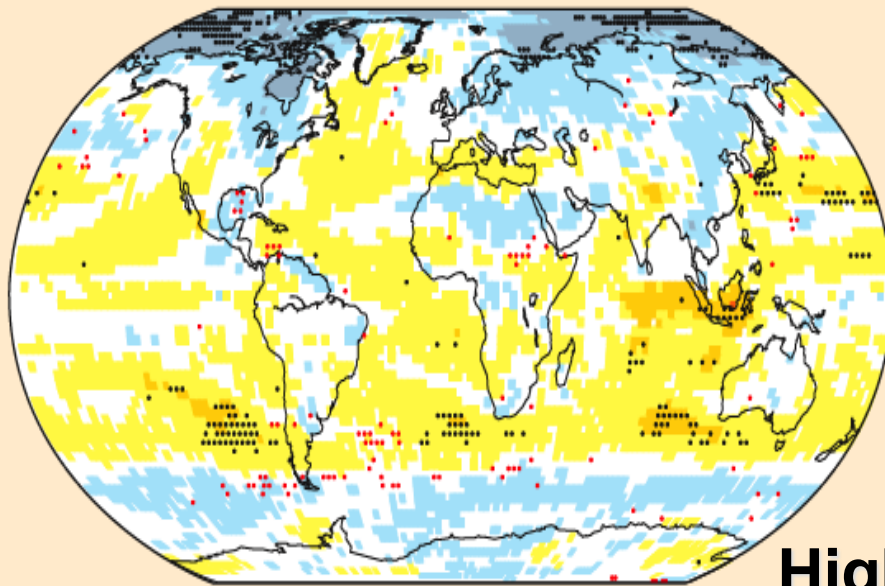


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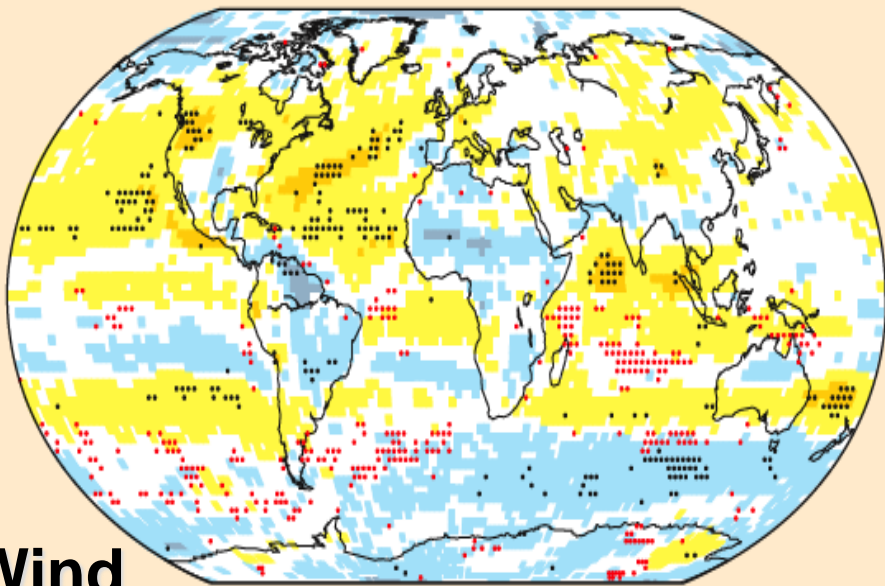


