The state and prospects of water resources in South East Asia: a case for a new sustainability approach?

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Monsoon Asia….

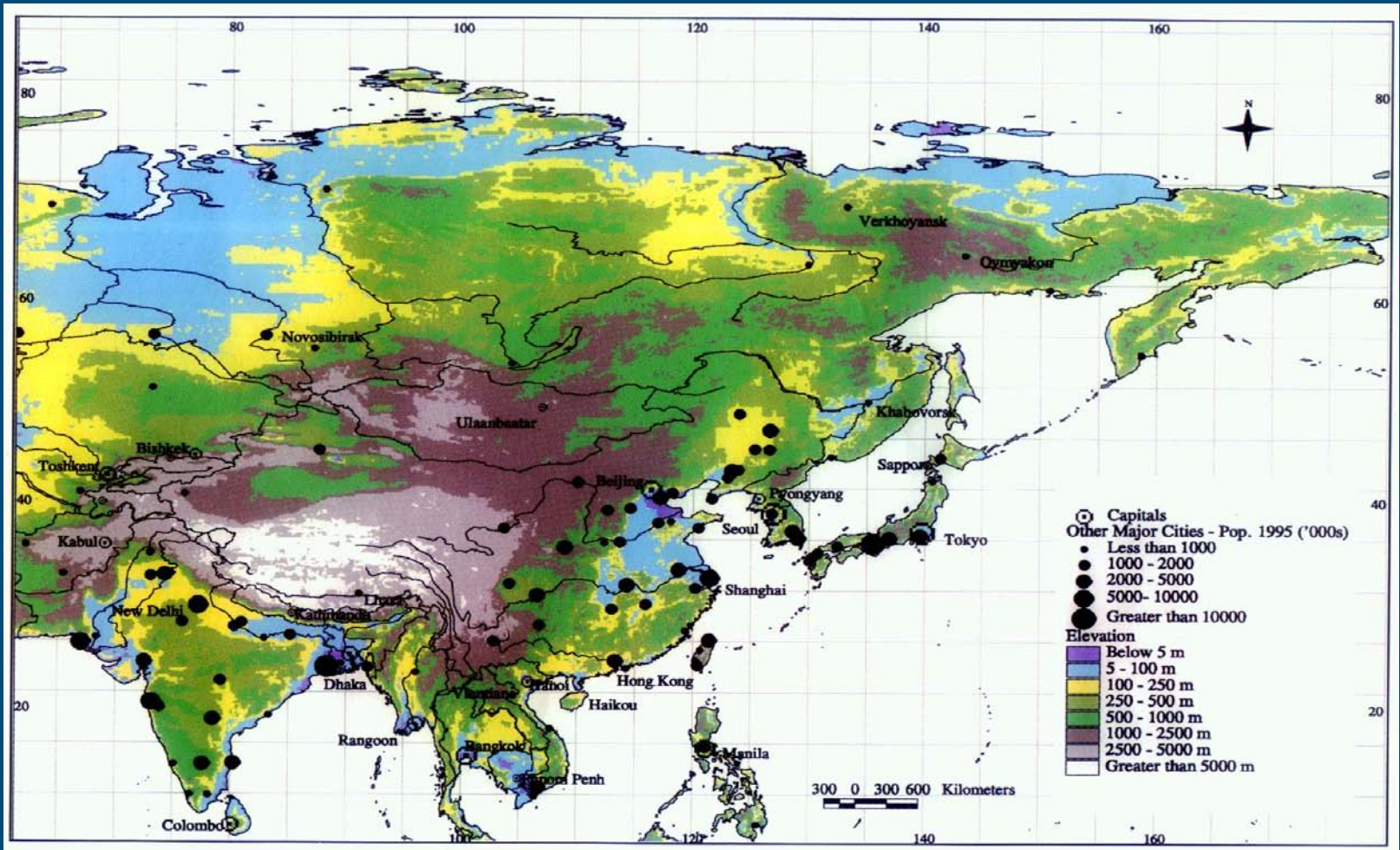


Figure 10-1: The Temperate Asia region (courtesy of David Gray/The World Bank).

Monsoon Asia:

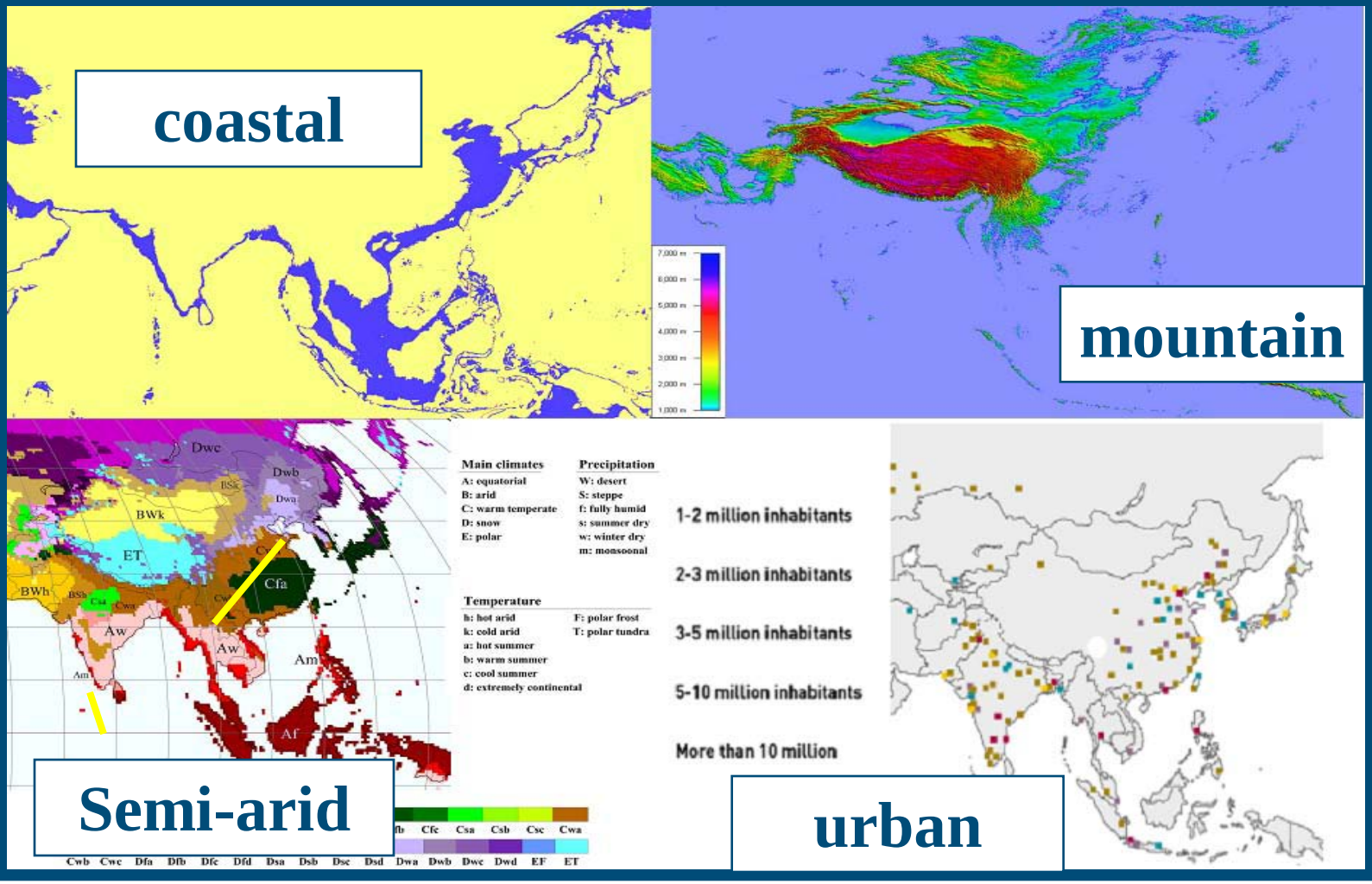
One of the most active human development regions

- Long history of civilization: more than 5000 years
- 57% of world population (2005)
- Most rapid development in last decades
- Continuous development in 21st century

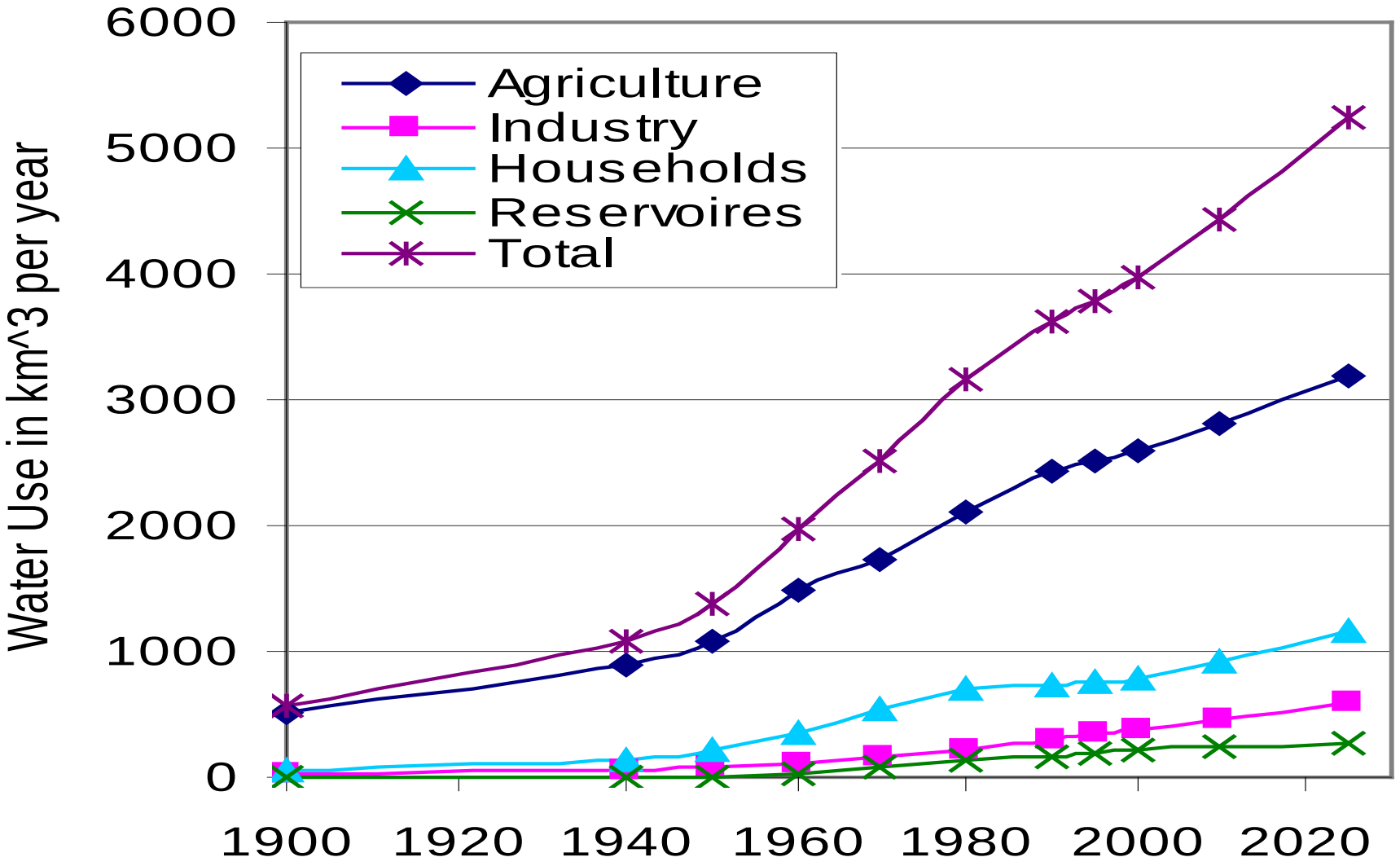
Monsoon Asia….

- Most rapidly industrializing & urbanizing part of the world
- GHG emissions to double in next 20 years, Asia will exceed OECD emission by 2025
- Asian cities are the “dirtiest” in world, 2x world average in pollutants

