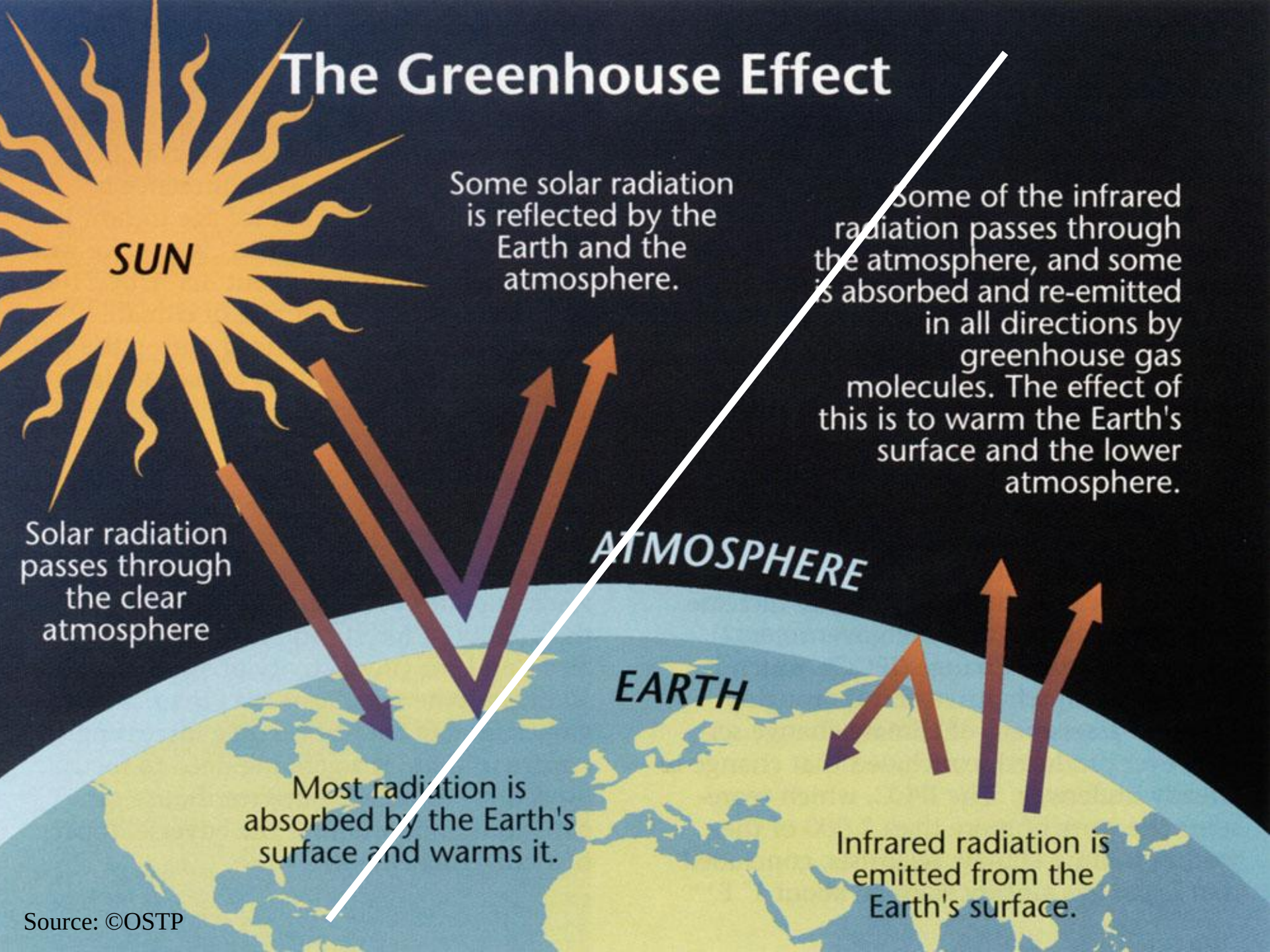
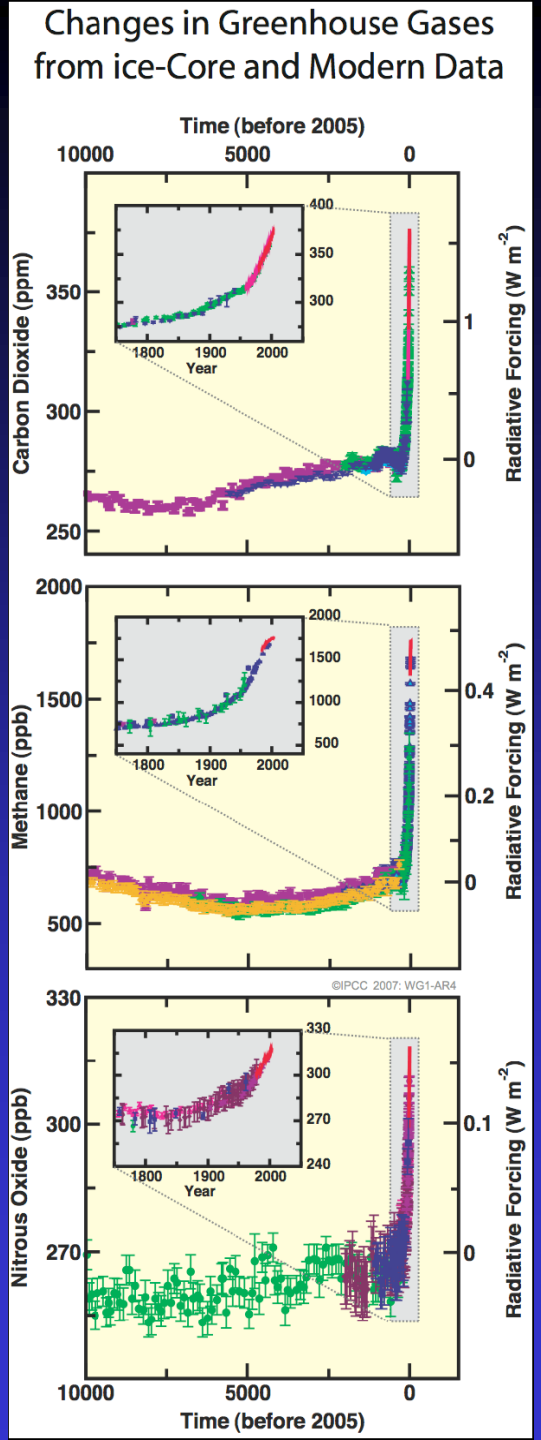
Climate Change Science, Vulnerability and Adaptation

Dr. Jeff Price, Managing Director
Climate Change Adaptation, WWF-US

Climate Change Basic Science


The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.

Source: ©OSTP



- Clear correlation between atmospheric CO_2, methane and temperature over last 750,000 years

- Current level of CO_2 is *outside* the bounds of natural variability

©IPCC 4AR

Why CO_2?

- The Earth's surface re-emits strongly in IR. This is why it is warmer at the surface than higher up.
- This IR can't escape to space because it is absorbed by CO_2 molecules in the atmosphere.
- Thus, the more CO_2, the more exiting IR is absorbed – and the more the temperature goes up.

Attribution

- are observed changes consistent with

☑expected responses to forcings

☒inconsistent with alternative explanations

Carbon dioxide is by far the largest contributor and those from fossil fuel use dominates

WMO

UNEP


YES, VIRGINIA, THERE IS GLOBAL WARMING!
NORTH POLE
KEVIN SIERS ©2000 THE CHARLOTTE OBSERVER

Direct Observations of Recent Climate Change

Global average air temperature

- Updated 100-year linear trend of 0.74 [0.56 to 0.92] ^{o}C for 1906-2005

- Larger than corresponding trend of 0.6 [0.4 to 0.8] ^{o}C for 1901-2000 given in TAR

Changes in Precipitation, Increased Drought

- Significantly increased precipitation in eastern parts of North and South America, northern Europe and northern and central Asia.
- The frequency of heavy precipitation events has increased over most land areas - consistent with warming and increases of atmospheric water vapour
- Drying in the Sahel, the Mediterranean, southern Africa and parts of southern Asia.
- More intense and longer droughts observed since the 1970s, particularly in the tropics and subtropics.