**Mean Wind**

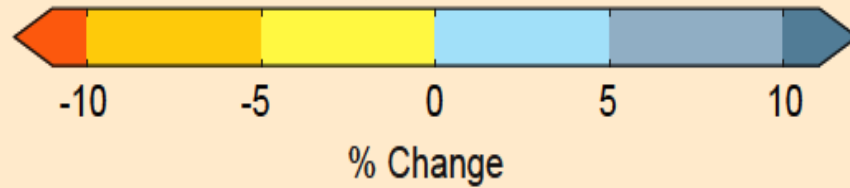
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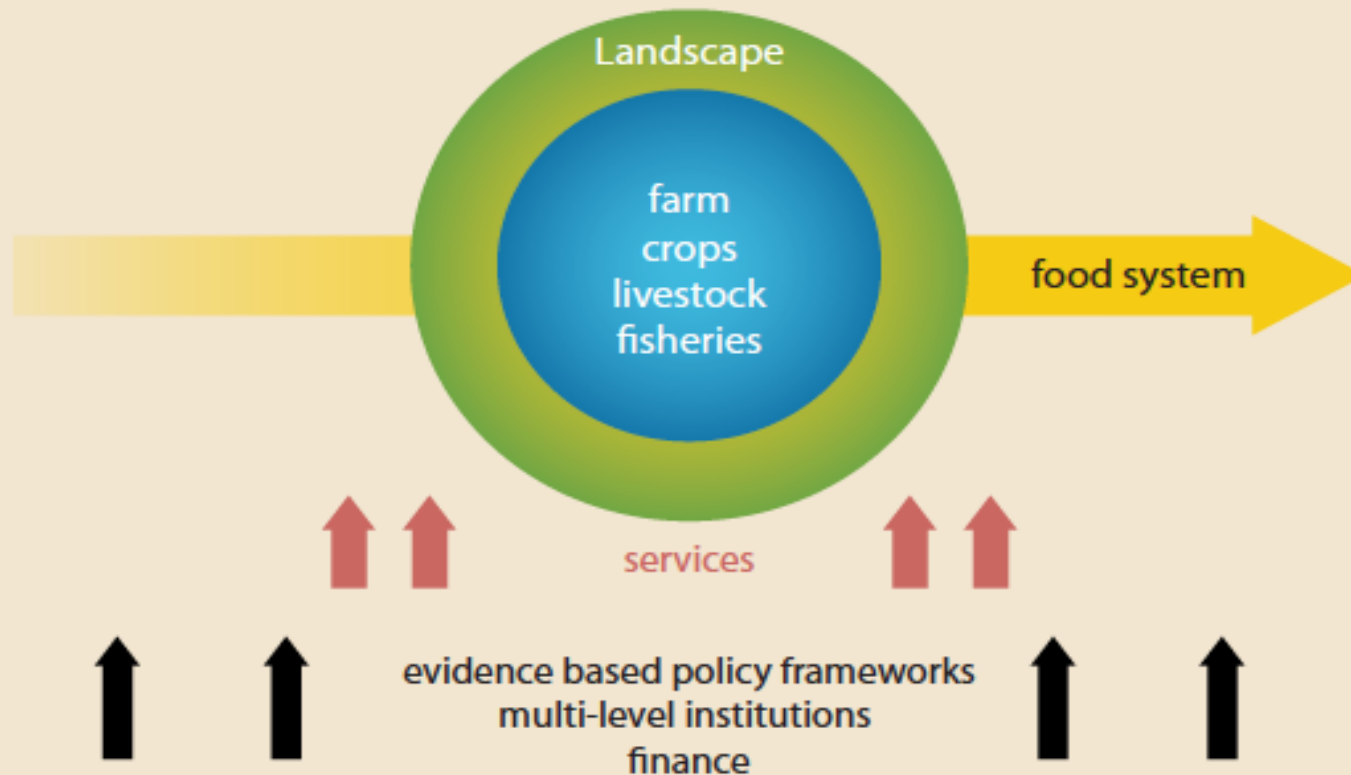
**High Wind**



## What are the main elements of climate-smart agriculture?

CSA is not a set of practices that can be universally applied, but rather an approach that involves different elements embedded in local contexts. CSA relates to actions both on-farm and beyond the farm, and incorporates technologies, policies, institutions and investment. Different elements which can be integrated in climate-smart agricultural approaches include:

- 1 *Management of farms, crops, livestock, aquaculture and capture fisheries to manage resources better, produce more with less while increasing resilience*
- 2 *Ecosystem and landscape management to conserve ecosystem services that are key to increase at the same time resource efficiency and resilience*
- 3 *Services for farmers and land managers to enable them to implement the necessary changes*



## Africa, AR5/3

- Progress has been achieved on managing risks to food production from current climate variability and near-term cc but these will not be sufficient to address long-term impacts of cc (high confidence). Livelihood-based approaches for managing risks to food production from multiple stressors, including rainfall variability, have increased substantially in Africa since AR4. While these efforts can improve the resiliency of agricultural systems in Africa over the near term, current adaptations will be insufficient for managing risks from long-term cc, which will be variable across regions and farming system types. Nonetheless, processes such as collaborative, participatory research that includes scientists and farmers, strengthening of communication systems for anticipating and responding to climate risks, and increased flexibility in livelihood options, which serve to strengthen coping strategies in agriculture for near-term risks from climate variability, provide potential pathways for strengthening adaptive capacities for cc.