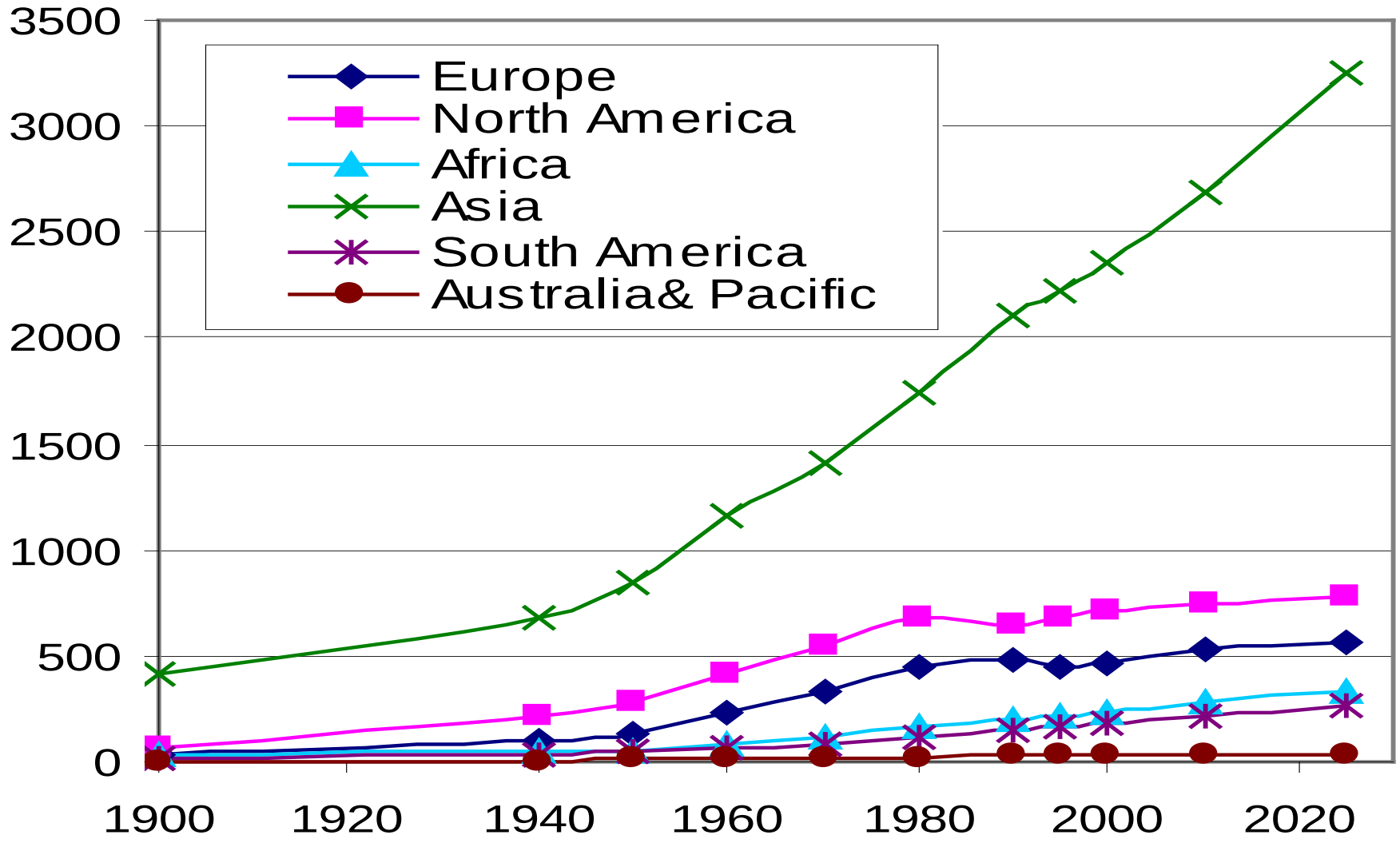
4 critical zones in monsoon Asia



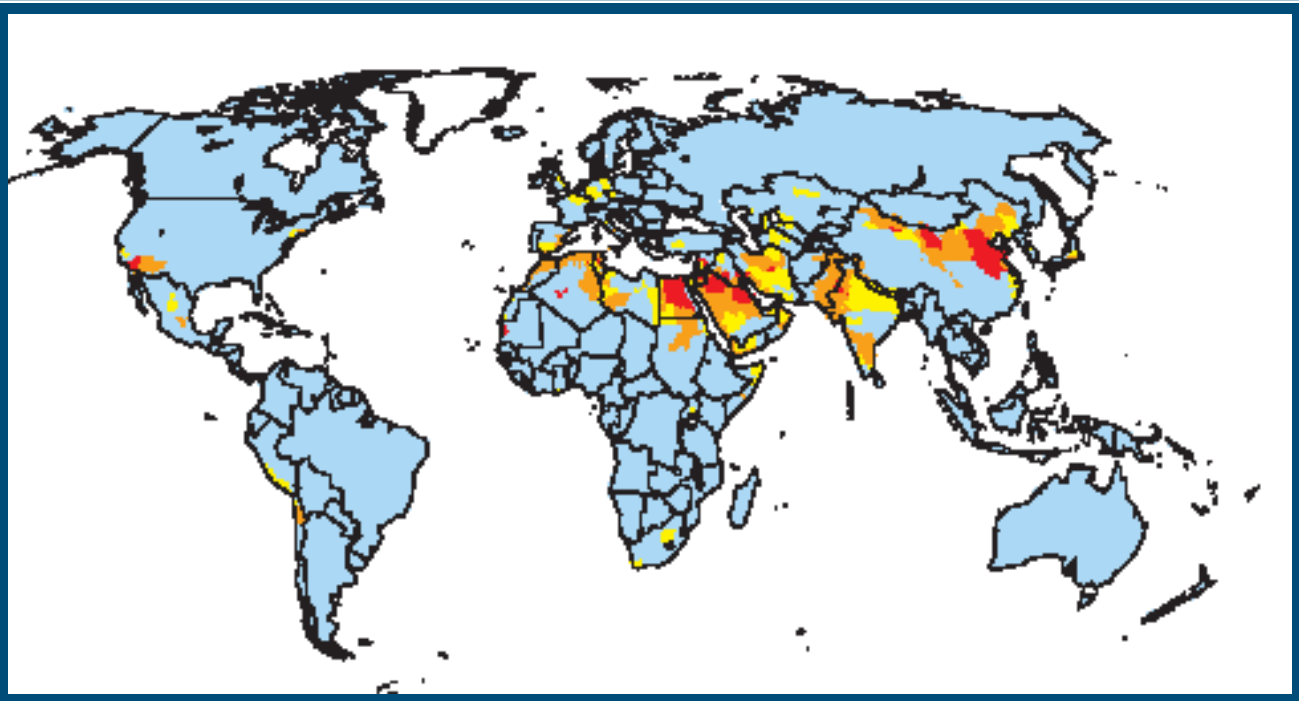
Worldwide Water Use by Sector



Worldwide Water Use by Region



The current situation



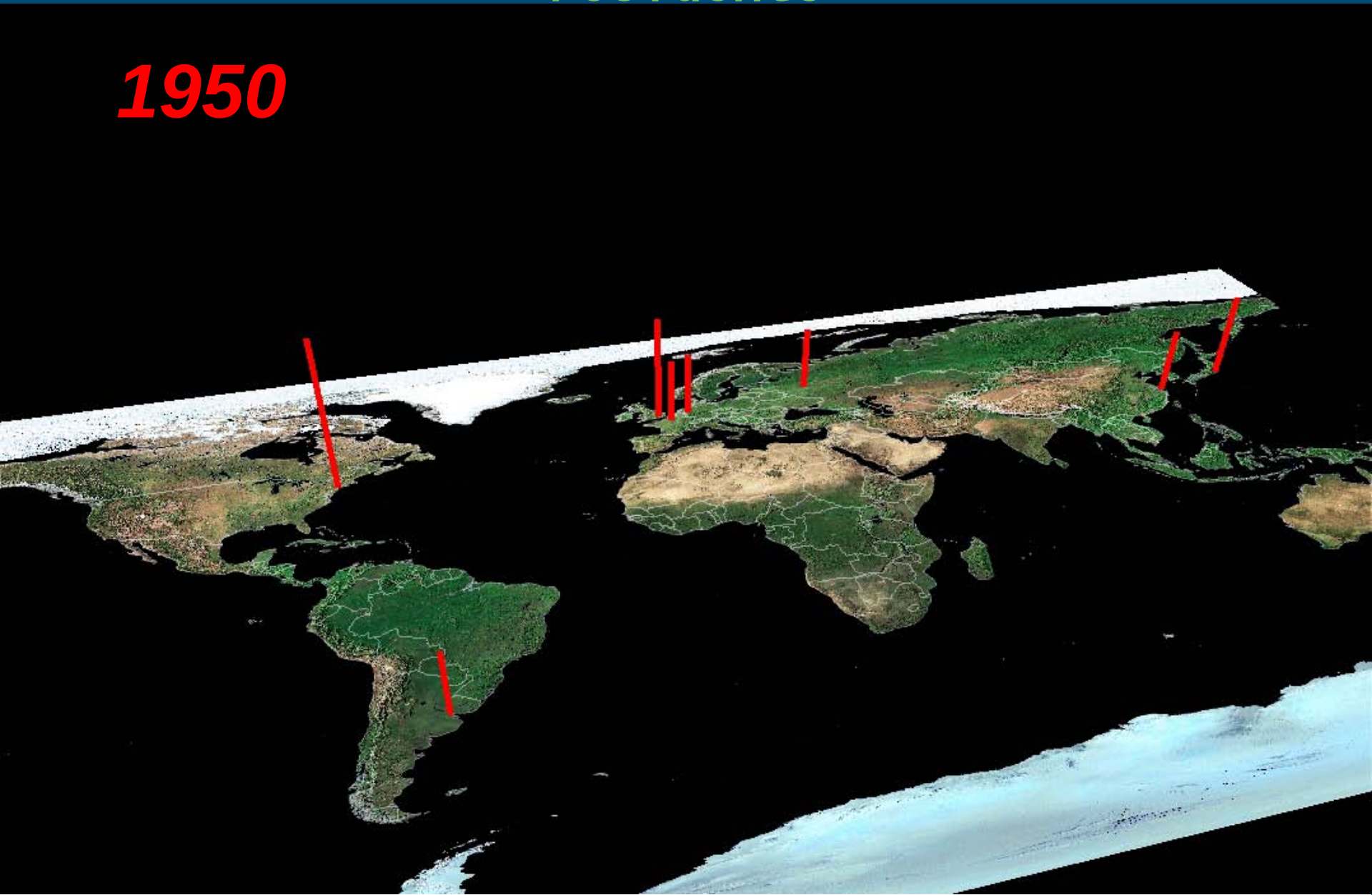
>1700 m3/capita | 1000-1700 m3/capita | 500-1000 m3/capita | <500 m3/capita

1.4 billion people in watersheds with < 1000m^3/capita/yea

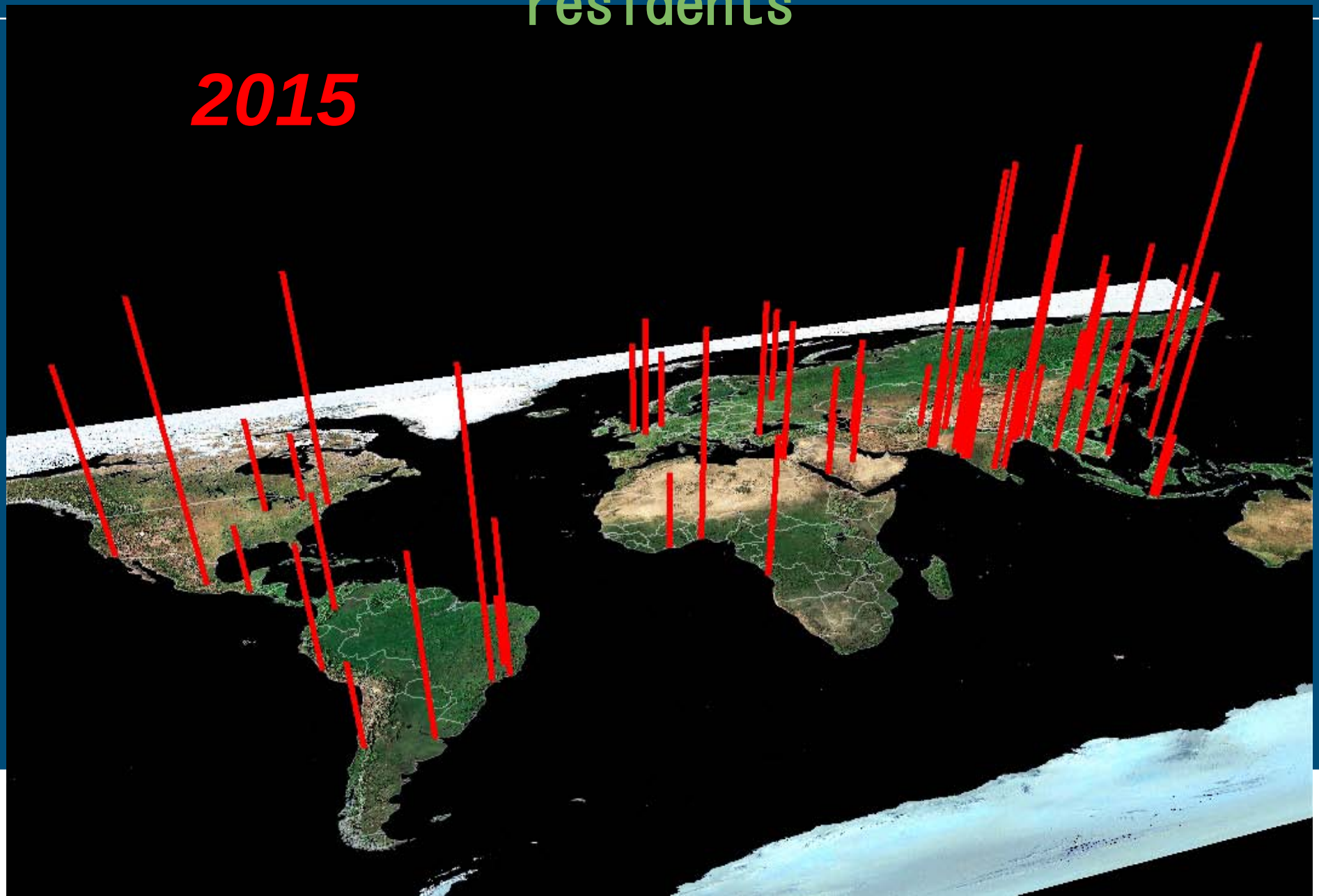
2.4 billion people with poor sanitation

1 billion people without access to safe drinking water

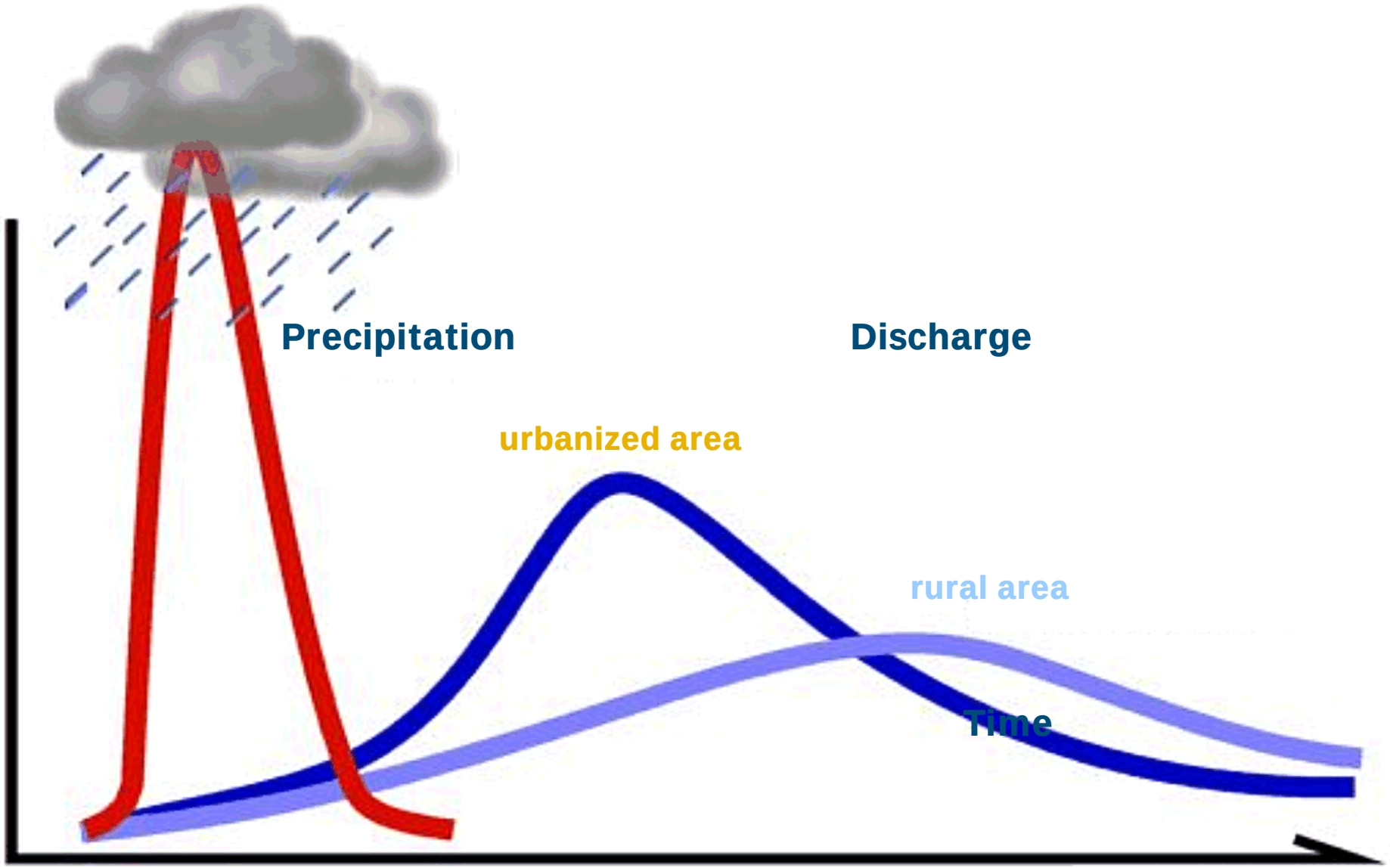
World Cities exceeding 5 million residents