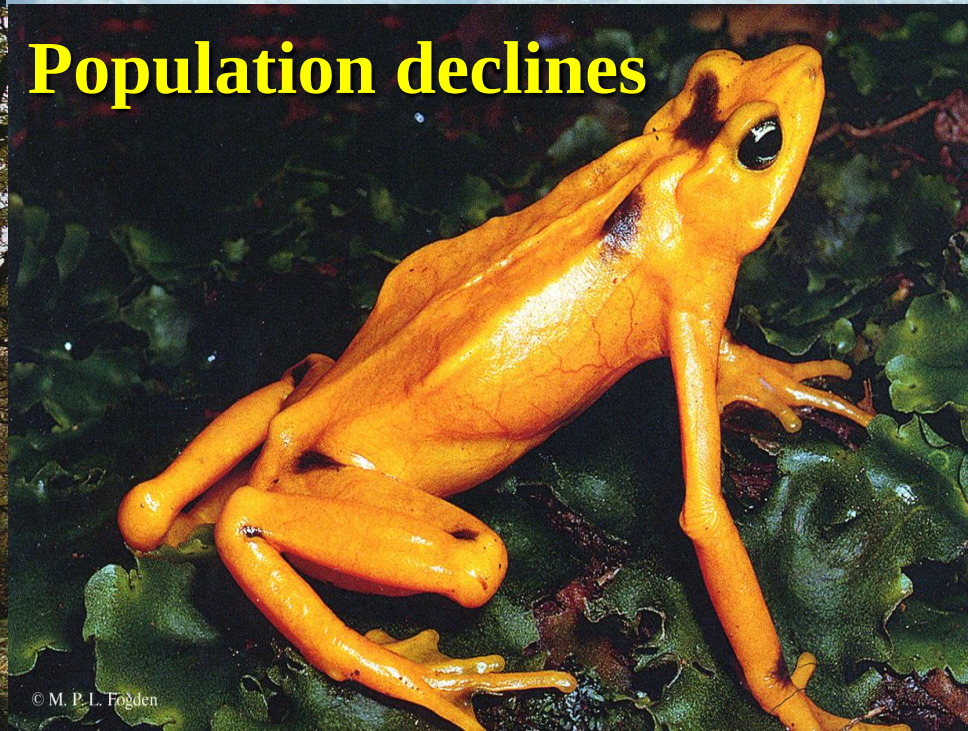
IPCC Key Finding of Working Group II

"Recent regional climate changes, particularly temperature increases, have already affected many physical and biological systems."


Melting sea ice
© PhotoLink


Changing penguin populations
© PhotoLink


Earlier spring leafing
© D. Broadbent

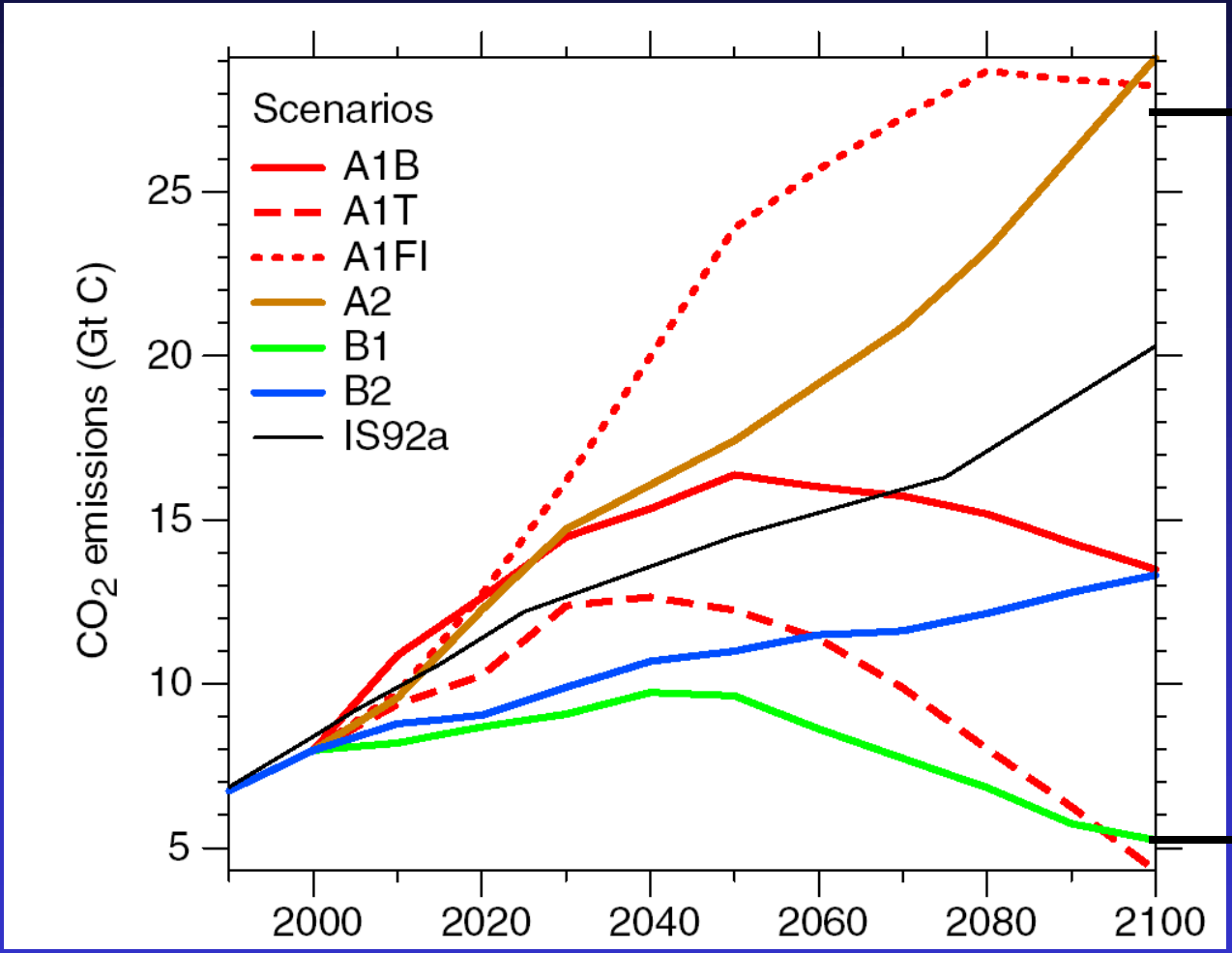

Population declines
© M. P. L. Fogden

Glacier mass balance

During the 20th century, glaciers and ice caps have experienced **widespread mass losses** and have contributed to **sea level rise**

Further **decline of mountain glaciers** projected to **reduce water availability** in many regions

What will be our future emissions?



Source:© Intergovernmental Panel on Climate Change

Projections of Future Changes in Climate

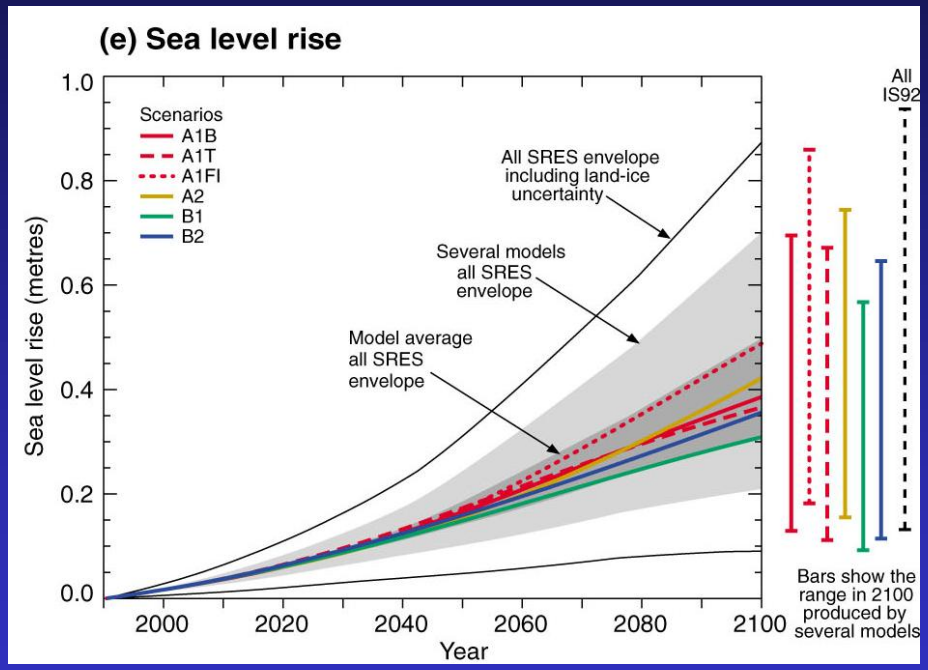
Best estimate for low scenario (B1) is 1.8 C (*likely* range is 1.1 C to 2.9 C), and for high scenario (A1FI) is 4.0 C (*likely* range is 2.4 C to 6.4 C).