## Africa, AR5/6

Of nine climate-related key regional risks identified for Africa, eight pose medium or higher risk even with highly adapted systems, while only one key risk assessed can be potentially reduced with high adaptation to below a medium risk level, for the end of the 21st century under 2° C global mean temperature increase above preindustrial levels (medium confidence). Key regional risks relating to:

shifts in biome distribution,

loss of coral reefs,

reduced crop productivity,

adverse effects on livestock,

vector- and water-borne diseases,

undernutrition, and

migration

are assessed as either medium or high for the present under current adaptation, reflecting Africa's existing adaptation deficit. The assessment of significant residual impacts in a 2 C world at the end of the 21<sup>st</sup> century suggests that, even under high levels of adaptation, there could be very high levels of risk for Africa. At a global mean temperature increase of 4 C, risks for Africa's food security (see key risks on livestock and crop production) are assessed as very high, with limited potential for risk reduction through adaptation.

## Africa, AR5/3

- Conservation agriculture provides a viable means for strengthening resilience in agro-ecosystems and livelihoods that also advance adaptation goals (high confidence). A wide array of conservation agriculture practices, including agroforestry and farmer-managed natural tree regeneration, conservation tillage, contouring and terracing, and mulching, are being increasingly adopted in Africa. These practices strengthen resilience of the land base to extreme events and broaden sources of livelihoods, both of which have strongly positive implications for climate risk management and adaptation. Moreover, conservation agriculture has direct adaptation-mitigation co-benefits. Addressing constraints to broader adoption of these practices, such as land tenure/usufruct stability, access to peer-to-peer learning, gender-oriented extension and credit and markets, as well as identification of perverse policy incentives, would help to enable larger scale transformation of agricultural landscapes.

## **Africa, AR5/4**

Africa's adaptation experiences highlight five common principles as lessons for the adaptation response, including principles for good practice and integrated approaches to adaptation (high confidence):

(1) supporting autonomous adaptation through a policy that recognizes the multiple-stressor nature of vulnerable livelihoods;

(2) increasing attention to the cultural, ethical, and rights considerations of adaptation by increasing the participation of women, youth, and poor and vulnerable people in adaptation policy and implementation;

(3) combining “soft path” options and flexible and iterative learning approaches with technological and infrastructural approaches and blending scientific, local, and indigenous knowledge when developing adaptation strategies;

(4) focusing on building resilience and implementing low-regrets adaptation with development synergies, in the face of future climate and socioeconomic uncertainties; and

(5) building adaptive management and social and institutional learning into adaptation processes at all levels.



## Africa, AR5/5

- Strengthened inter-linkages between adaptation and development pathways and a focus on building resilience would help to counter the current adaptation deficit and reduce future maladaptation risks (high confidence). Development strategies are currently not able to counter current climate risks, as highlighted by the impacts of recent extreme events; national policies that disregard cultural, traditional, and context-specific factors can act as barriers to local adaptation; and there is increased knowledge of maladaptation risks from narrowly conceived development interventions and sectoral adaptation strategies that decrease resilience in other sectors or ecosystems. Given multiple uncertainties in the African context, successful adaptation will depend on building resilience. Options for pro-poor adaptation/resilient livelihoods include improved social protection, social services, and safety nets; better water and land governance and tenure security over land and vital assets; enhanced water storage, water harvesting, and post-harvest services; strengthened civil society and greater involvement in planning; and more attention to urban and peri-urban areas heavily affected by migration of poor people.

## Africa, AR5/5

- Climate change and climate variability have the potential to exacerbate or multiply existing threats to human security including food, health, and economic insecurity, all being of particular concern for Africa (medium confidence). Many of these threats are known drivers of conflict (high confidence). Causality between climate change and violent conflict is difficult to establish owing to the presence of these and other interconnected causes, including country-specific sociopolitical, economic, and cultural factors. For example, the degradation of natural resources as a result of both overexploitation and climate change will contribute to increased conflicts over the distribution of these resources. Many of the interacting social, demographic, and economic drivers of observed urbanization and migration in Africa are sensitive to climate change impacts.