World Cities exceeding 5 million residents



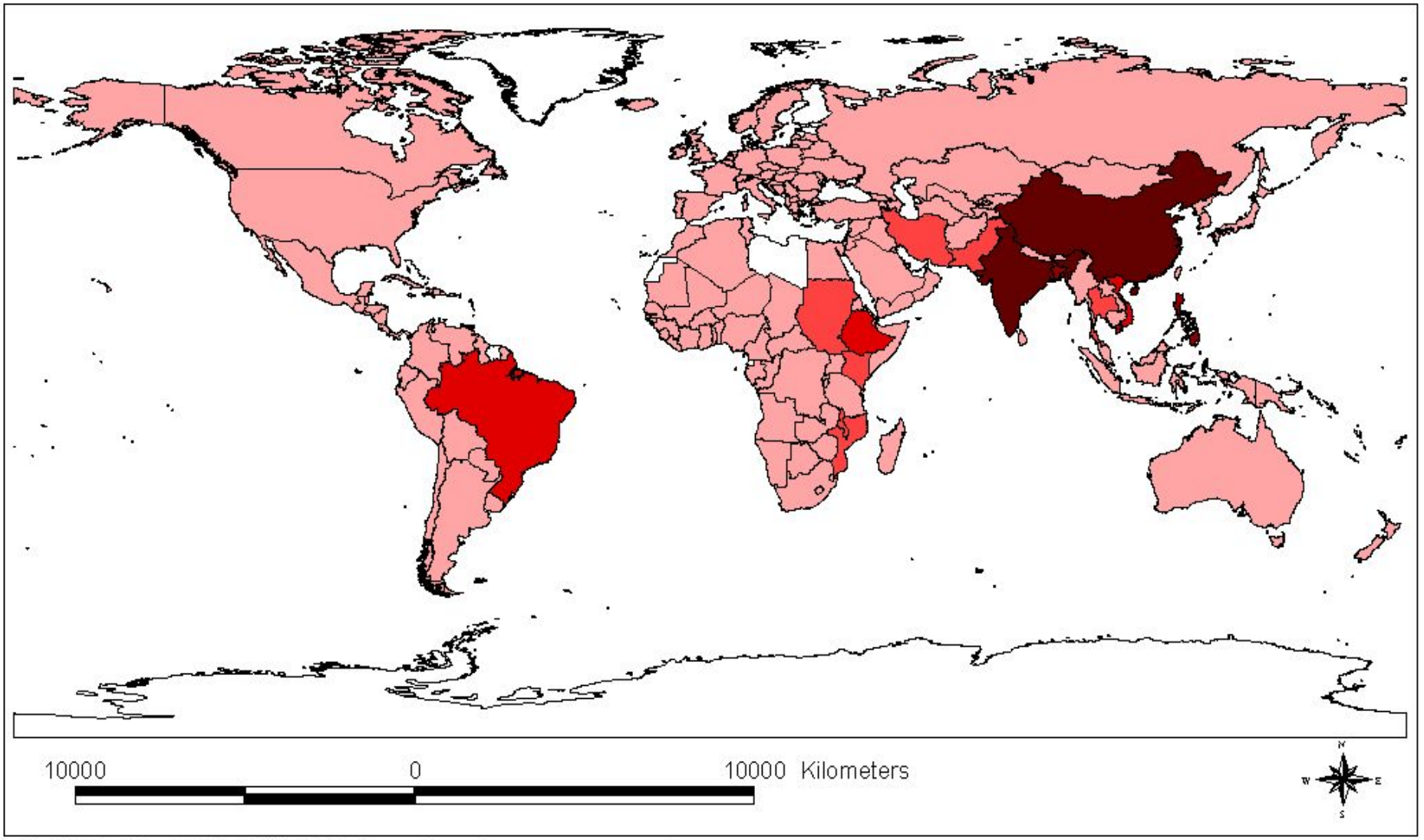
Precipitation transform curve: runoff



Vulnerability projections

City	Population estimates (millions)			Estimated GDP (US$ billion)		
	2005	2015	Change (%)	2005	2015	Increase in Loss Potential by 2015 (%)
Tokyo, Japan	35.2	35.5	0.8	1191	1452	22
Mumbai, India	18.2	21.9	20.2	126	226	79
Mexico City, Mexico	19.4	21.6	11.1	315	489	55
São Paulo, Brazil	18.3	20.5	12.0	225	336	49
New York, USA	18.7	19.9	6.2	1133	1408	24
Delhi, India	15.0	18.6	23.6	93	170	82
Shanghai, China	14.5	17.2	18.8	139	261	88
Kolkata, India	14.3	17.0	18.9	94	167	77
Dhaka, Bangladesh	12.4	16.8	35.5	52	94	81
Jakarta, Indonesia	13.2	16.8	27.3	98	184	88

Distribution of people affected by natural disasters (1975-2001)

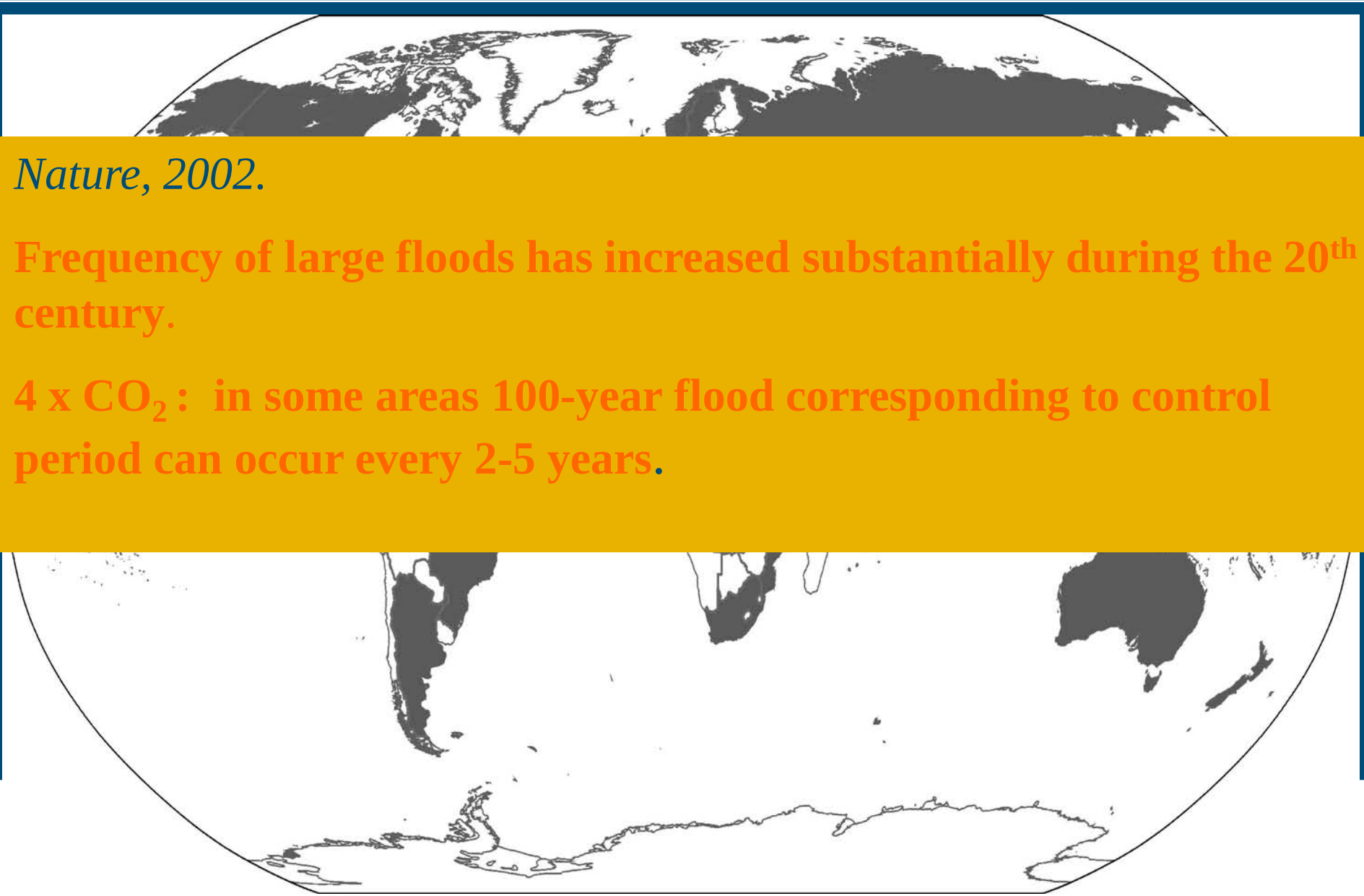


EM-DAT: The OFDA/CRED International Disaster Database (http://www.cred.be; email: cred@epid.ucl.ac.be)

LEGEND

- 0 aff.
- 1 - 18,000,000 aff.
- 18,000,001 - 48,000,000 aff.
- 48,000,001 - 100,000,000 aff.
- 100,000,001 - 350,000,000 aff.
- > 350,000,000 aff.

Countries affected by destructive flooding since 1990



Nature, 2002.

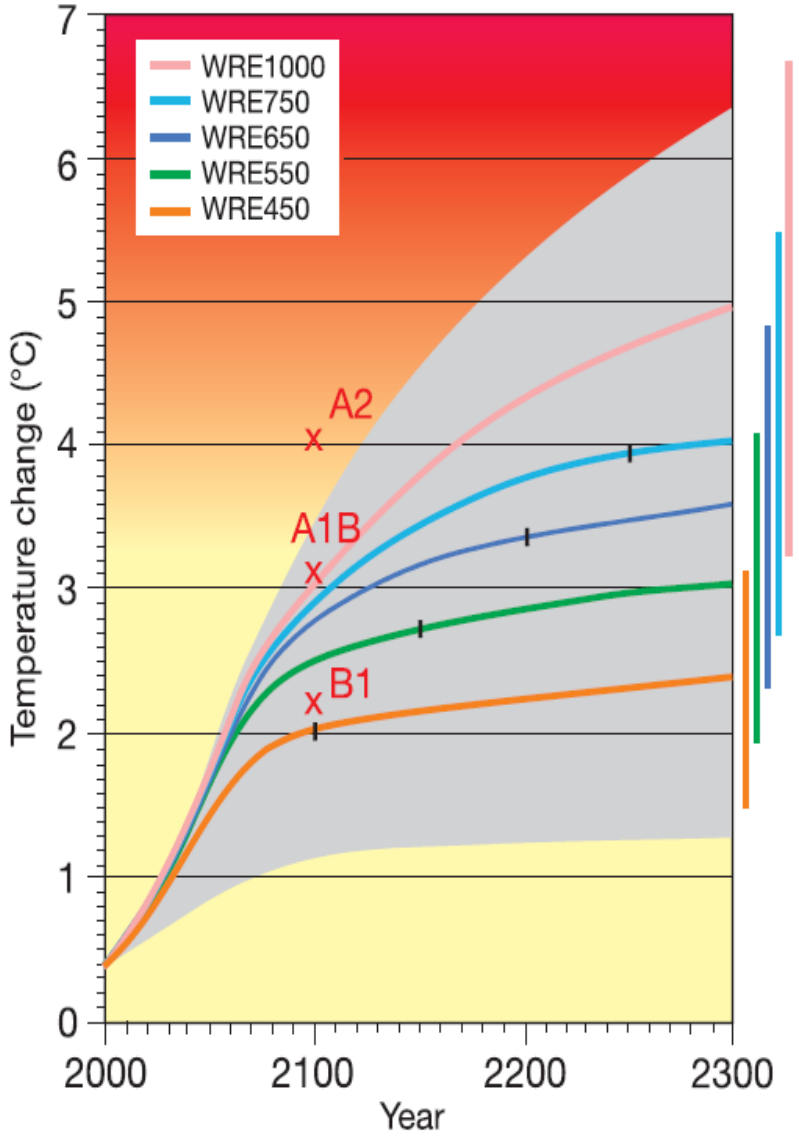
Frequency of large floods has increased substantially during the 20th century.

4 x CO_2 : in some areas 100-year flood corresponding to control period can occur every 2-5 years.

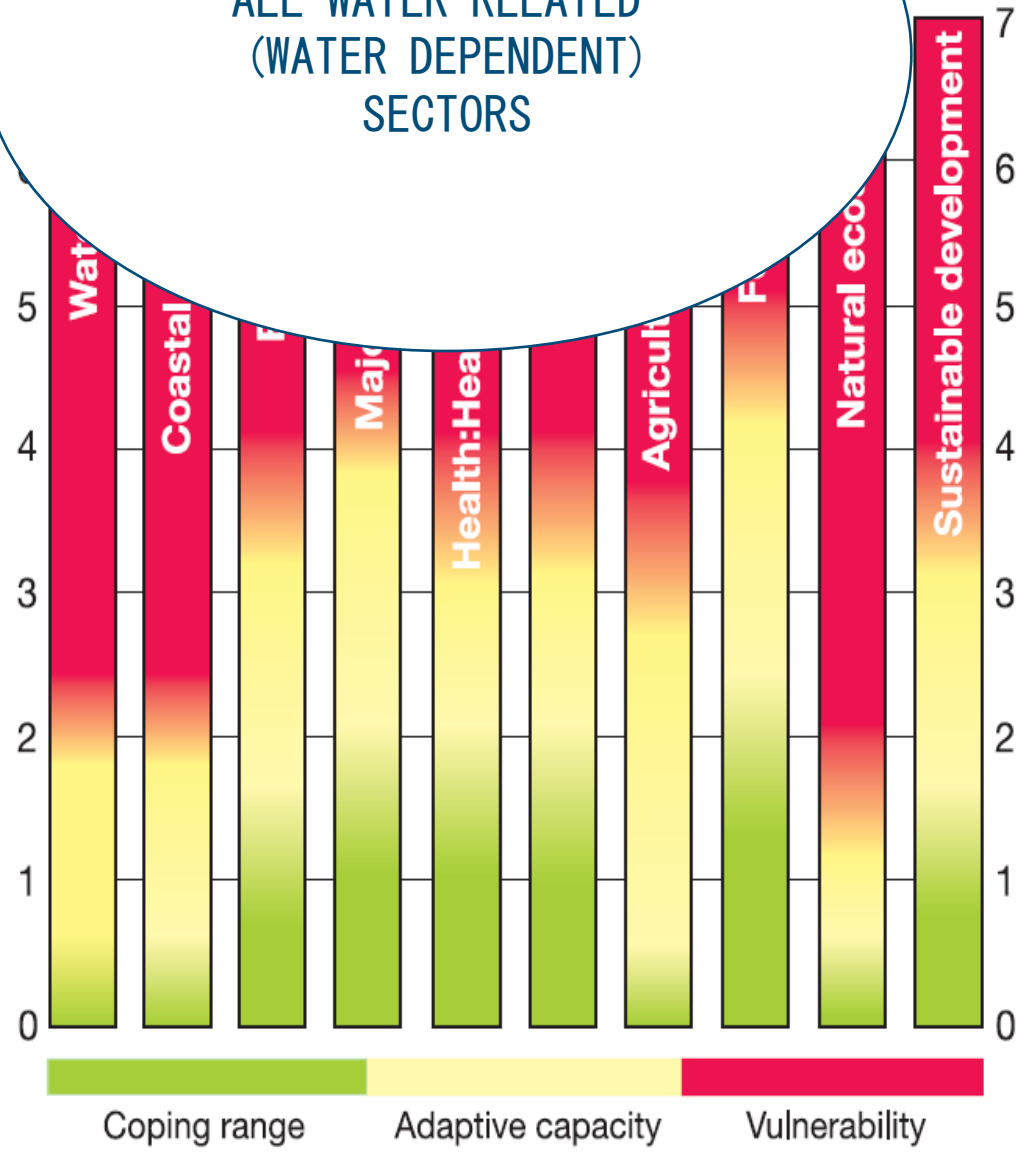
IPCC 4AR:

- Most vulnerable regions are : Africa, **Asian megadeltas**, small islands, the Arctic.
- Most vulnerable sectors are: **water** (espec in the dry tropics), **agriculture** (espec in low latitudes), **human health** in countries with low adaptive capacity, some **ecosystems**: viz. coral, sea-ice biomes, coastal (eg mangrove and saltmarshes), tundra/boreal/mountain