Broadly consistent with span quoted for SRES in TAR, but not directly comparable

Precipitation Projections

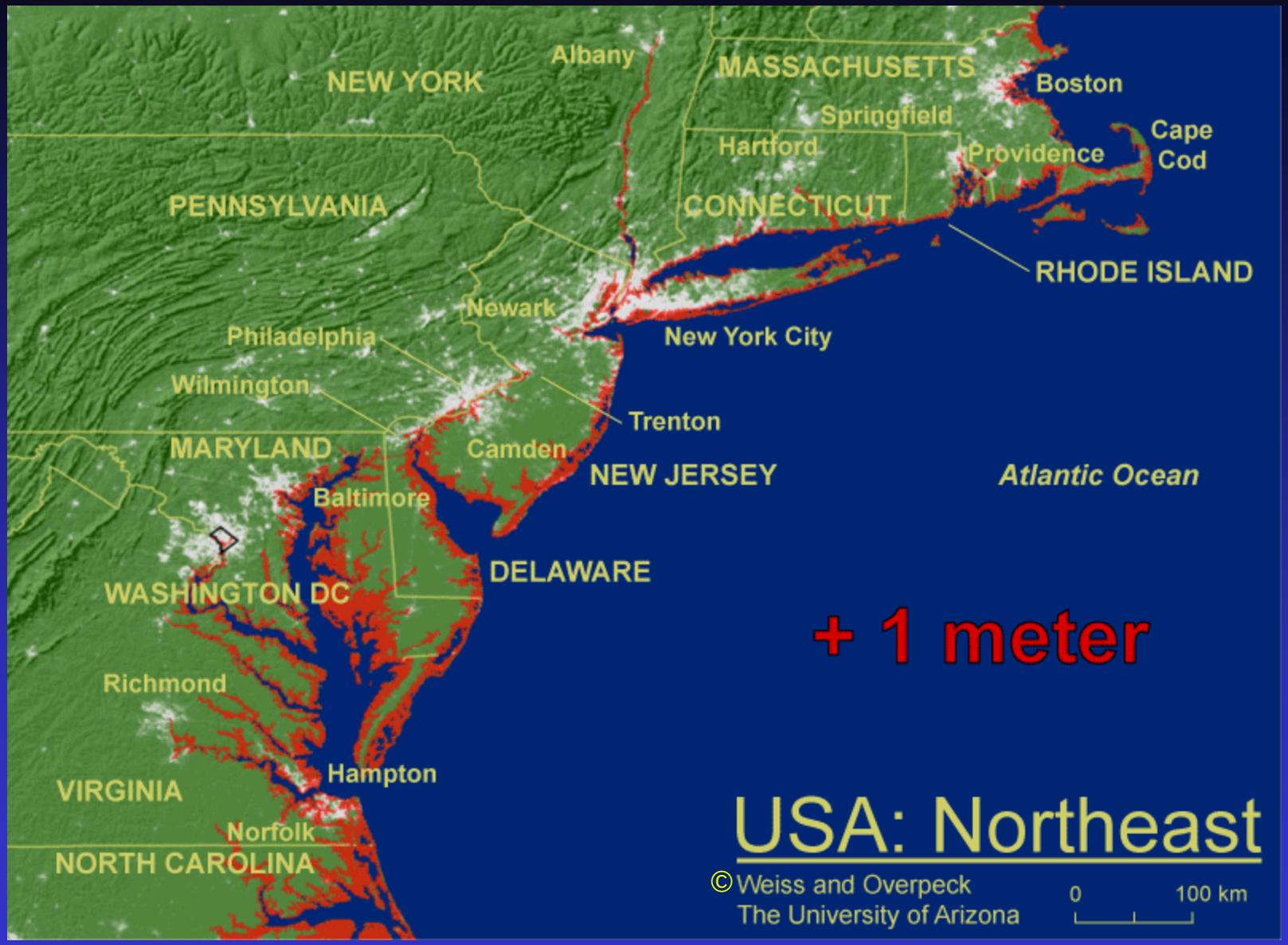
- Global average water vapor and global mean precipitation will increase
- Larger year to year variations in precipitation
- Timing of precipitation may change

Sea-Level Rise Projections

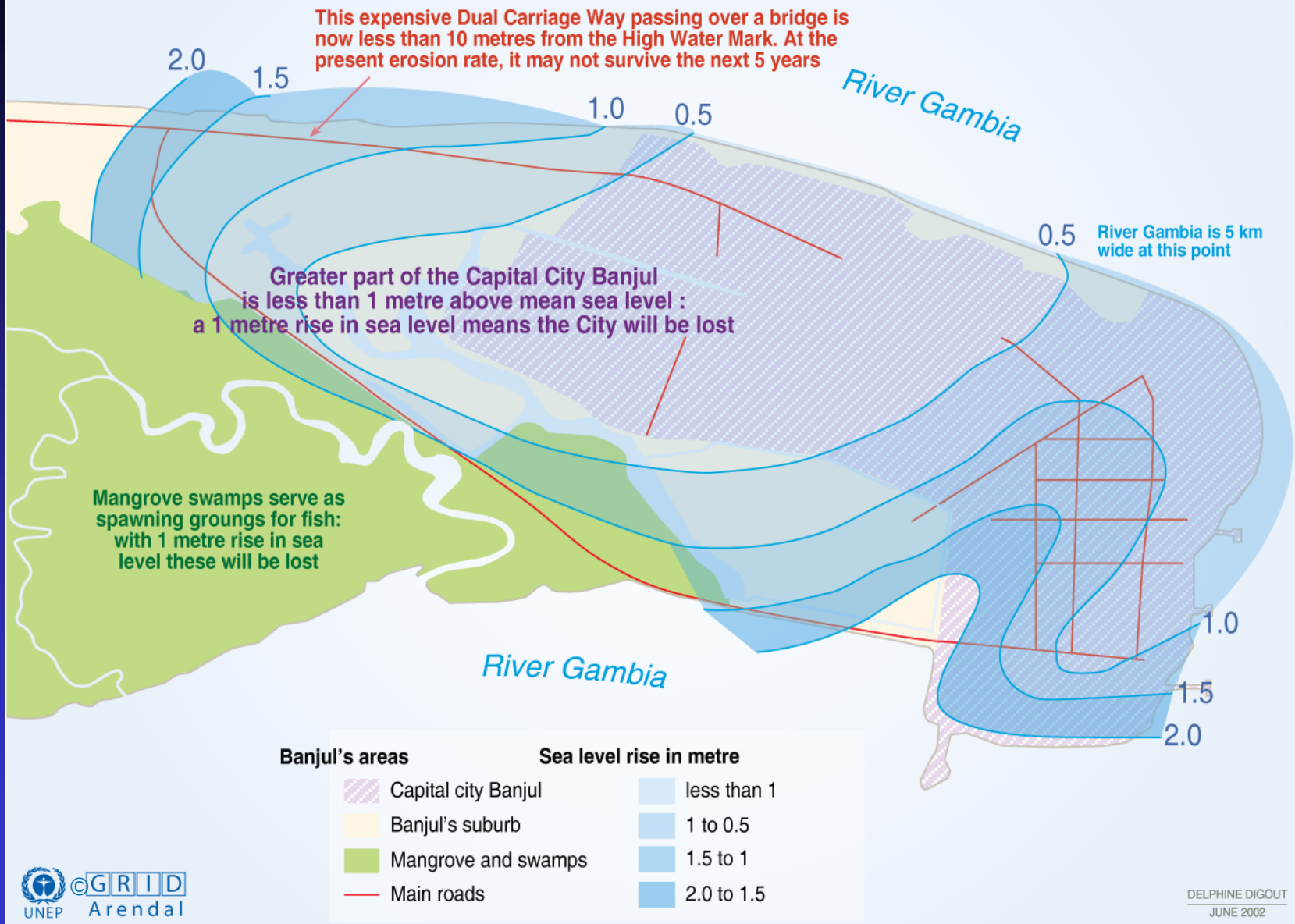


Source: ©IPCC TAR 2001/UCS

- Global average sea level is projected to rise by 10 to 90 cm between 1990 and 2100 (new estimates 0.75-1.5 m)
- Global average sea level has risen between 10–20 cm over the 20th century
- Sea level will continue to rise for hundreds of years after stabilization of greenhouse gas concentrations


NEW YORK
Albany
MASSACHUSETTS
Boston
Springfield
Hartford
Providence
Cape Cod
CONNECTICUT
PENNSYLVANIA
RHODE ISLAND
Newark
New York City
Philadelphia
Wilmington
Trenton
MARYLAND
Camden
NEW JERSEY
Atlantic Ocean
Baltimore
DELAWARE
WASHINGTON DC
+ 1 meter
Richmond
Hampton
VIRGINIA
Norfolk
NORTH CAROLINA
USA: Northeast
© Weiss and Overpeck
The University of Arizona
0
100 km