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## FAQ 22.1 | How could climate change impact food security in Africa?

Food security is composed of availability (is enough food produced?), access (can people get it and afford it?), utilization (how local conditions bear on people's nutritional uptake from food), and stability (is the supply and access ensured?). Strong consensus exists that climate change will have a significantly negative impact on all these aspects of food security in Africa.

Food availability could be threatened through direct climate impacts on crops and livestock from increased flooding, drought, shifts in the timing and amount of rainfall, and high temperatures, or indirectly through increased soil erosion from more frequent heavy storms or through increased pest and disease pressure on crops and livestock caused by warmer temperatures and other changes in climatic conditions. Food access could be threatened by climate change impacts on productivity in important cereal-producing regions of the world, which, along with other factors, could raise food prices and erode the ability of the poor in Africa to afford purchased food. Access is also threatened by extreme events that impair food transport and other food system infrastructure. Climate change could impact food utilization through increased disease burden that reduces the ability of the human body to absorb nutrients from food. Warmer and more humid conditions caused by climate change could impact food availability and utilization through increased risk of spoilage of fresh food and pest and pathogen damage to stored foods (cereals, pulses, tubers) that reduces both food availability and quality. Stability could be affected by changes in availability and access that are linked to climatic and other factors.

**Table 6-3 |** Information requirements for selected disaster risk management and adaptation to climate change activities. Adapted from Wilby (2009).

	Activities	Examples of information needs
<b>Cross-cutting</b>	Climate change modeling	Time series information on climate variables – air and sea surface temperatures, rainfall and precipitation measures, wind, air circulation patterns, and greenhouse gas levels
	Hazard zoning and ‘hot spot’ mapping	Georeferenced inventories of landslide, flood, drought, and cyclone occurrence and impacts at local, sub-national and national levels
	Human development indicators	Geospatial distribution of poverty, livelihood sources, access to water and sanitation
	Disbursement of relief payments	Household surveys of resource access, social well-being, and income levels
	Seasonal outlooks for preparedness planning	Seasonal climate forecasts; sea surface temperatures; remotely sensed and <i>in situ</i> measurements of snow cover/depth, soil moisture, and vegetation growth; rainfall-runoff; crop yields; epidemiology
	A system of risk indicators reflecting macro and financial health of nation, social and environmental risks, human vulnerability conditions, and strength of governance (Cardona et al., 2010)	<p>Macroeconomic and financial indicators (Disaster Deficit Index)</p> <p>Measures of social and environmental risks</p> <p>Measures of vulnerability conditions reflected by exposure in disaster-prone areas, socioeconomic fragility, and lack of social resilience in general</p> <p>Measures of organizational, development, and institutional strengths</p>
<b>Flood risk management</b>	Early warning systems for fluvial, glacial, and tidal hazards	Real-time meteorology and water-level telemetry; rainfall, stream flow, and storm surge; remotely sensed snow, ice, and lake areas; rainfall-runoff model and time series; probabilistic information on extreme wind velocities and storm surges
	Flooding hot spots, and structural and non-structural flood controls	Rainfall data, rainfall-runoff, stream flow, floods, and flood inundation maps Inventories of pumps, stream gauges, drainage and defense works; land use maps for hazard zoning; post-disaster plan; climate change allowances for structures; floodplain elevations
	Artificial draining of proglacial lakes	Satellite surveys of lake areas and glacier velocities; inventories of lake properties and infrastructure at risk; local hydro-meteorology
<b>Drought management</b>	Traditional rain and groundwater harvesting, and storage systems	Inventories of system properties including condition, reliable yield, economics, ownership; soil and geological maps of areas suitable for enhanced groundwater recharge; water quality monitoring; evidence of deep-well impacts
	Long-range reservoir inflow forecasts	Seasonal climate forecast model; sea surface temperatures; remotely sensed snow cover; <i>in situ</i> snow depths; multi-decadal rainfall-runoff series
	Water demand management and efficiency measures	Integrated climate and river basin water monitoring; data on existing systems’ water use efficiency; data on current and future demand metering and survey effectiveness of demand management