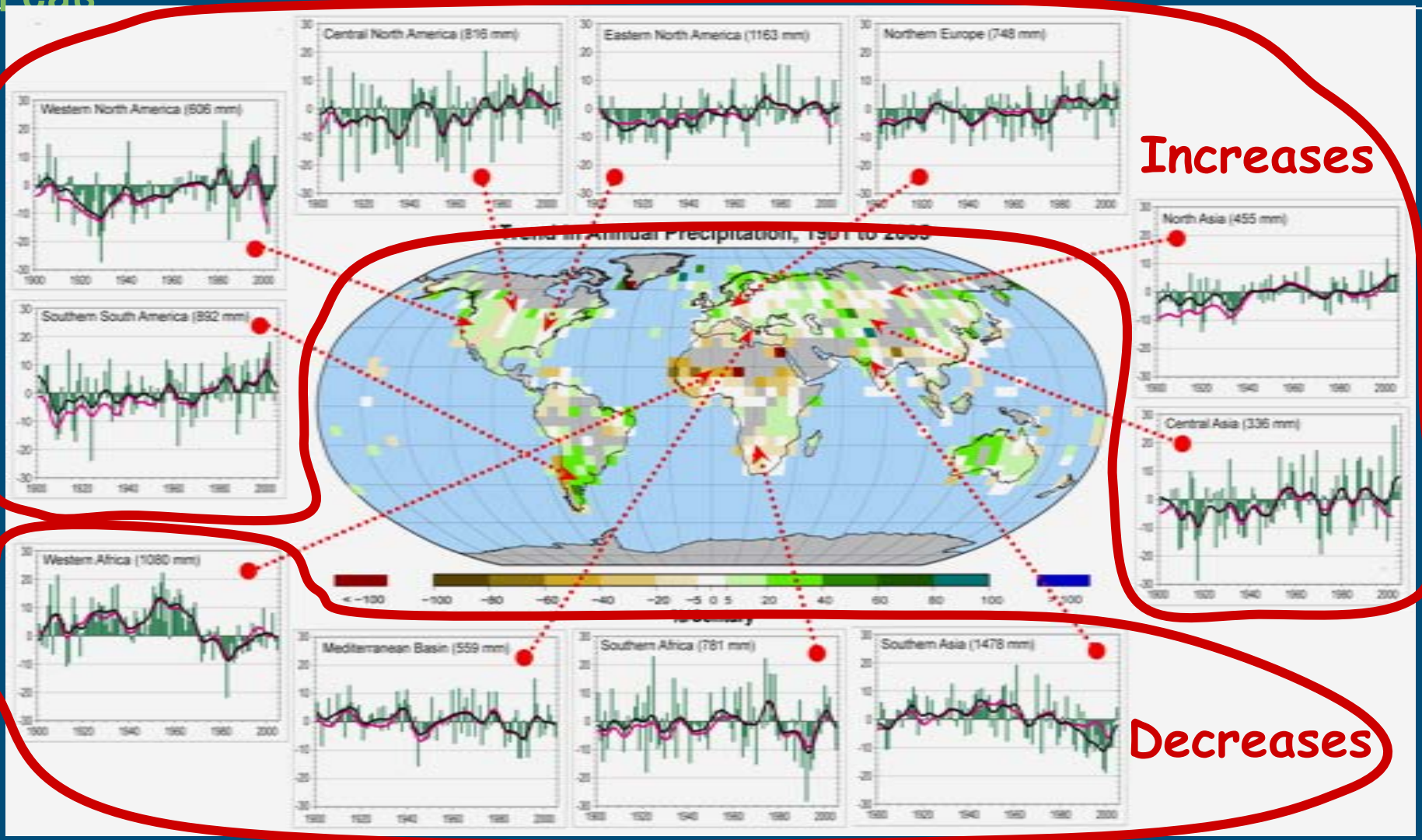
IPCC 2007



ALL WATER RELATED (WATER DEPENDENT) SECTORS



Land precipitation is changing significantly over broad areas



Smoothed annual anomalies for precipitation (%) over land from 1900 to 2005; other regions are dominated by variability.

Monsoon rainfall is the main water resource of the region;

High frequency of climate related disasters, such as flood, drought and heat wave, cause great damages of the region;

Evidence of potential impacts of human activities on monsoon climate….

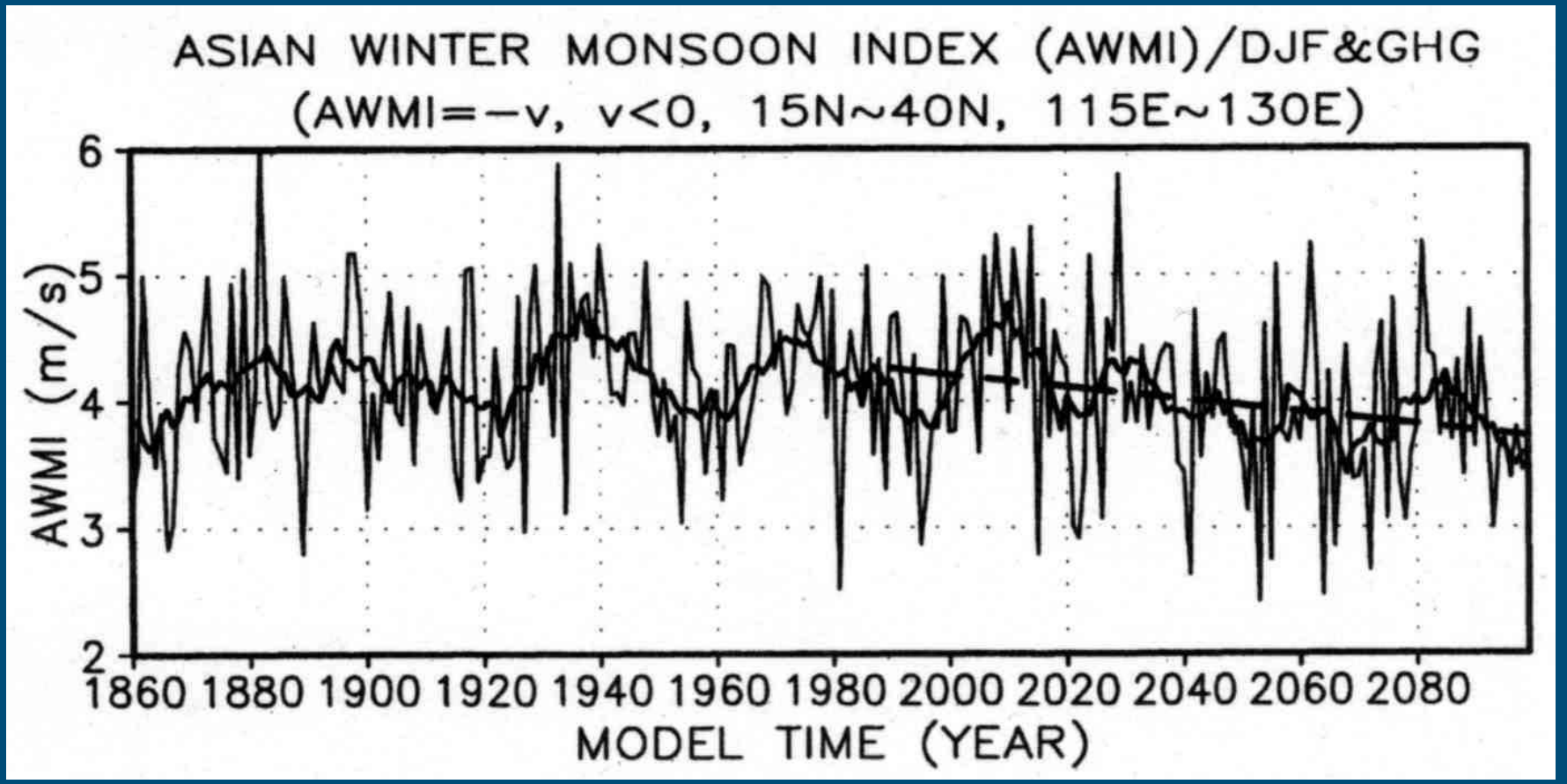
1. Changing monsoon climate under greenhouse effect
2. Impacts of anthropogenic aerosols (sulphate aerosols , black carbon, ABC, etc) on monsoon climate
3. Impacts of large scale changes of land use /cover on monsoon climate

Changing monsoon climate under greenhouse effect

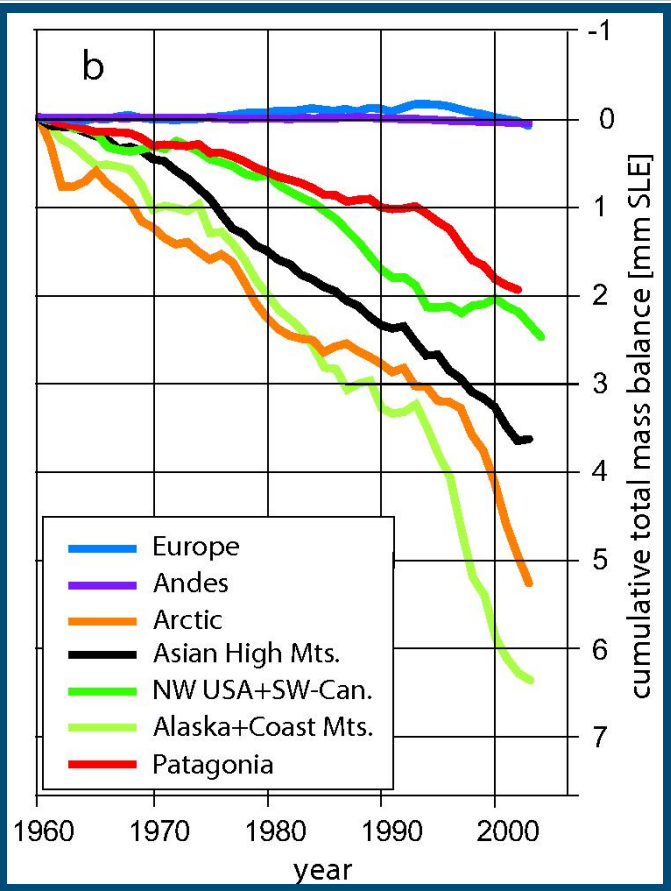
e.g.

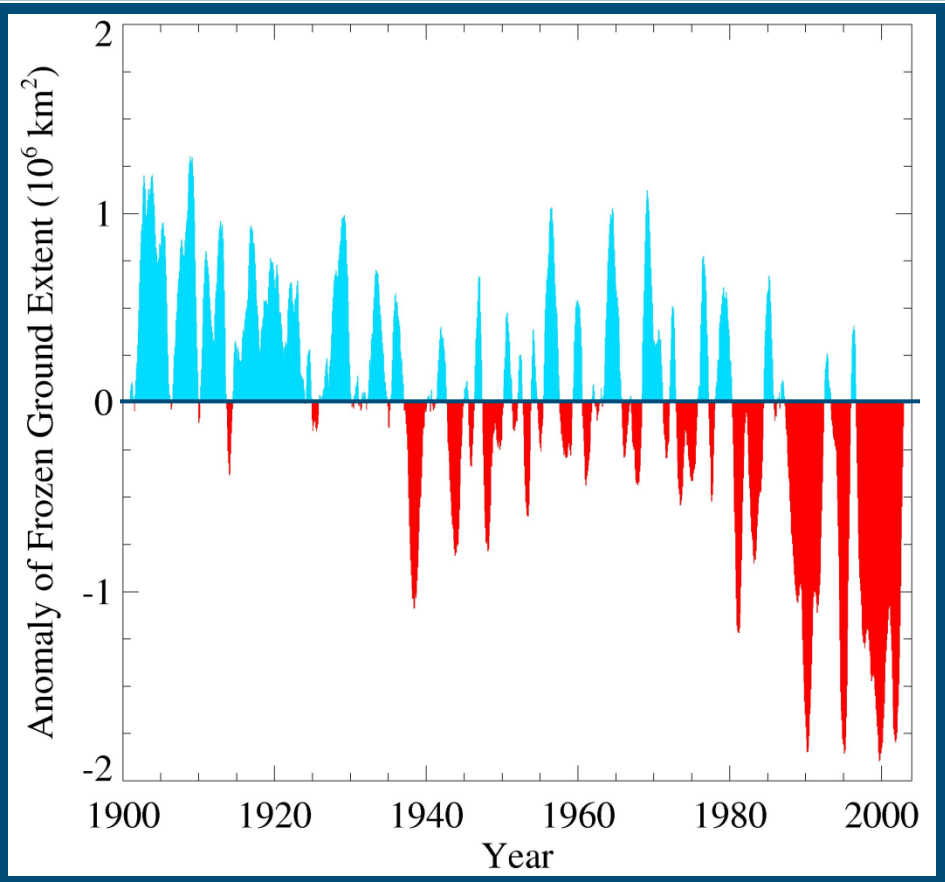
- Increasing summer monsoon rainfall and variability in South Asia;
- Weakening of winter monsoon over Asia continent;
- Early onset of Indian summer monsoon

Weakening of winter monsoon under global warming (IS92a, ECHAM4)



Glaciers and frozen ground are receding

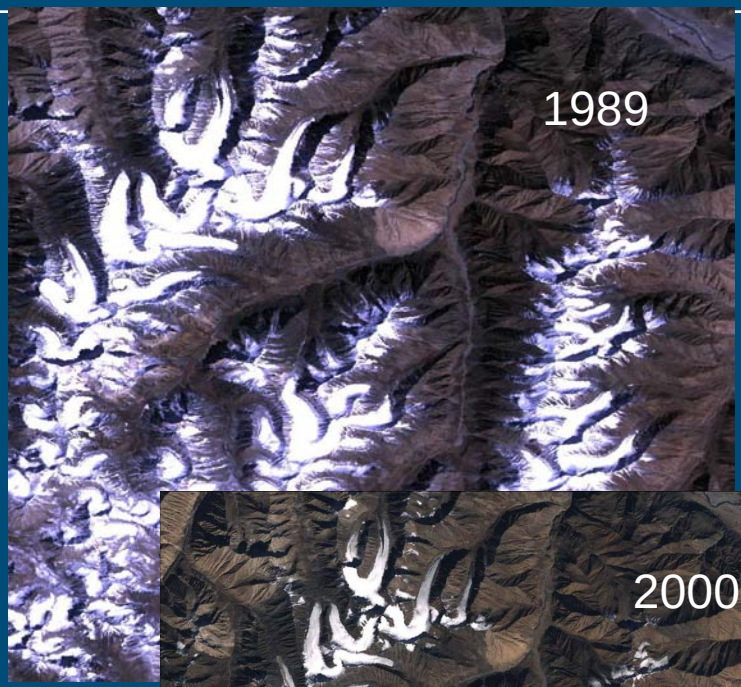


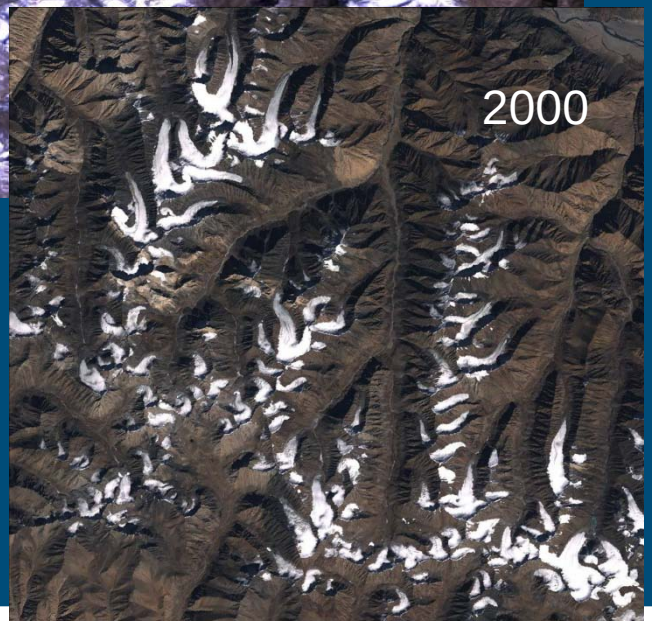


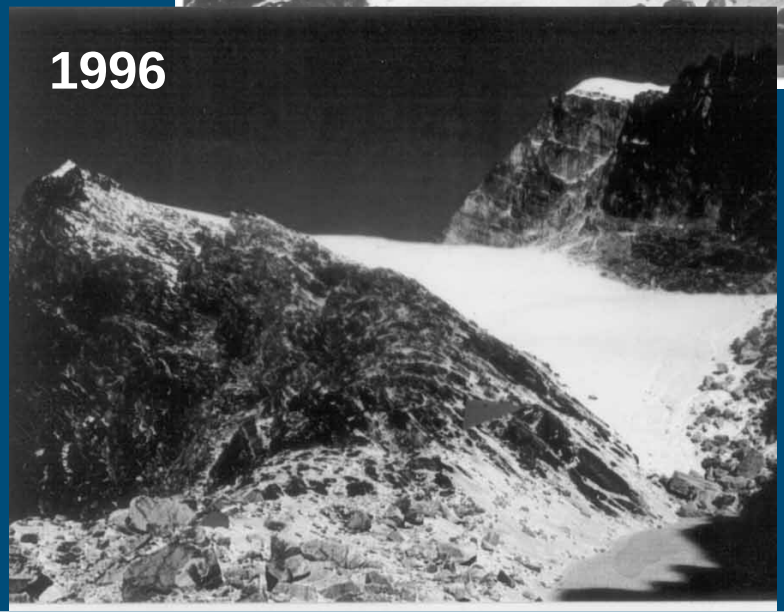
Increased Glacier retreat since the early 1990s