Impact of Sea Level Rise in Banjul, Gambia



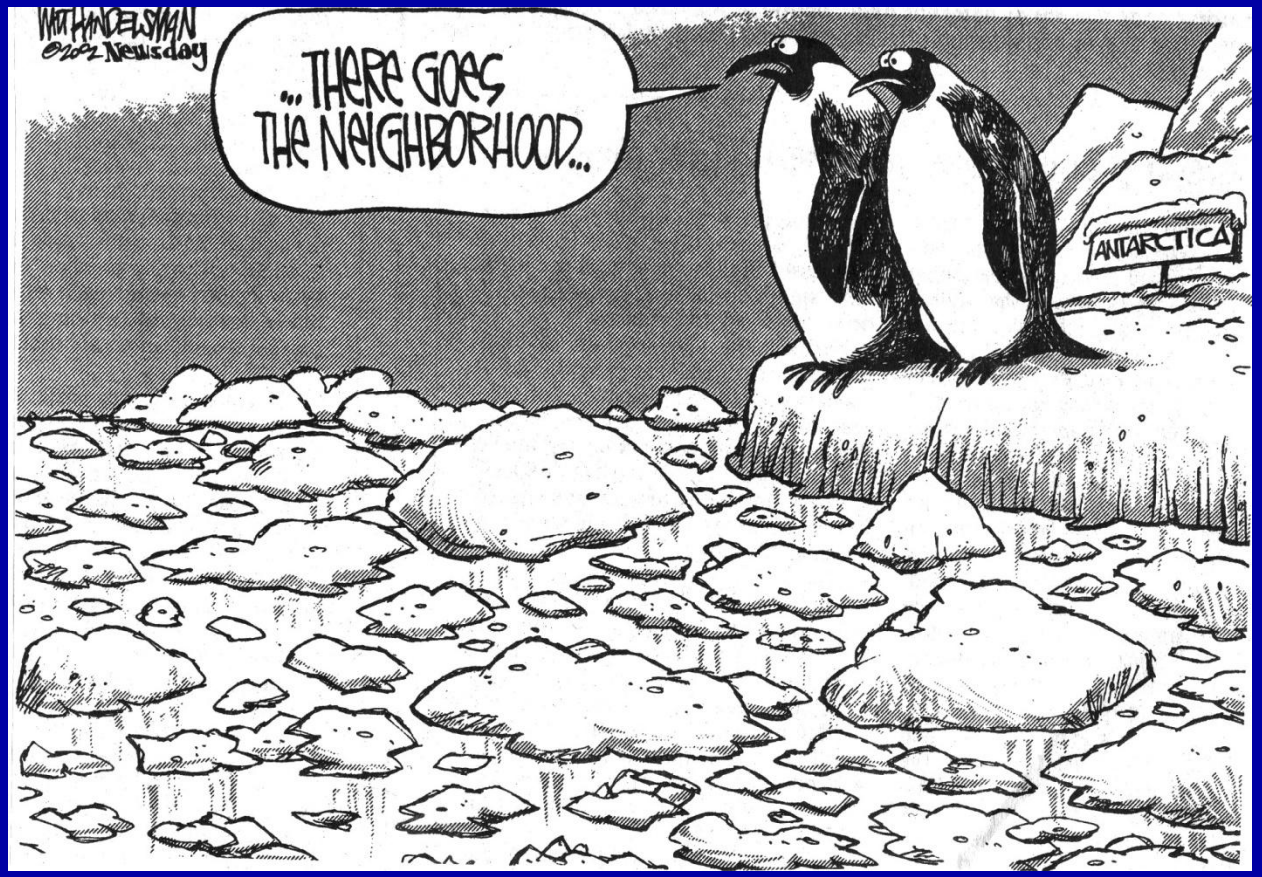
UNEP ©GRID Arendal

DELPHINE DIGOUT
JUNE 2002

Sources: *Coastal Zone of the Gambia and th Abidjan region in Cote d'Ivoire: Sea Level Rise Vulnerability, Response Strategies, and Adaptation Option, National Assessment Results of Climate Change: Impacts and Responses,* Jallow, B.P., S. Toure, M.M.K. Barrow, and A.A. Mathieu, Mimura, N., Oldendorf Luhe, Inter-Research, Germany, 1999.

Coastal settlements most at risk

Climate Change: Avoiding Damages



Note that aerosols offset approximately 100 CO_2e

Projections for 1°C above pre-industrial: what seems inevitable at this point

- Major loss of coral reefs (bleaching)
- Dangerous floods in Himalayas
- Extinctions in cloud forests
- Increased malaria & dengue

+18-60 m.a.r. hunger

~10% crop yield loss Africa

+300-1600 m.a.r. increased water stress

Source: Dr. Rachel Warren, Tyndall Centre

Impacts projected for 2°C above pre-industrial (400-450 ppm)

- Agricultural yields begin to fall
- Vector borne disease expands poleward
- 1 to 2.8 billion increased water stress
- 12-26 million displaced from coasts
- Up to 200 m.a.r. hunger

Source: Dr. Rachel Warren, Tyndall Centre

Impacts projected for 2°C above pre-industrial (400-450 ppm)

- Suitable climates of 25% of eucalypts exceeded
- 80% loss Karoo, S Africa endangering 2800 plants
- Risk of extinctions accelerates
- Major loss of coral reef ecosystems

Source: Dr. Rachel Warren/IPCC 4AR

Impacts projected for 2-3°C above pre-industrial (450-550 ppm)

- Large loss forest & grassland over globe
- Amazon rainforest begins to dry
- Vegetation becoming a carbon SOURCE
- African crop failures of 75%

Source: Dr. Rachel Warren, Tyndall Centre

Impacts projected for 3°C above pre-industrial (550 ppm)

- up to 400 million hunger, 75% Africa
- 25-40 million displaced coasts
- 1.2-3 billion water stress
- 18% increase in seasonal and perennial malaria transmission zones (200-300 mar)

Source: Dr. Rachel Warren, Tyndall Centre

Impacts projected for 3°C above pre-industrial (550 ppm)

- Few ecosystems can adapt
- Large % species at risk of extinction globally
- 50% nature reserves can no longer fulfil objectives
- 7 to 74% ecosystems transforming

Source: Dr. Rachel Warren/IPCC 4AR

Beyond adaptation

- **Adaptation to climate change is necessary** to address impacts resulting from the warming which is already unavoidable due to past emissions
- However:
  - Adaptation alone cannot cope with all the projected impacts of climate change
  - The costs of adaptation and impacts will increase as global temperatures increase
- Targets are critical to know how much adaptation is needed

Making development more sustainable can enhance both mitigative and adaptive capacity, and reduce emissions and vulnerability to climate change

Are there limits to how much we can adapt? …physical, behavioural and technological limits

- **Physical limits:** there are physical limits to potential adaptation on small low lying islands e.g. Cayman Islands

- **Behavioural limits:** there are behavioural constraints that influence where we live and why, e.g. New Orleans

- **Technological limits:** there are technological limits to the flood defences that can be constructed, e.g. Thames Barrier, London

Definitions

KEEP IT SIMPLE…

Keeping it simple…

Vulnerability: the potential to be harmed

Adaptation: adjustments to reduce vulnerability

Impacts: the manifestation of vulnerability

ADAPTATION INVOLVES…

(recent perspective)

~~adjusting to slow, gradual changes in climate and sea level, by…~~

reducing the **incremental risks** from climatic hazards (e.g. cyclones, droughts, floods) due to climate and sea-level change

~~adopting discrete measures to reduce impacts (e.g. chnge crop type), through…~~

a **dynamic process** that includes awareness raising, capacity building, mainstreaming into policies and plans, monitoring, risk assessment and knowledge acquisition.

