

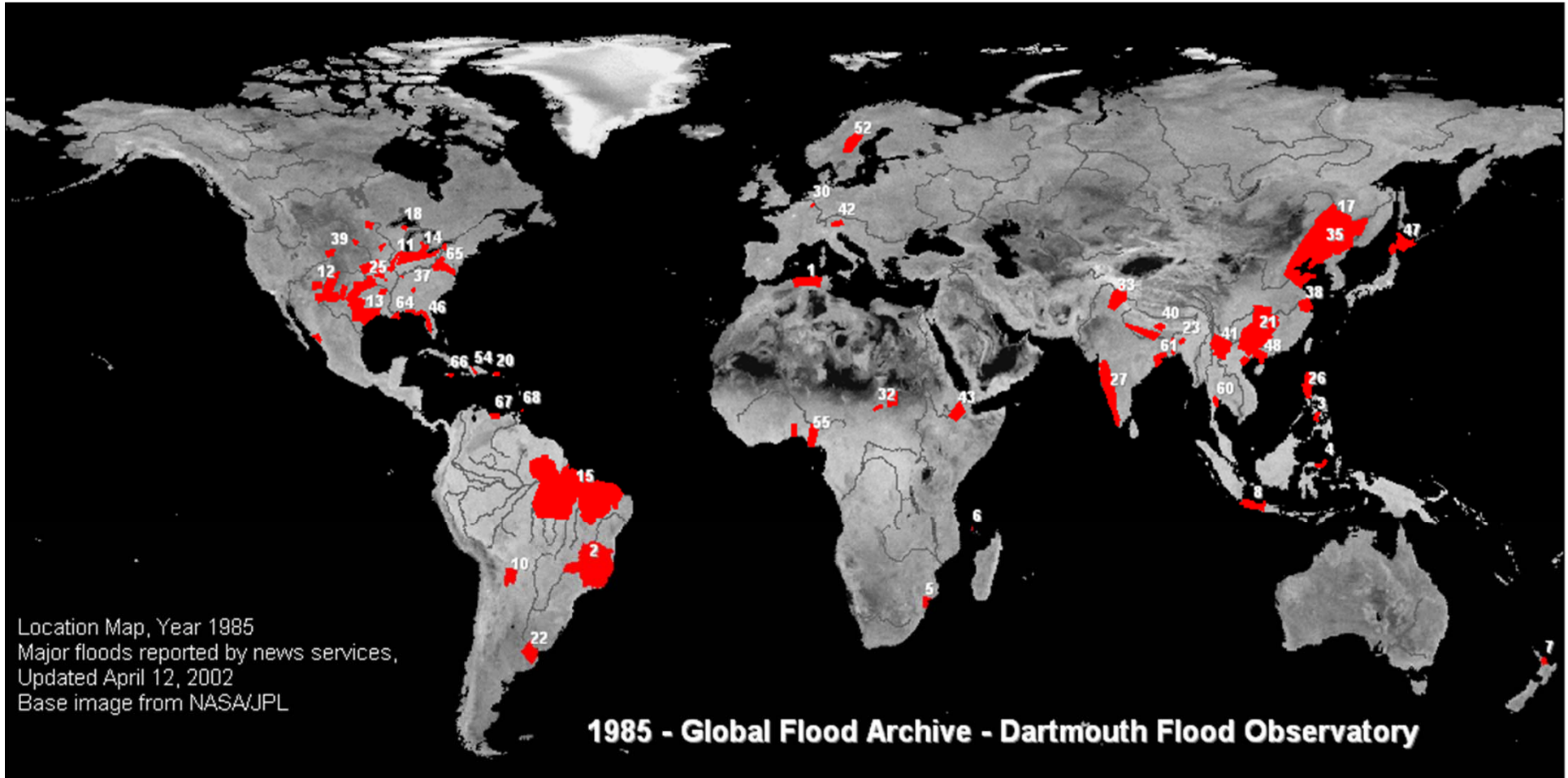
Climate Change and Floods

Professor Dr Shahbaz Khan

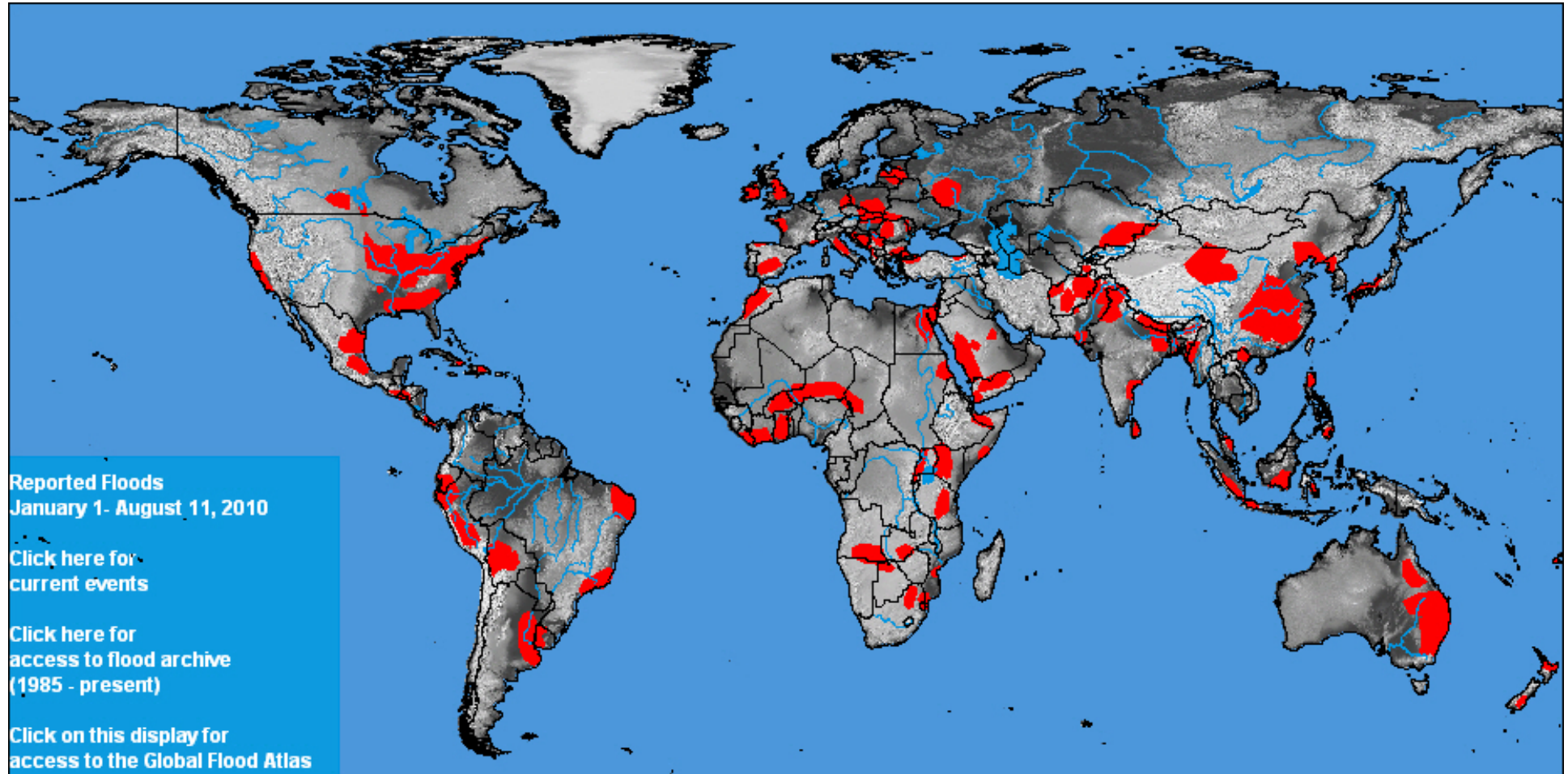
Chief, Water and Sustainable Development
UNESCO Division of Water Sciences, Paris

Acknowledgements: UNESCO Colleagues, ICHARM, JAXA, PMD and SUPARCO
and numerous Pakistani professionals