Area of seasonally frozen ground in NH has decreased by 7% from 1901 to 2002

Glacier melt in the Himalayas

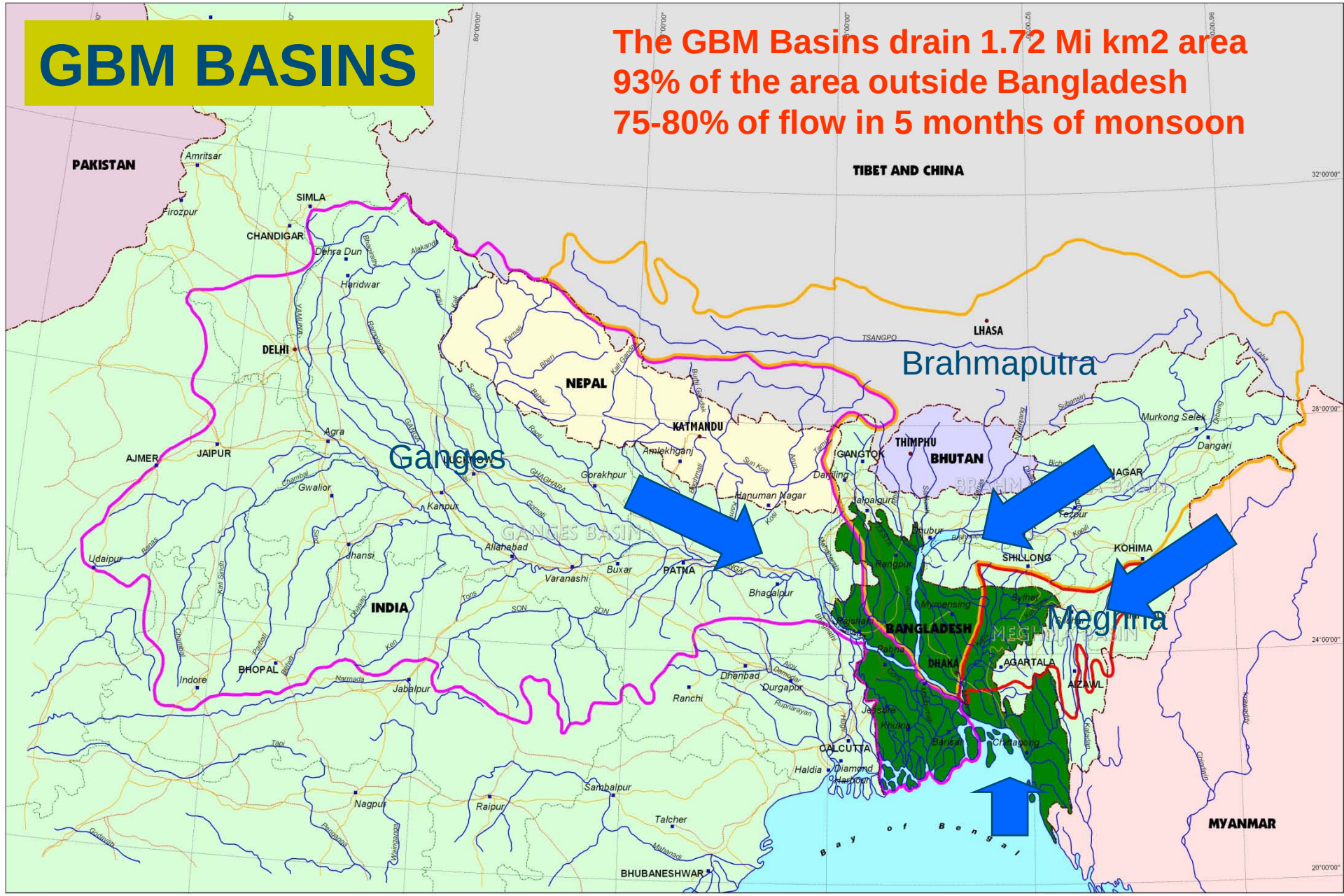






GBM BASINS

The GBM Basins drain 1.72 Mi km2 area
93% of the area outside Bangladesh
75-80% of flow in 5 months of monsoon



Legend

- International Boundary
- Indian State Boundary
- Capital
- Cities
- River
- Road
- Railway

Basin Area

- Meghna
- Brahmaputra
- Ganges

The Ganges, The Brahmaputra & The Meghna River Basins

N

50 0 50 100 150 Kilometers

INSTITUTE OF WATER MODELLING

IWM

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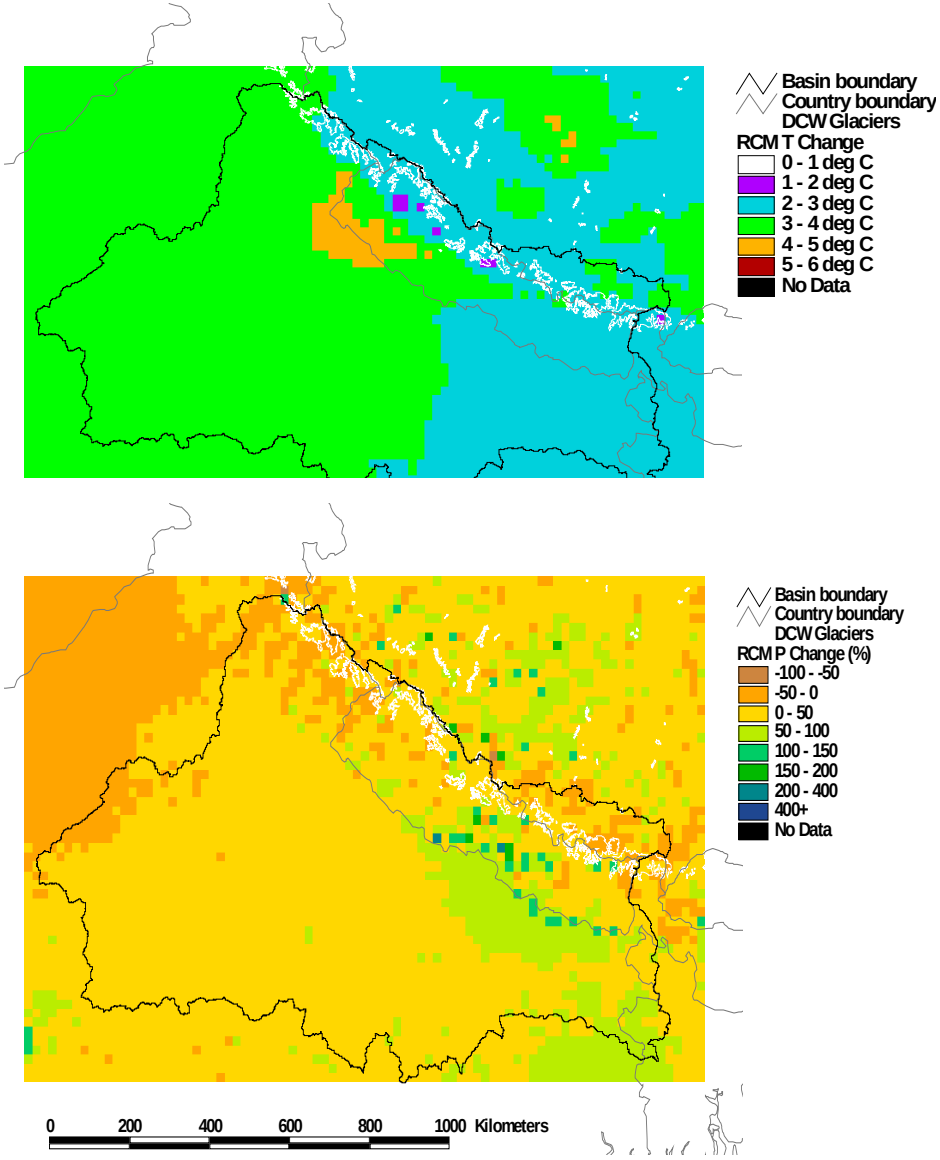
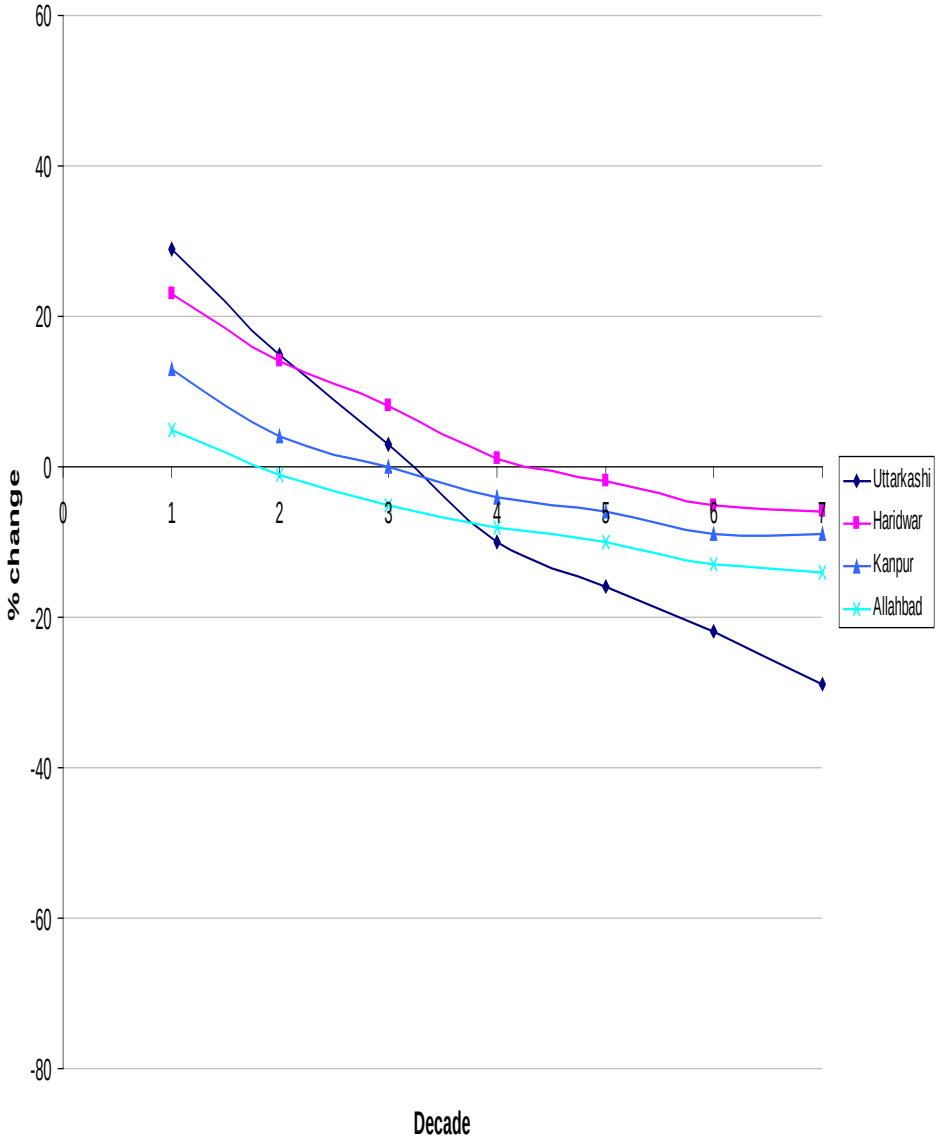
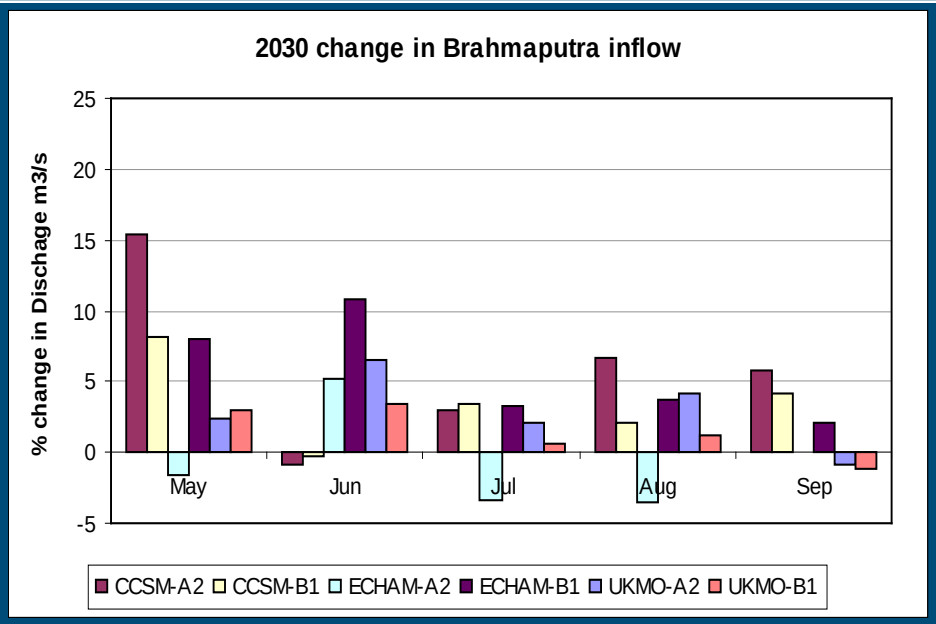
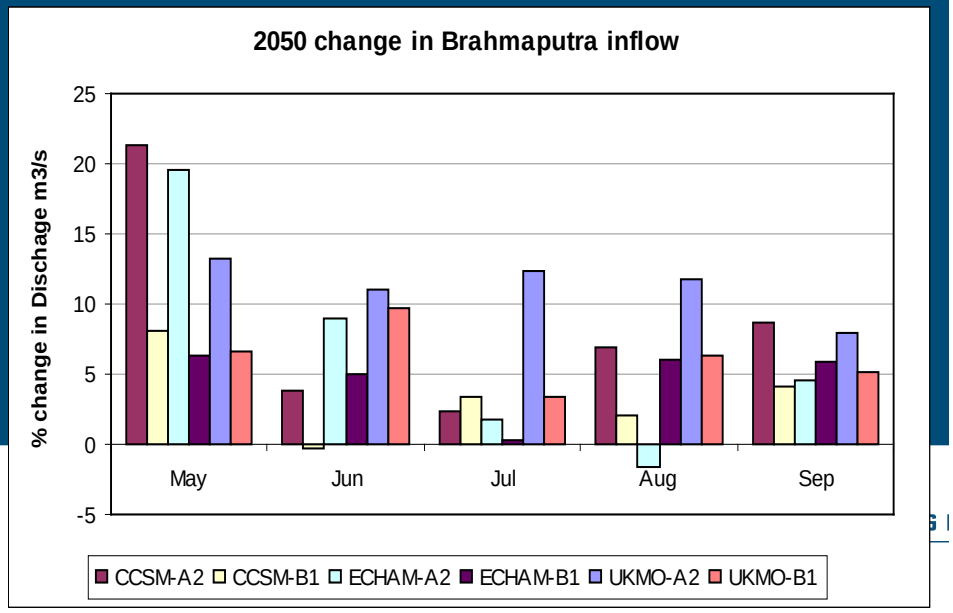
%change in decadal mean flow for Ganges from regional climate