~~providing external assessments of impacts and "shopping lists" of options for reducing them~~

internalising adaptation within governments, communities and development agencies (e.g. ADB, World Bank) in order to ***climate-proof*** **development** projects over time

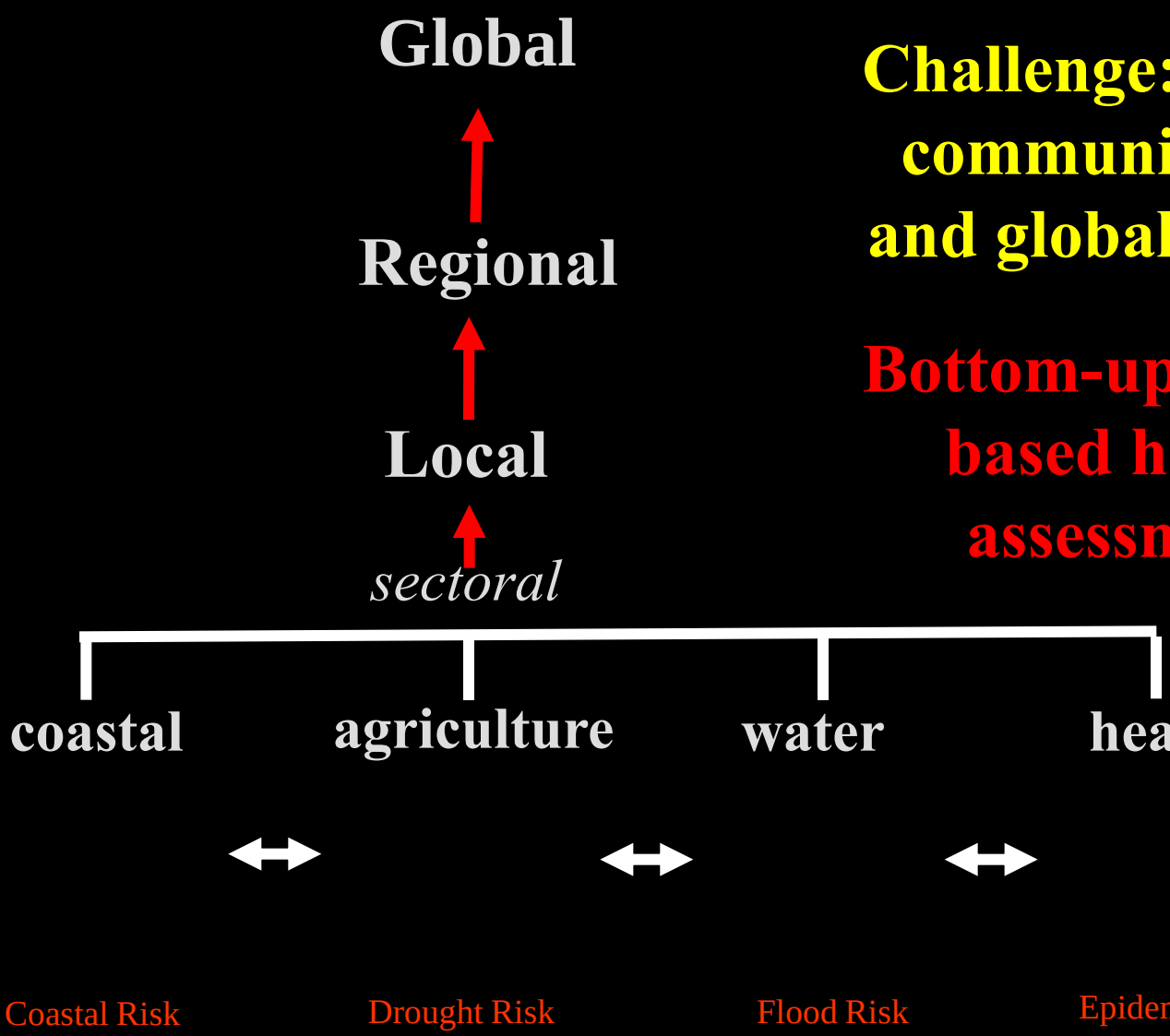
- approaches to assessment -

Conventional Top-Down Climate Impact Assessments

- approaches to assessment -

Conventional Top-Down Climate Impact Assessments

- approaches to assessment -



Challenge: Link community risk and global change

Bottom-up, risk-based hazard assessments

In other words, linking…

Climate and sea-level change

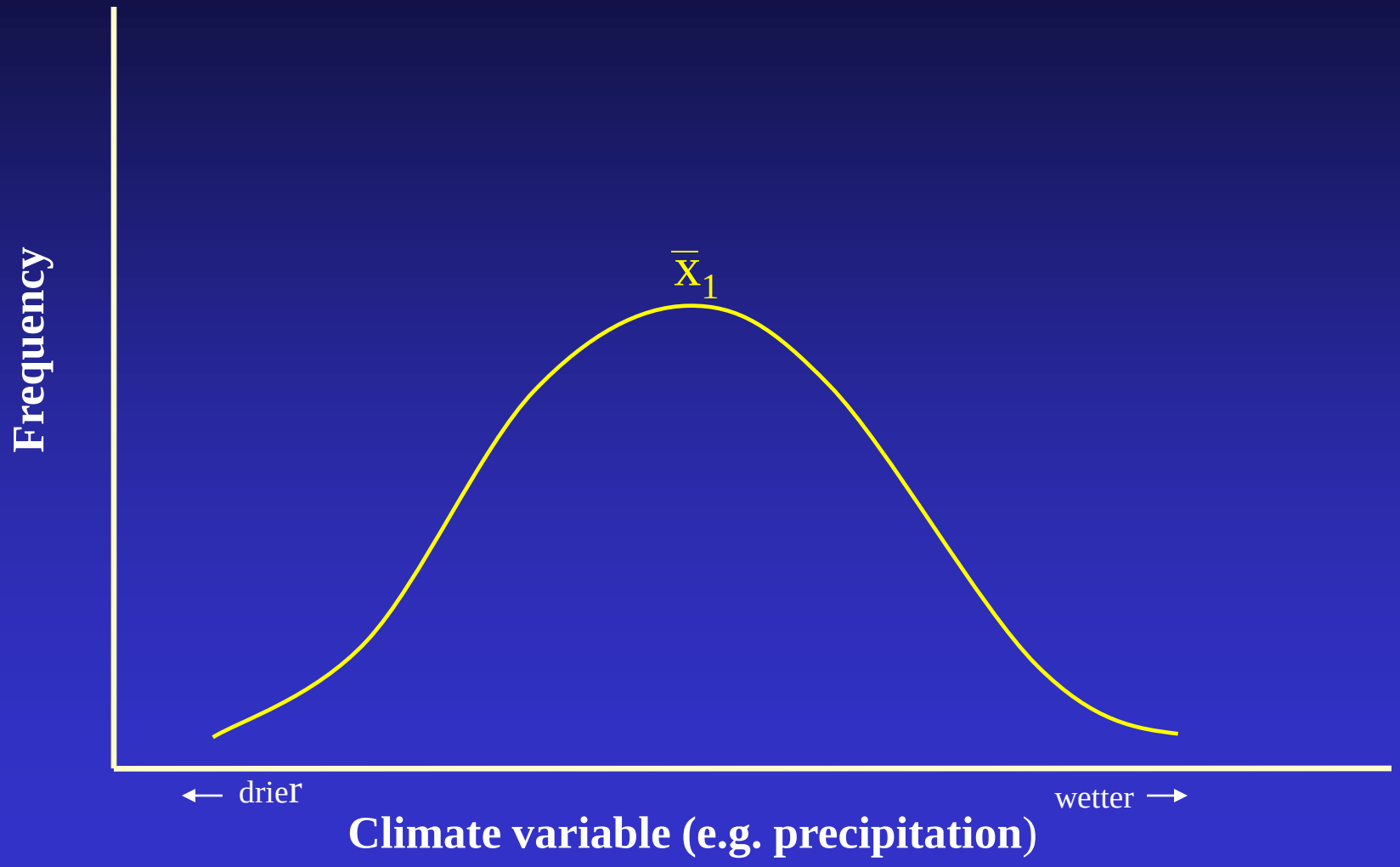
+

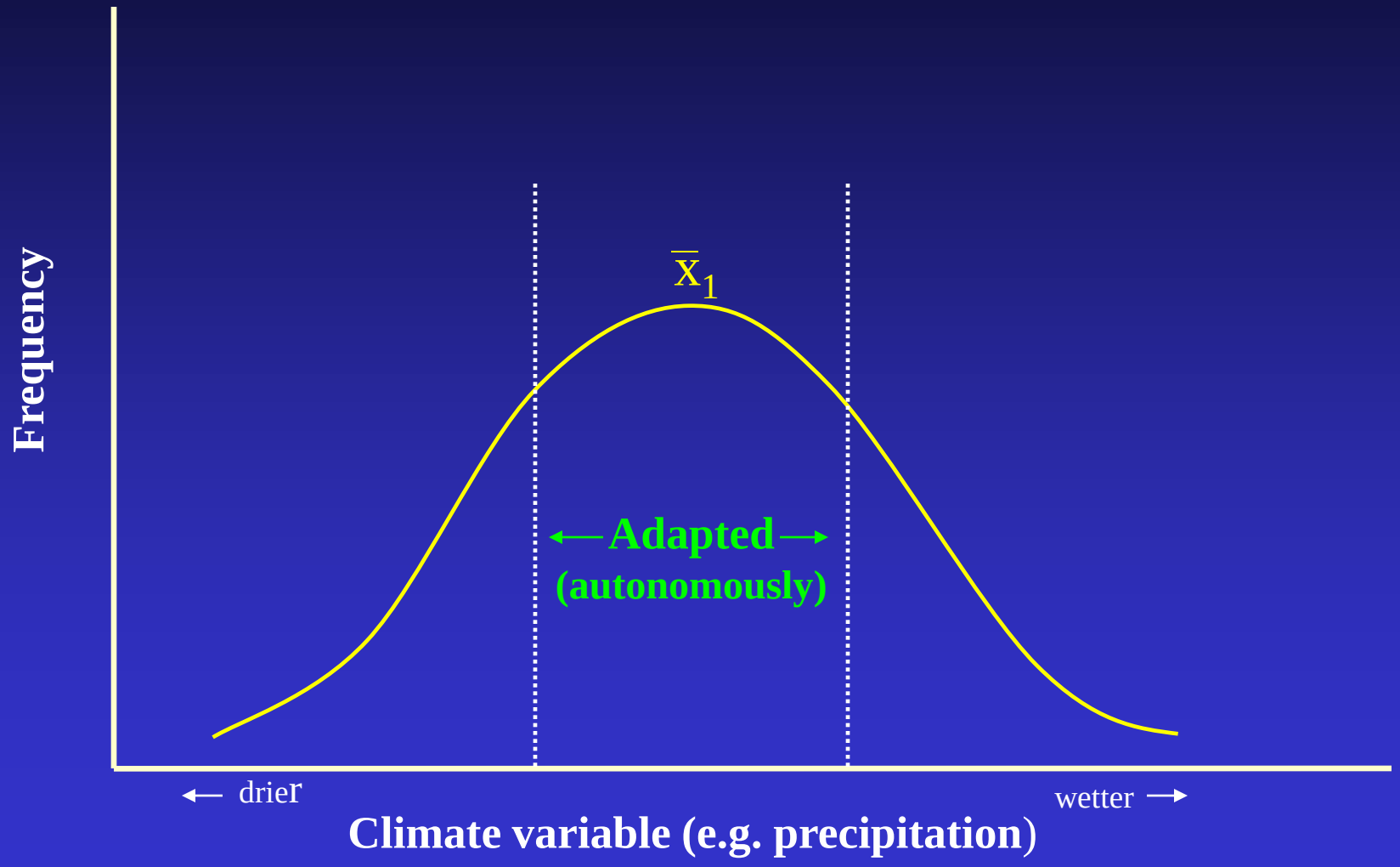
Hazard reduction and risk management

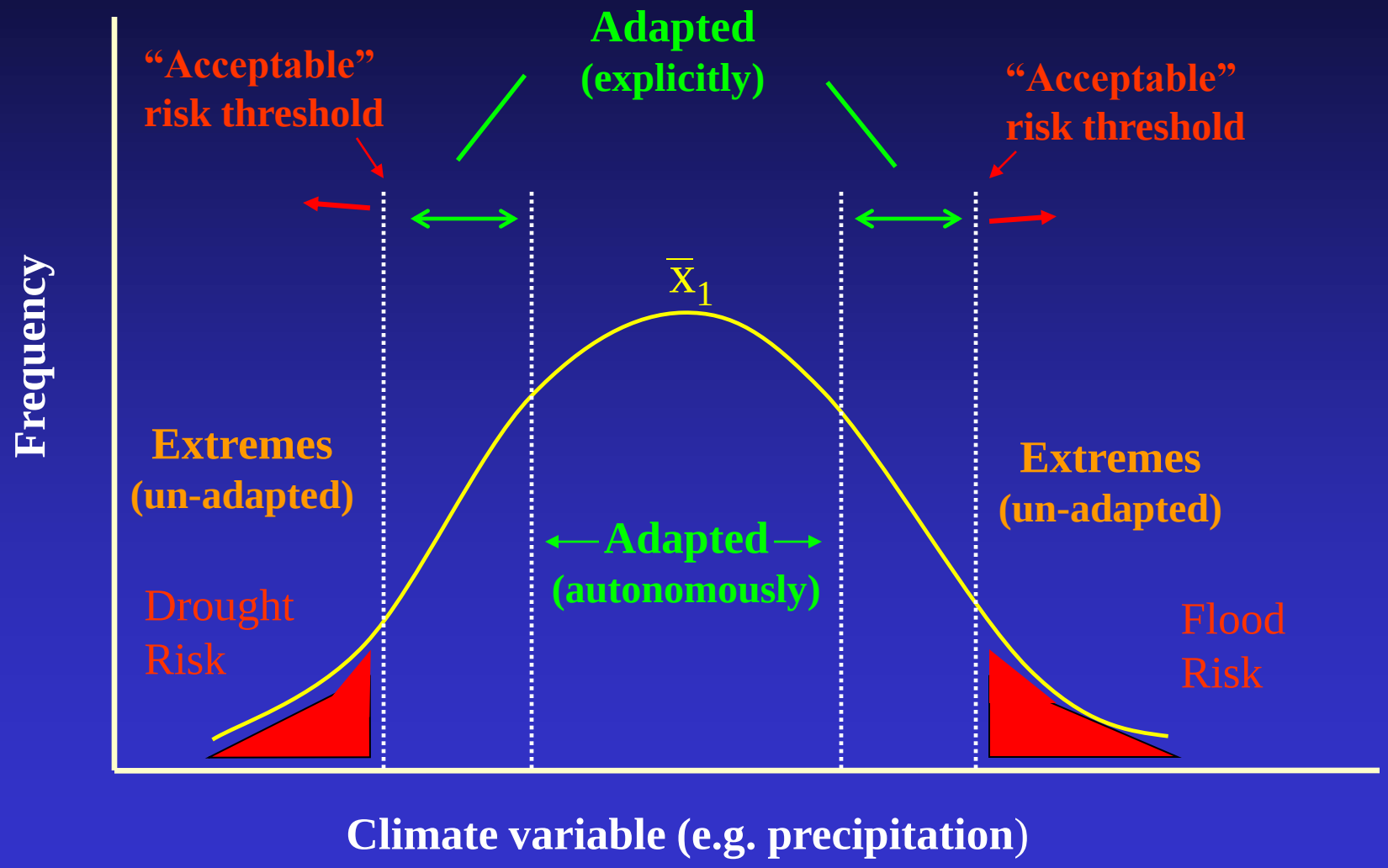
+

Sustainable development

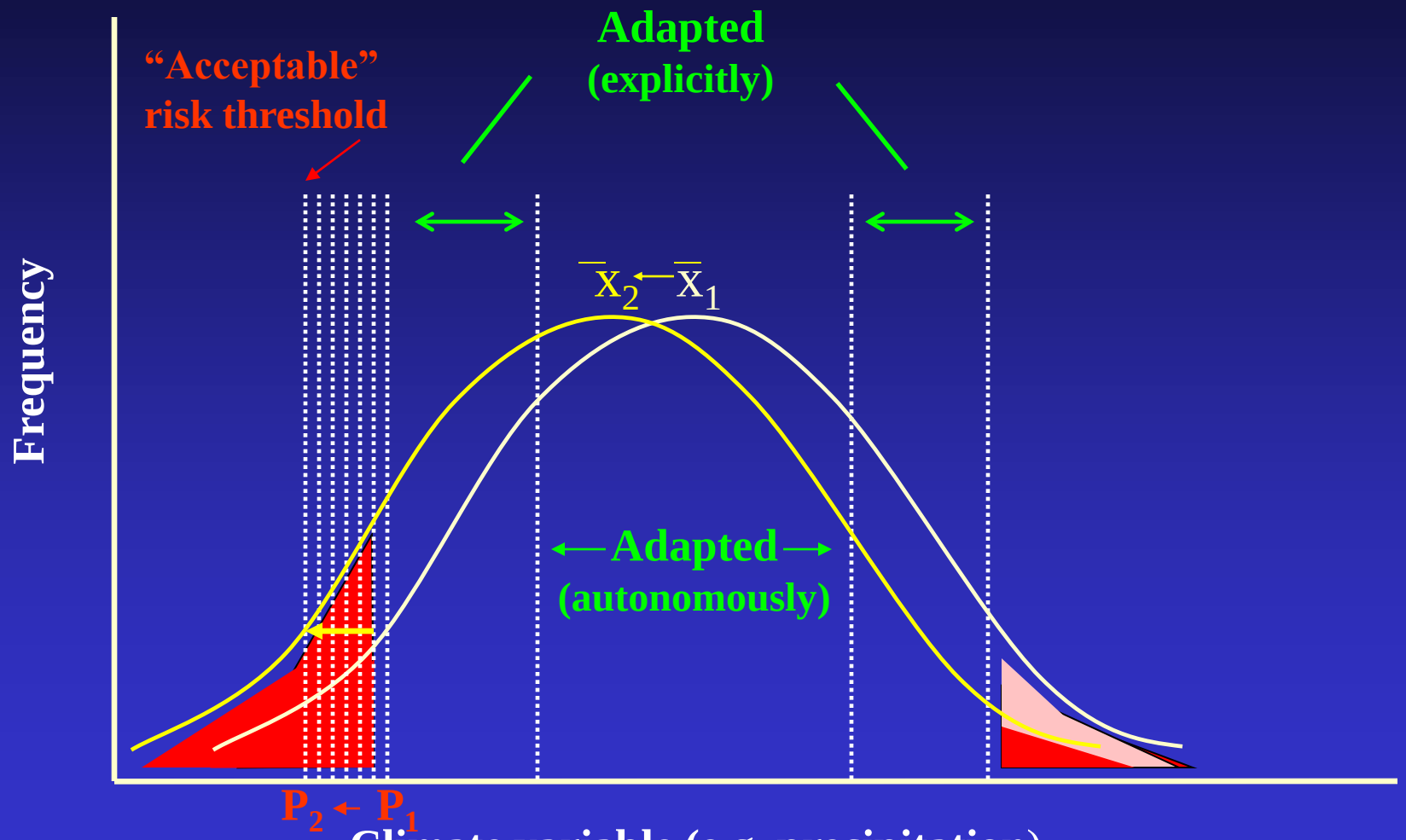
Adaptation to climate change is, in large part, a continuous ***process*** that involves the adjustment of society to ***risks*** arising from climatic extremes