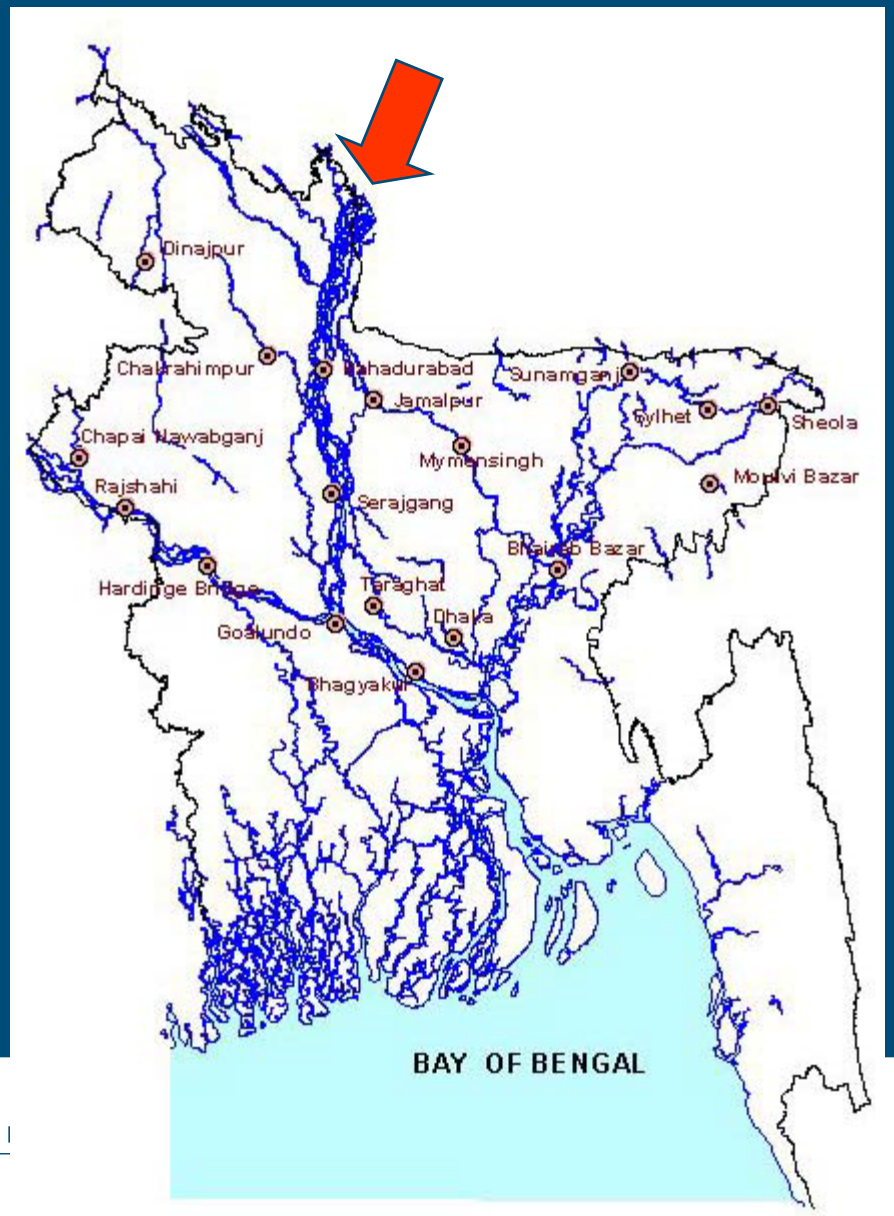




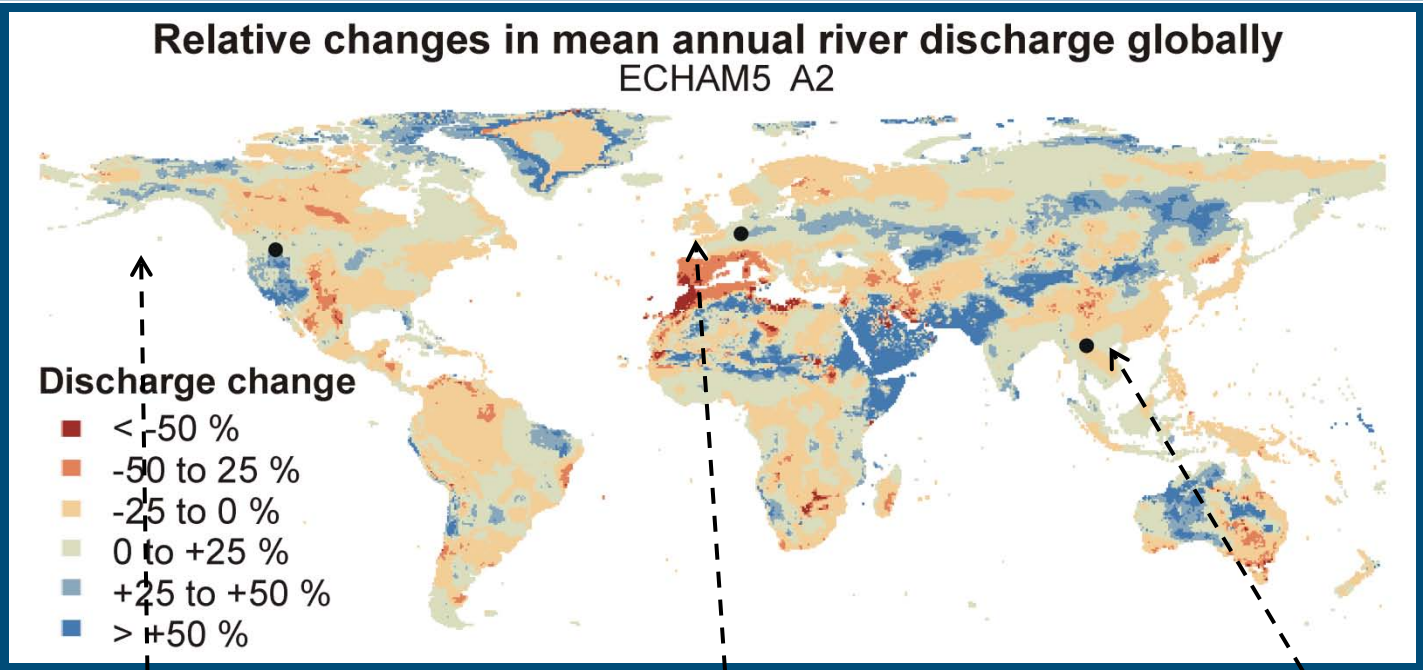
% change in inflow of Brahmaputra

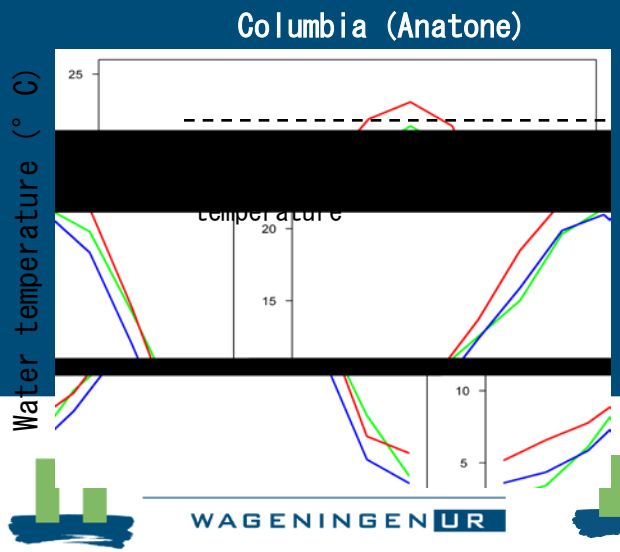


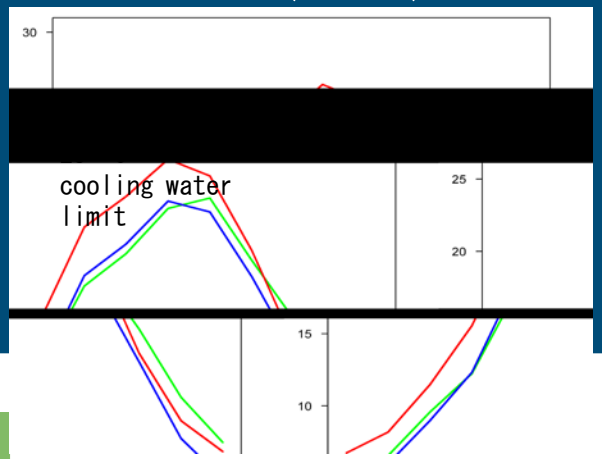


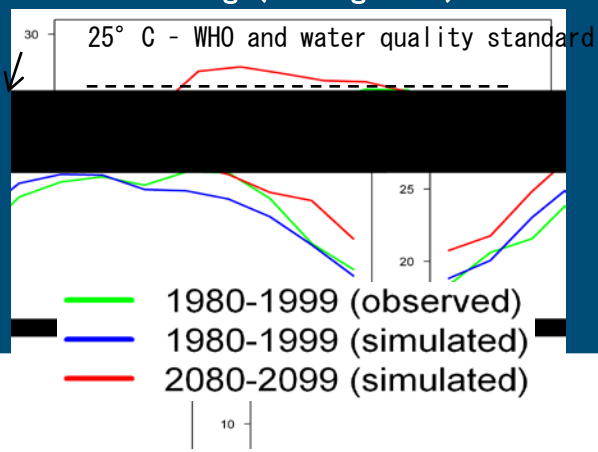


Future changes in discharge and water temperatures









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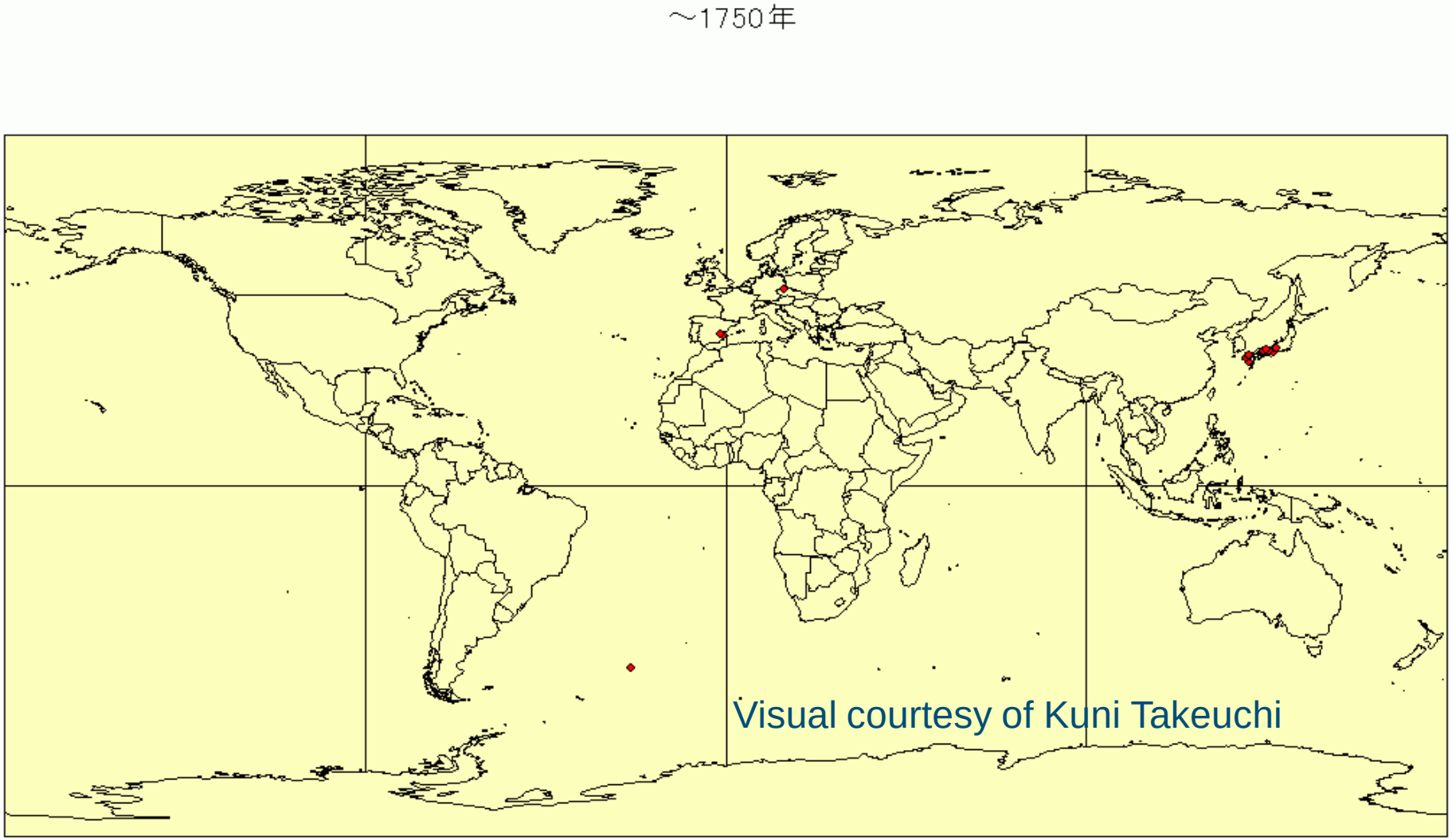
Global Reservoir Database

Location (lat./lon.), Storage capacity, Area of water surface, Purpose of dam, Year of construction, …

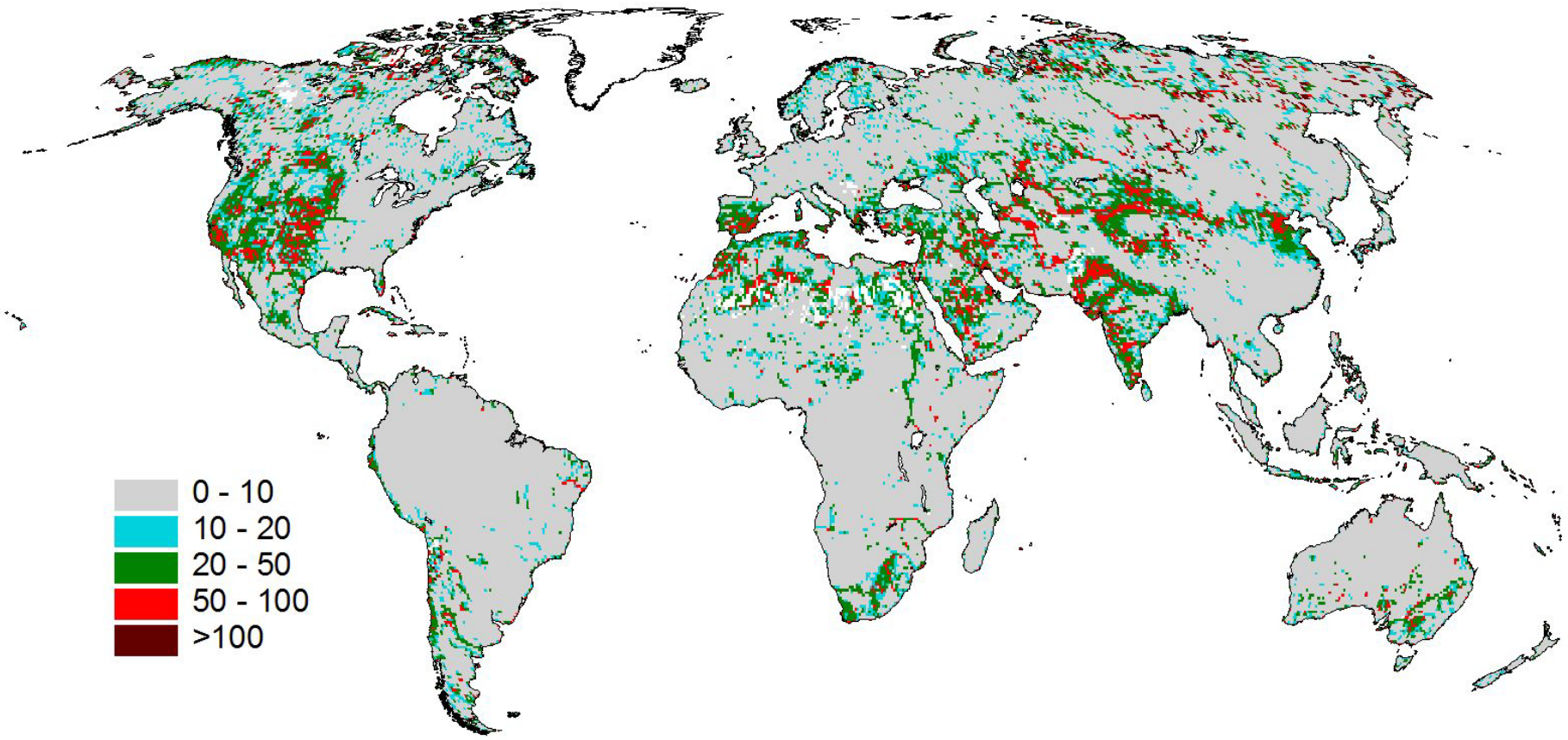


Alteration of river flow regimes due to withdrawals and reservoirs

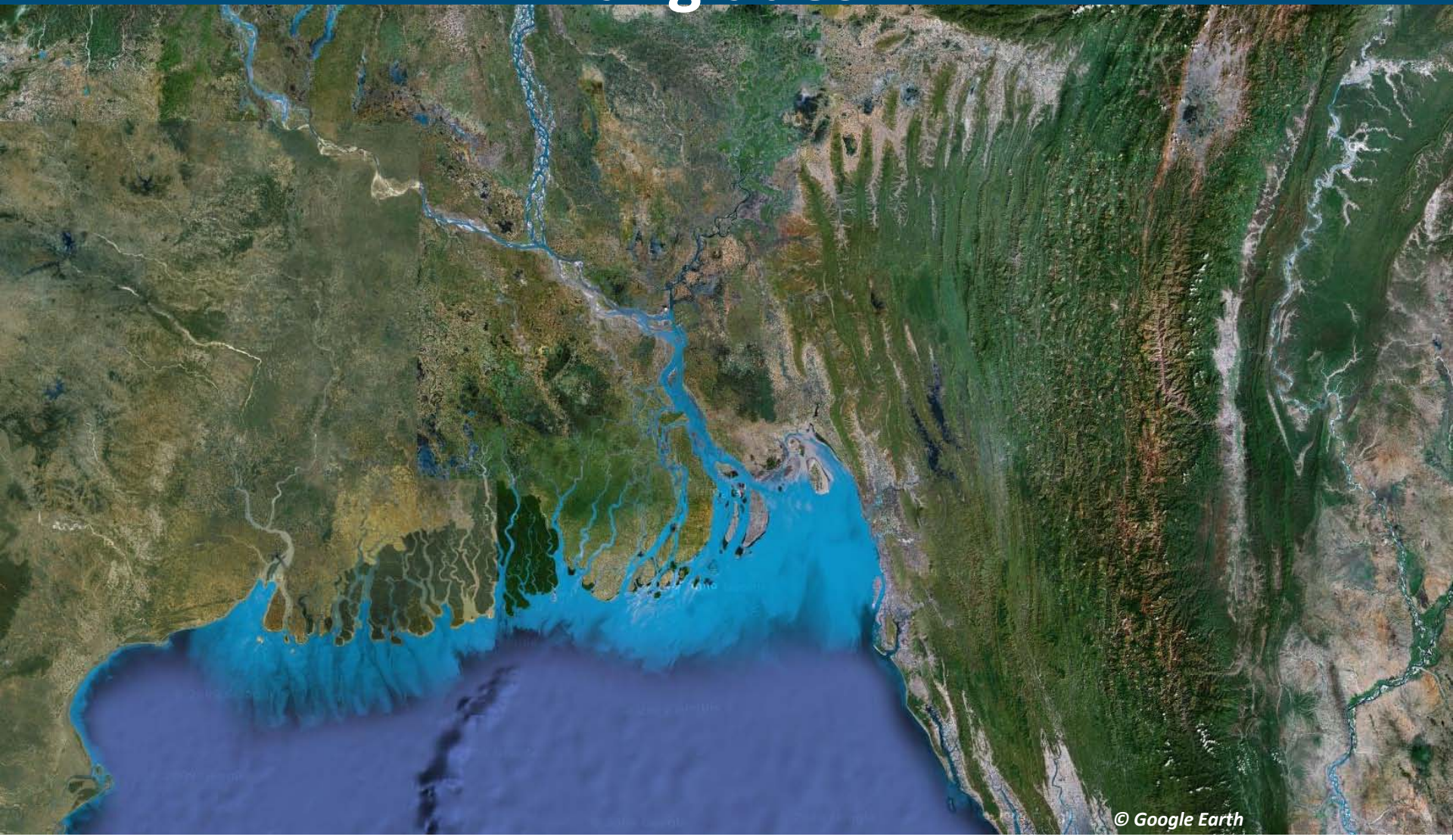
WaterGAP analysis based on “Range of Variability” approach of Richter et al. (1997)

Change in seasonal regime

Average absolute difference between 1961-1990 **mean monthly river discharge** under natural and anthropogenically altered conditions, in %



Bangladesh



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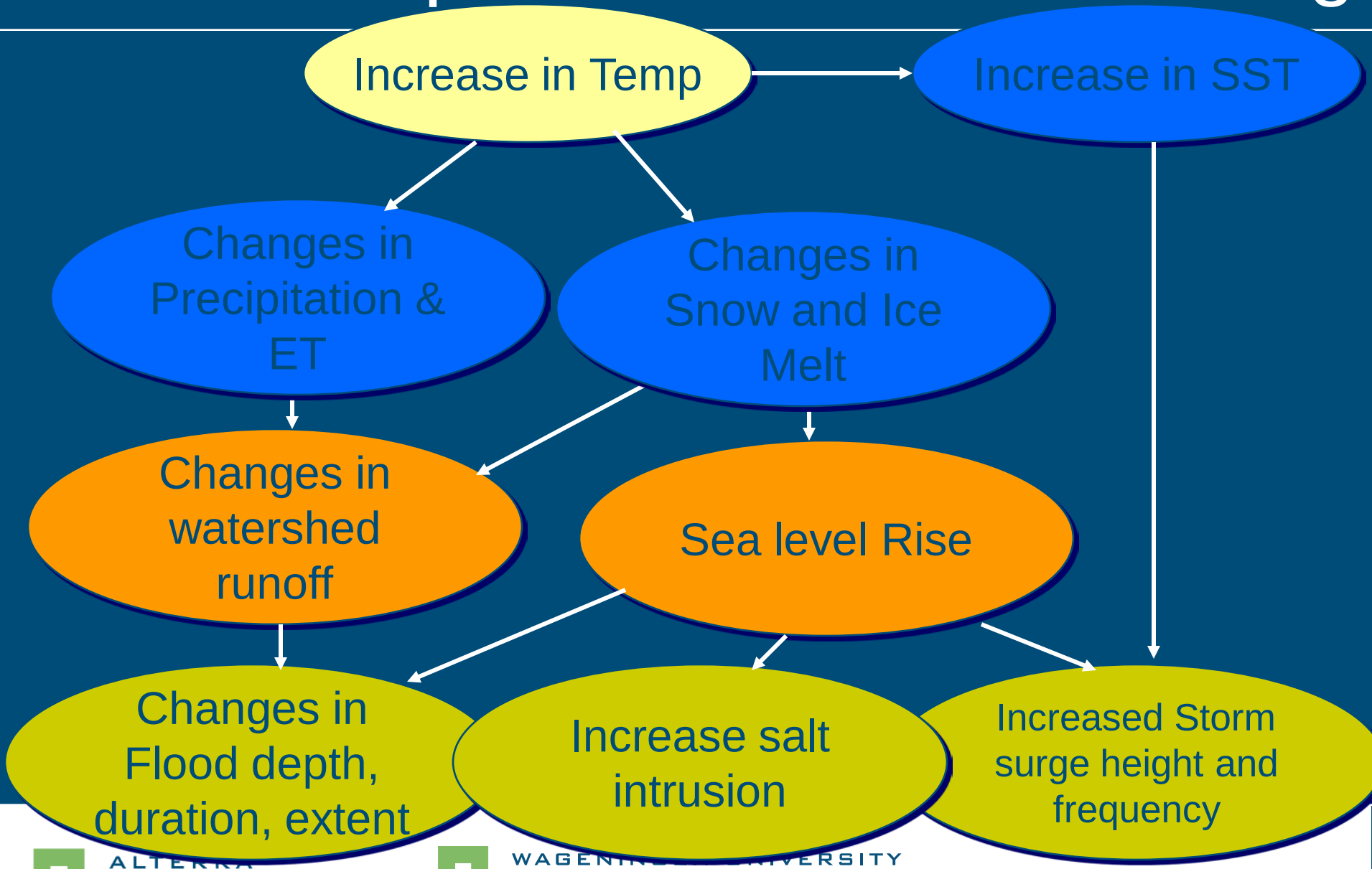
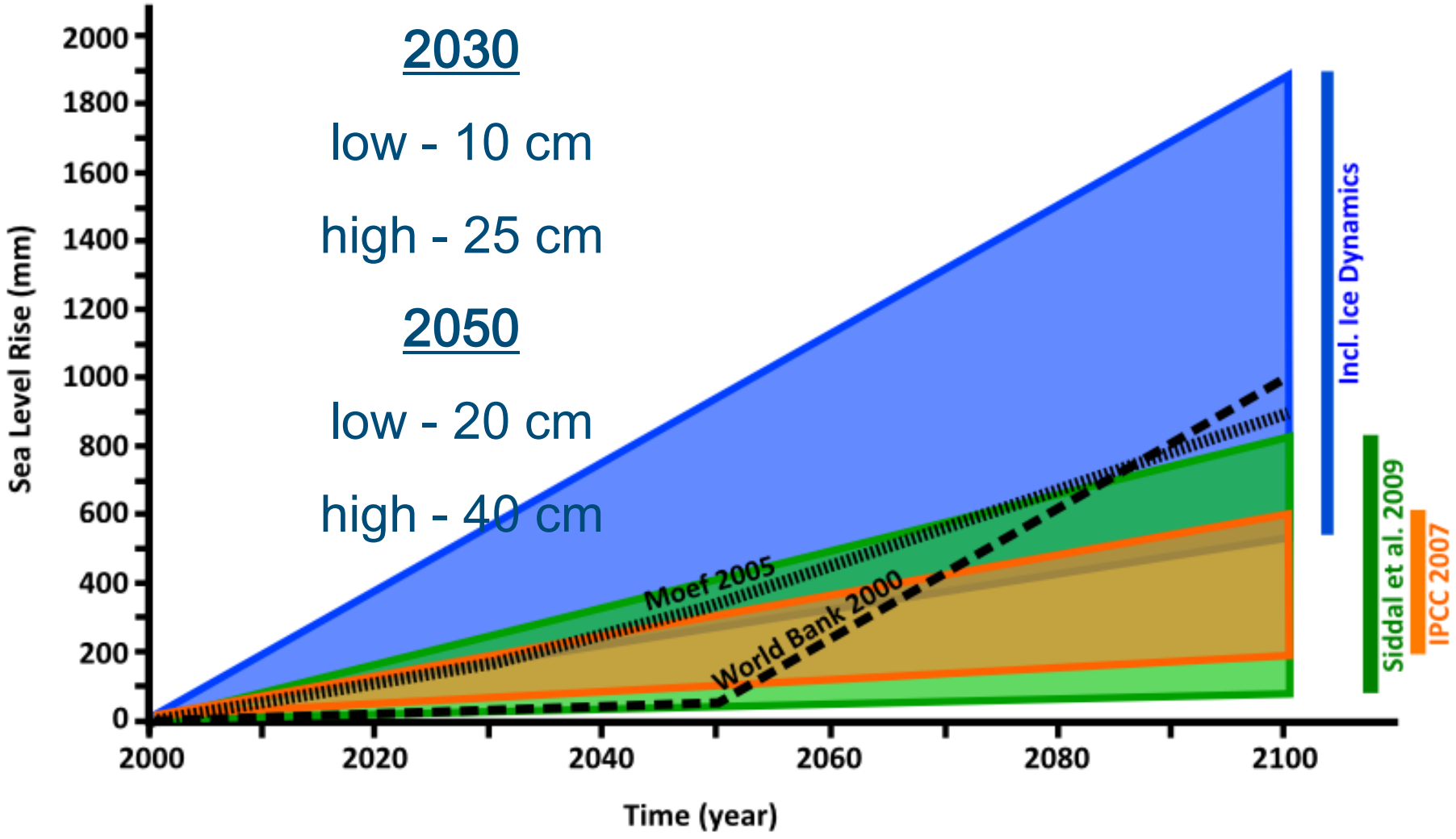
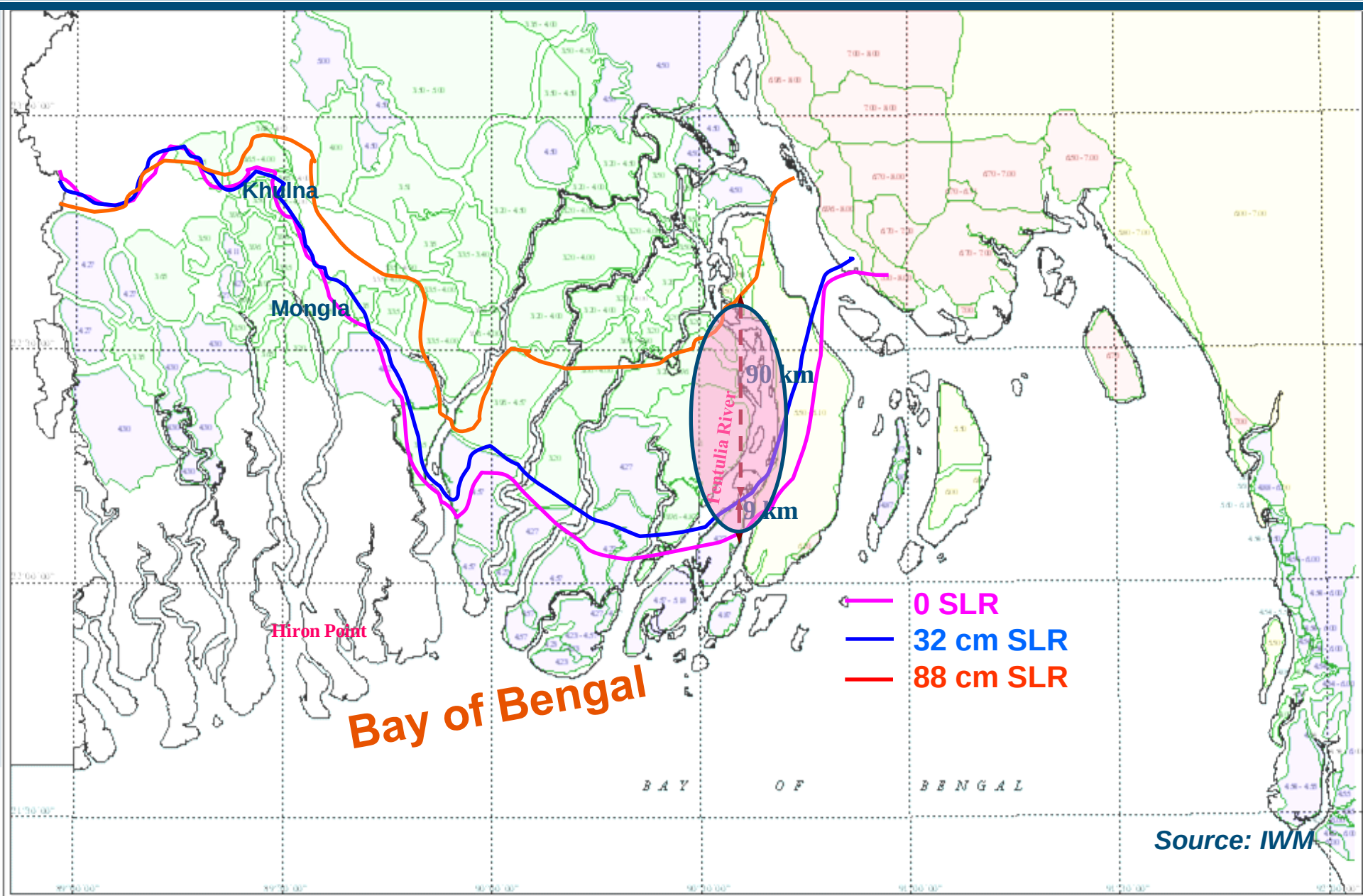
General Implications Climate Change