Frequency
$\overline{x}_1$
drier
wetter
Climate variable (e.g. precipitation)

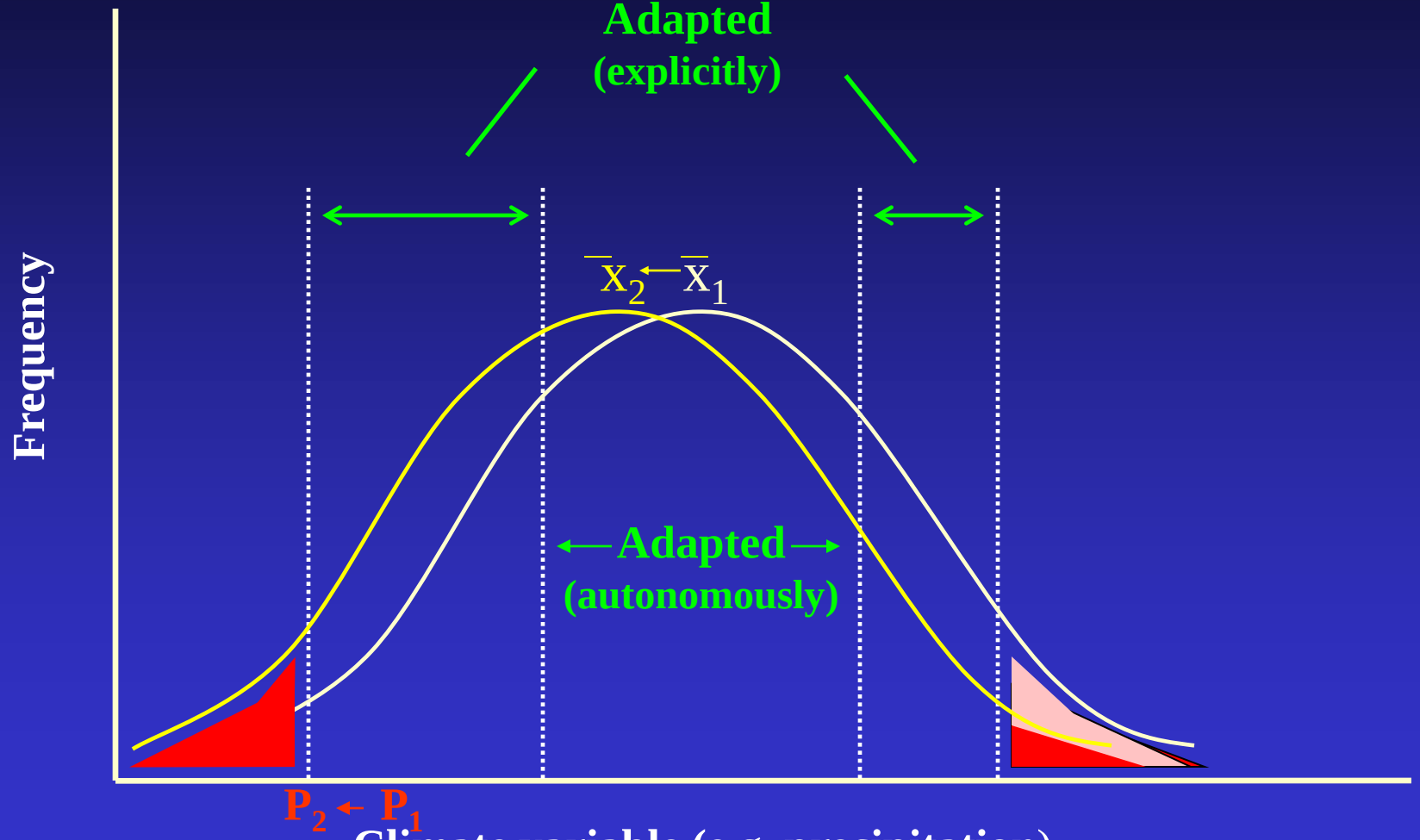

Frequency
$\overline{x}_1$
Adapted
(autonomously)
drier
wetter
Climate variable (e.g. precipitation)


"Acceptable" risk threshold
Adapted (explicitly)
"Acceptable" risk threshold
$\overline{X}_1$
Frequency
Extremes (un-adapted)
Adapted (autonomously)
Extremes (un-adapted)
Drought Risk
Flood Risk
Climate variable (e.g. precipitation)