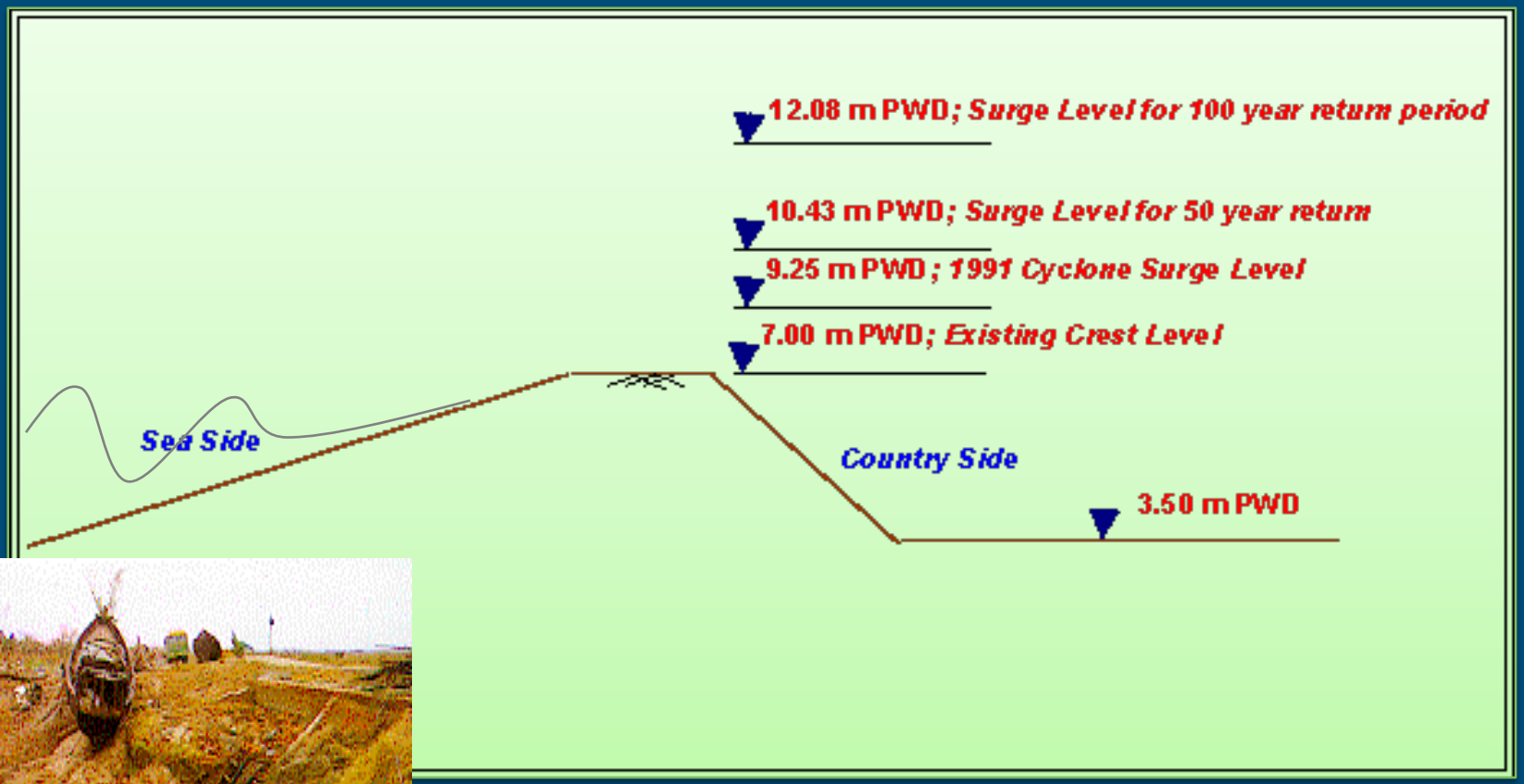
Climate scenarios - Sea level rise



Impact of SLR on Salinity Intrusion



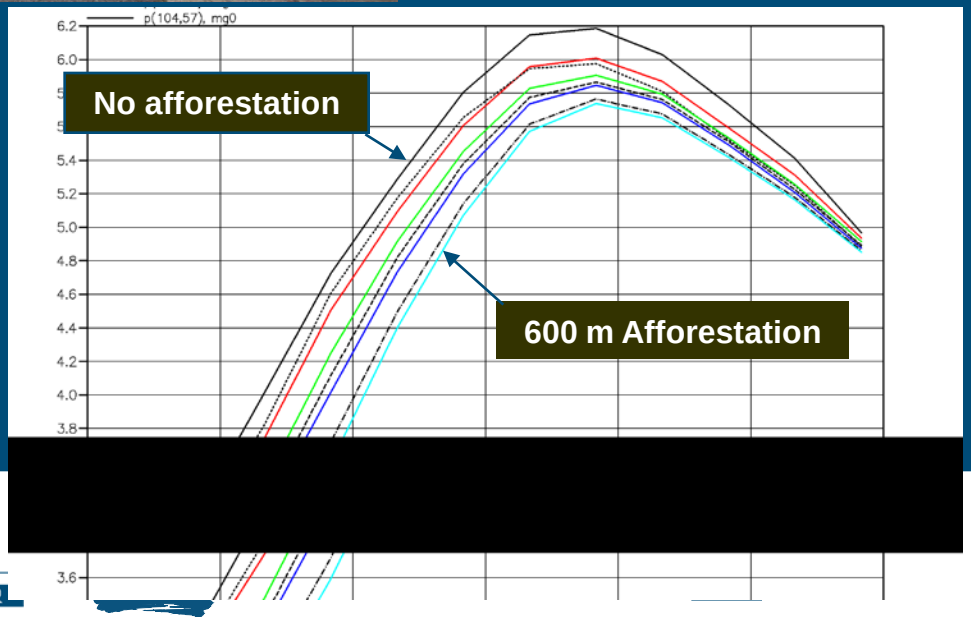
Bangladesh: SLR should be considered in design of sea dyke section and height



Patenga Polder (P62)

Source: IWM

Afforestation width of 600m reduces the Surge Level by 50cm



Source: IWM

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The monsoon climate (change) and SLR play an important role in the social and economic development of monsoon Asia region.....

But the (monsoon) climate and socio-economic scenarios have many uncertainties…

So is *adaptation* to climate variability and change, as a part of sustainable development, therefore impossible?

Not if we understand the *wider contexts* in which adaptation and sustainable development take place
...and if we *explicitly incorporate the uncertainties* in the type adaptation measures….

... spatial planning, technical regulation, economic priorities, adaptive management, risk management, cultural preferences, risk psychology …..

Implications for sustainable development

….future scenario selection must go hand in hand with the target application, and it should be accompanied by broader vulnerability, risk and cost-benefit analysis…

….selected infrastructural measure should be robust and flexible to reflect scenario and uncertainty ranges….

... Sustainable development strategies can therefore be developed in the face of remaining uncertainties…

"Acceptable risk"

Adaptation (with investments)

"Acceptable risk"

$\overline{X}_1$

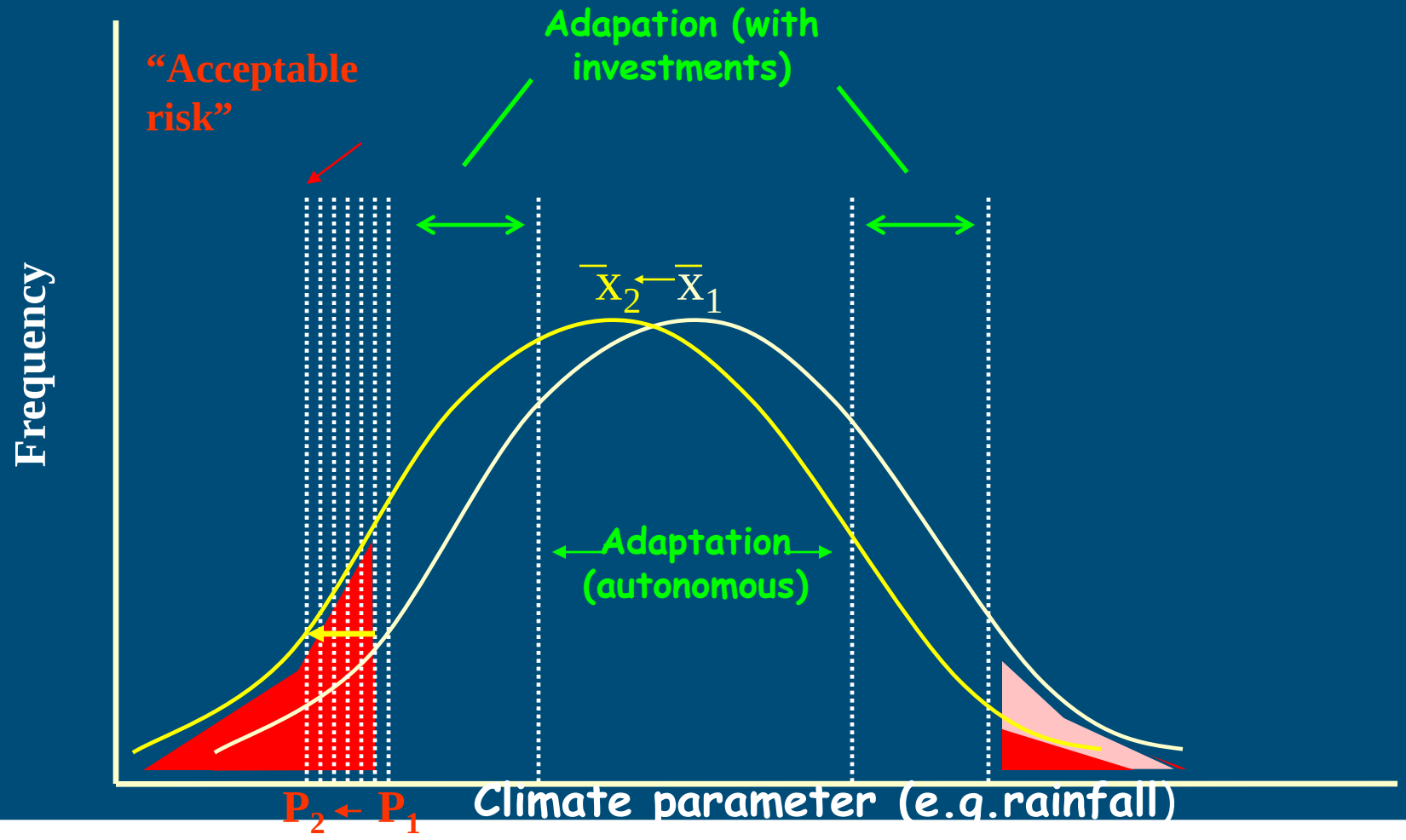
Adaptation (autonomous)

Drought risk

Flood risk

Climate parameter (e.g. rainfall)

Climate Change



New Regional Challenges

New Planetary Questions

Major Planetary Issues

Energy and Carbon

- Water Scarcity
- Food Availability
- Air Quality
- Human Health
- Urbanization and Population Migration
- Poverty and Education

- The need to understand interactions and feedbacks in the entire Earth System
- The need to develop integrated regional studies to assess the two-way coupling between the biophysical and social systems

Important Requirements (1)

1. Improve understanding: Agencies/countries must work together and support research based on societal needs, not on their own agenda
2. Use the successful weather-climate observation and prediction systems as the foundation for the next generation Earth system monitoring , analysis and prediction system.
3. Provide detailed regional information but recognize that these require global models that can represent high resolution processes such as convection, hurricanes, surface hydrology.

Important Requirements (2)

4. Communicate the excitement of the problem to a new generation of natural and social scientists, including scientists in emerging countries.
5. Maintain and expand the global observing system.
6. Provide the supercomputing capability needed to resolve key high-resolution processes and treat complexity in Earth system models.

Important Requirements (3)

7. Develop awareness and communicate information to society through a dialogue between scientists, decision-makers and the public.

8. This will require a real cultural revolution:
   - Scientists must focus on societal questions
   - The development of environmental knowledge centers requires a cultural shift towards interdisciplinarity.

What we need

- The development of an **Ap** w
  internationally-funded infrastructure, and specifically

(1) **human resources** that conduct **innovative** trans-and cross disciplinary research across all domains (social and natural sciences...

(2) a multi-national **supercomputing capability** that allows the development of global models at typically **1 km** resolution;

(3) Earth system models that are adapted to **massively parallel** multi-petaflop machines (>100,000 processors)

(4) coherent observations, **data systems**, and shared

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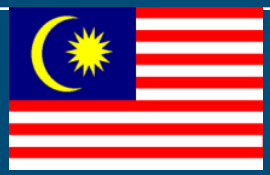
A Global Research Institute

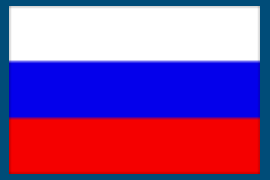
- established as a scientific bridge between East and West
- after Cold War ended focused on multiple dimensions of global change
- now embarking on the new research strategy for the next decade

National Member Organizations











- International, independent, interdisciplinary
- Research on major global problems
- Solution oriented, integrated systems analysis





IIASA 40th Anniversary Conference

- Hofburg (27-28 June 2012)
- IIASA (29 June)

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Thank you !