Climate Change



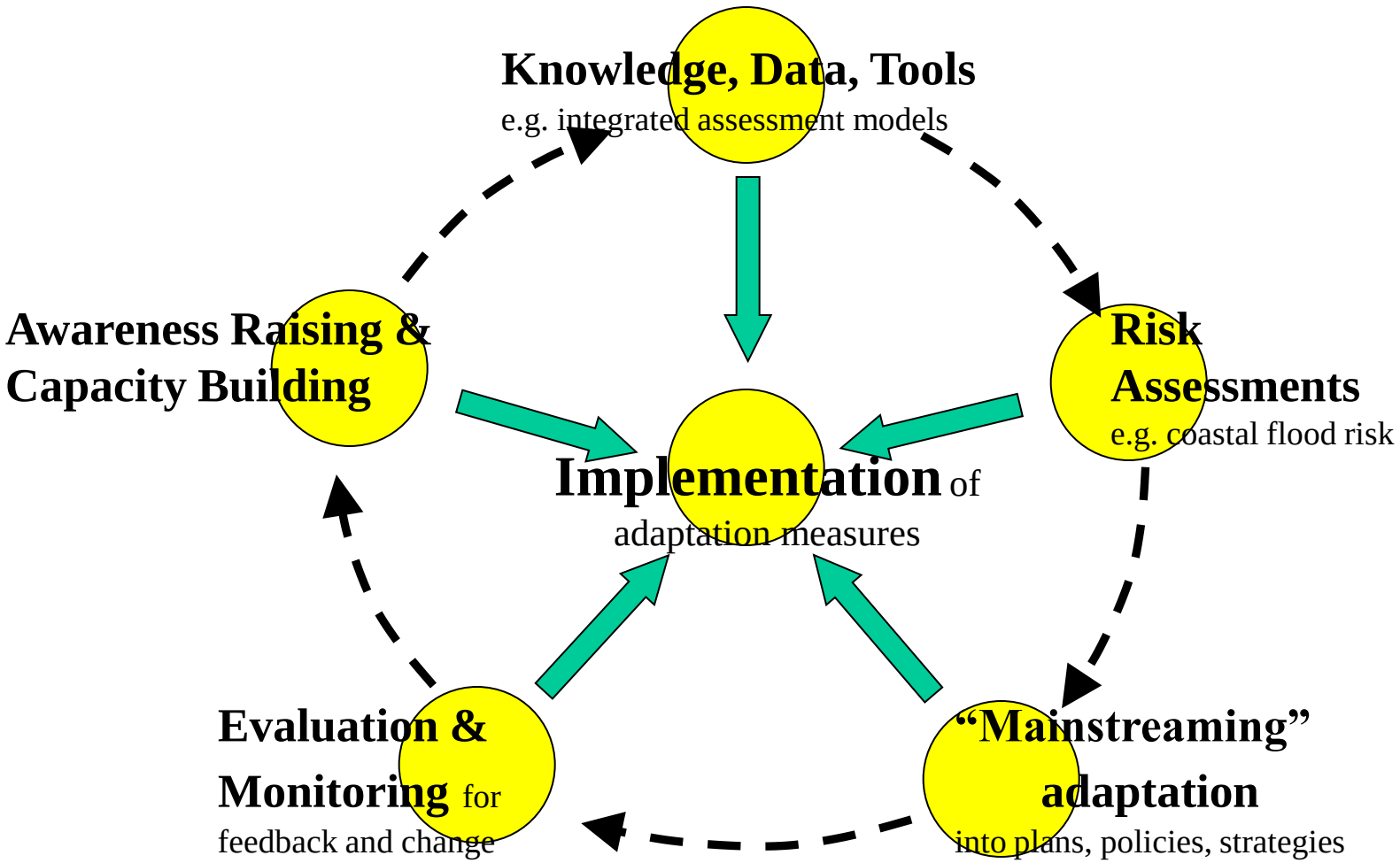
Adapted to Climate Change



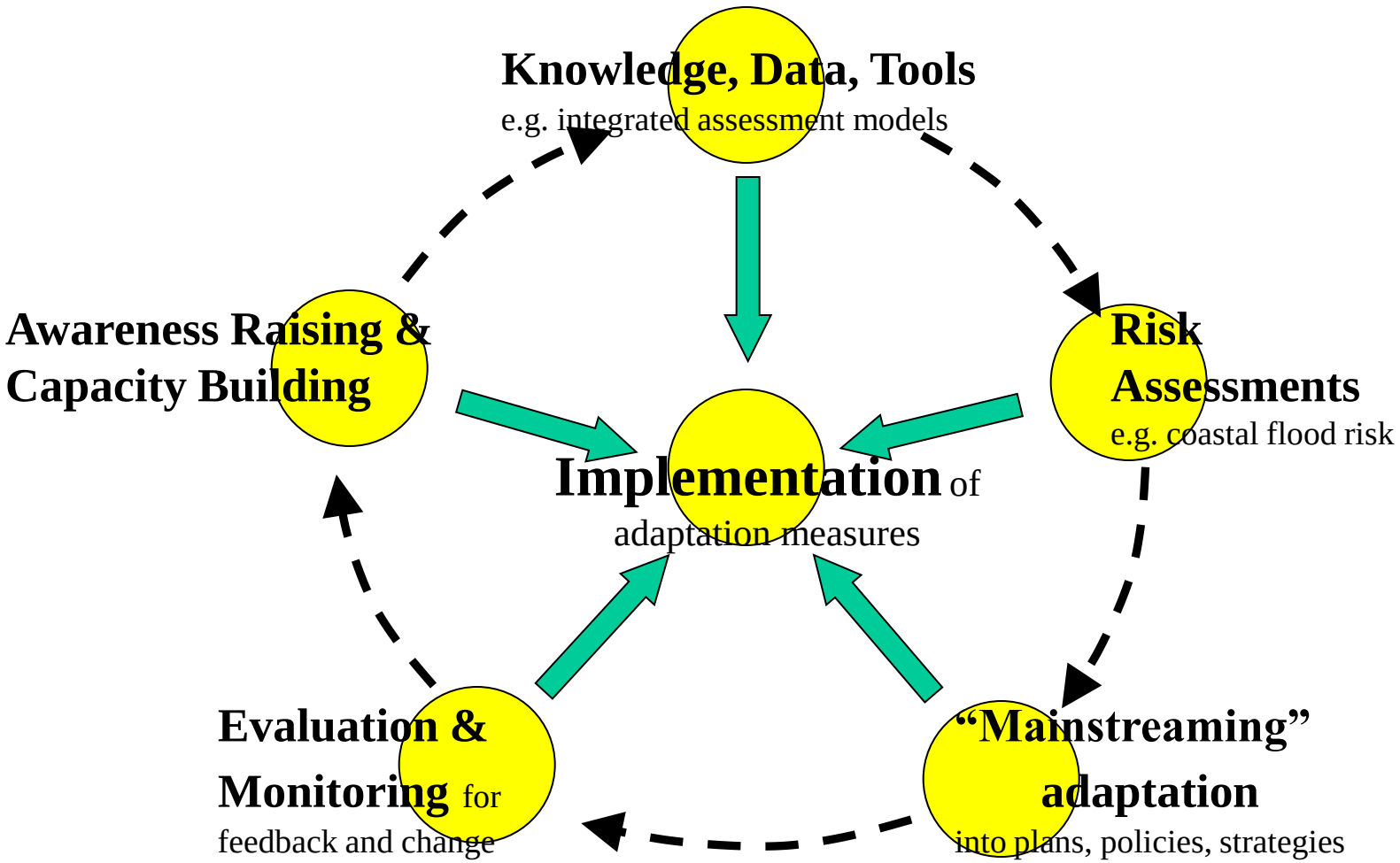
Adaptation as:

- discrete ***measures*** or actions
- the ***capacity*** to adapt
- an evolving, dynamic ***process***

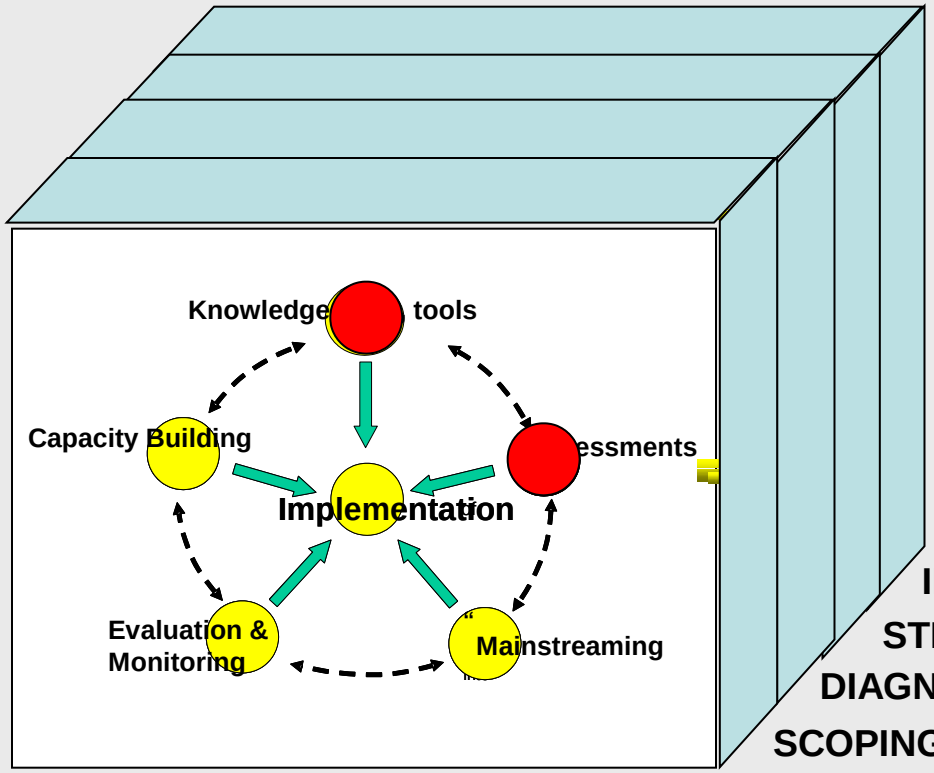
Adaptation as a Process



Promoting Adaptation as a Process:
Climate Change Adaptation through Integrated Risk Reduction (CCAIRR)



Stages in Implementing CCAIRR



IMPLEMENTATION – Promoting adaptation

STRATEGY – How can impediments be overcome?

DIAGNOSIS – What are the barriers and gaps?

SCOPING – What is the current situation and capacity?

Climascope

- ***Projections of potential future local/regional climate changes (including uncertainty)***
- ***Projections of potential future climate impacts***
  - ***Water Stress – droughts/floods***
  - ***Coastal – sea-level rise, erosion***
  - ***Ecosystems – extinction risks, refugia, shifts***
  - ***Agriculture – crop climate suitability***
  - ***Health –disease vectors, other***
- ***Across a range of emission scenarios and socioeconomic futures***

Wallace Initiative

- ***Mapping refugia, species range shifts and migratory pathways***
- ***For tens of thousands of species***
- ***For wild crop types***
- ***For commercial marine species (fish and invertebrates), including yield***

ELAN

- ***Enabling biodiversity and human communities in vulnerable landscapes to adapt to a changing climate by building resilience and adaptive capacity***
  - Knowledge management and exchange (ALPs)
  - Support impact, adaptation and vulnerability assessments and develop core science on ecosystem-based adaptation
  - Improve adaptation policy
  - Facilitate ecosystem-based adaptation practice in landscapes where ecosystems and people are most vulnerable to climate change

WWF

IUCN

-- Summary and Conclusions --

How can we best promote climate change adaptation?

- by focusing on **risk reduction**
- by including the **incremental risks** from future climate change into current efforts to manage hazards
- by considering adaptation as an evolving **dynamic process**
- by making adaptation an integral part of **sustainable development**
- by integrating **science and stakeholders**