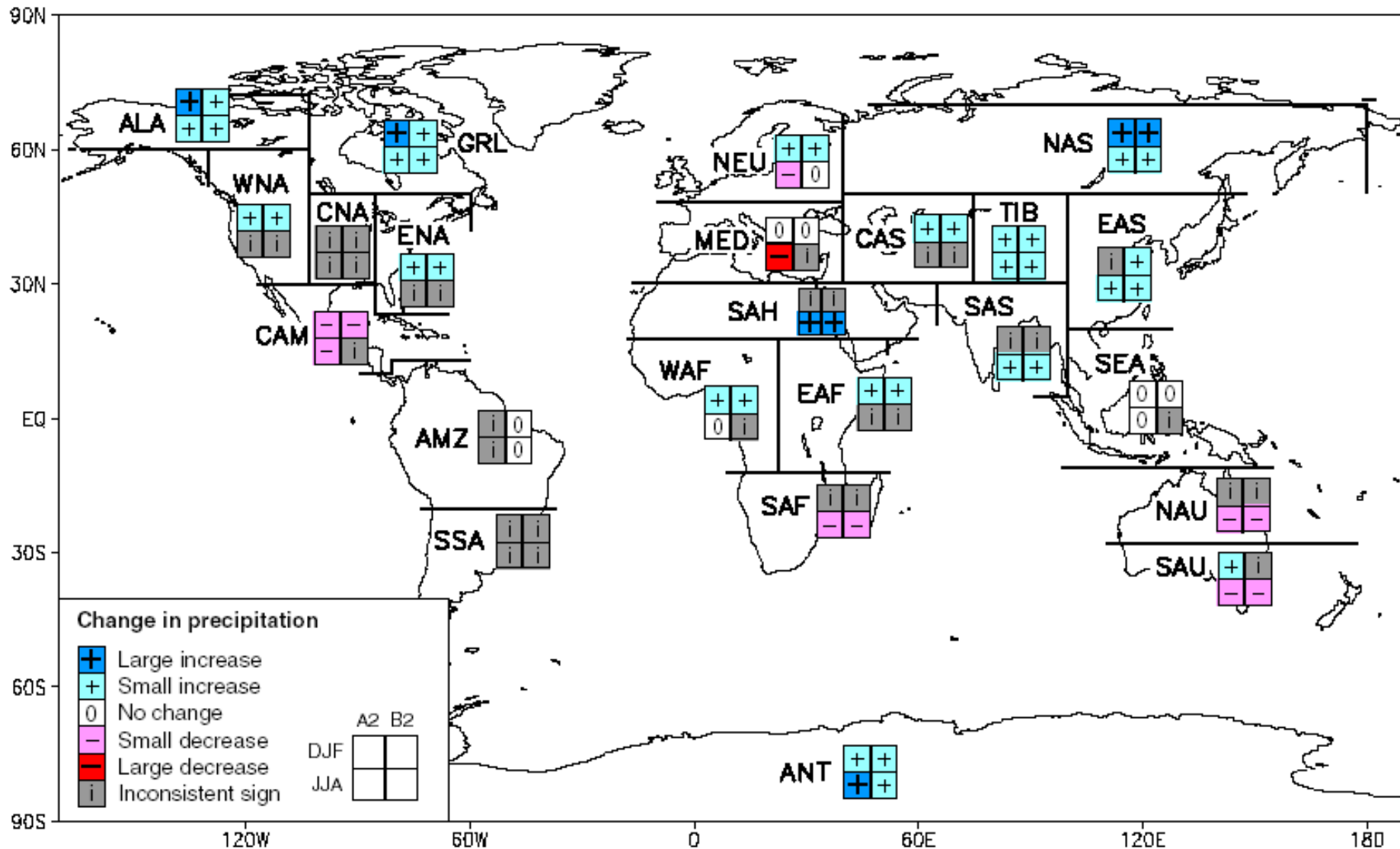
Floods in the World



Global Distribution of 2010 Floods

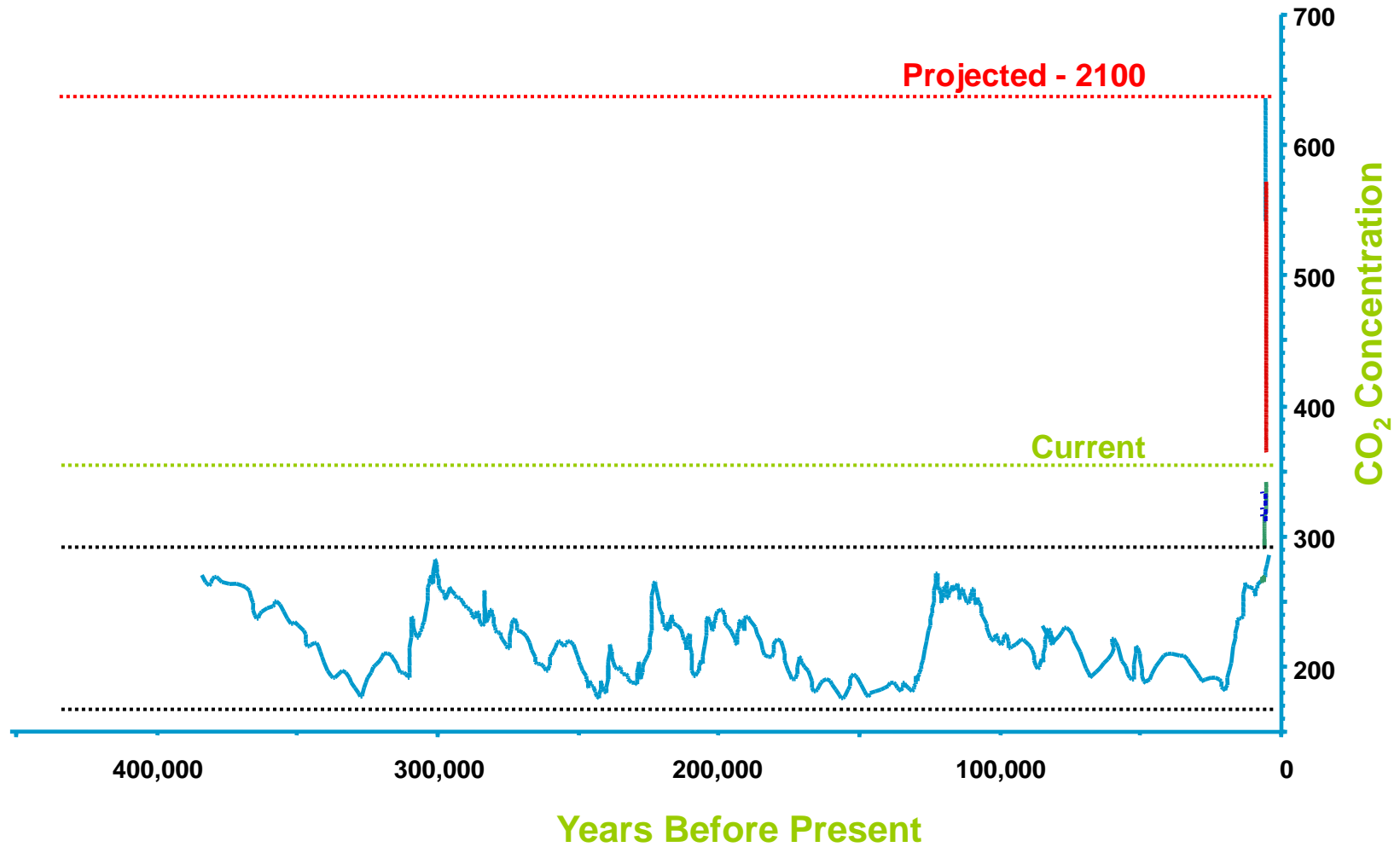


Uncertain Climate Futures



Projected future changes in precipitation patterns, according to 9 different models coupled Atmosphere Ocean General Circulation Models (AOGCMs). The gray boxes 'i', show inconsistent results across the different models

Increased Emissions a Reality !



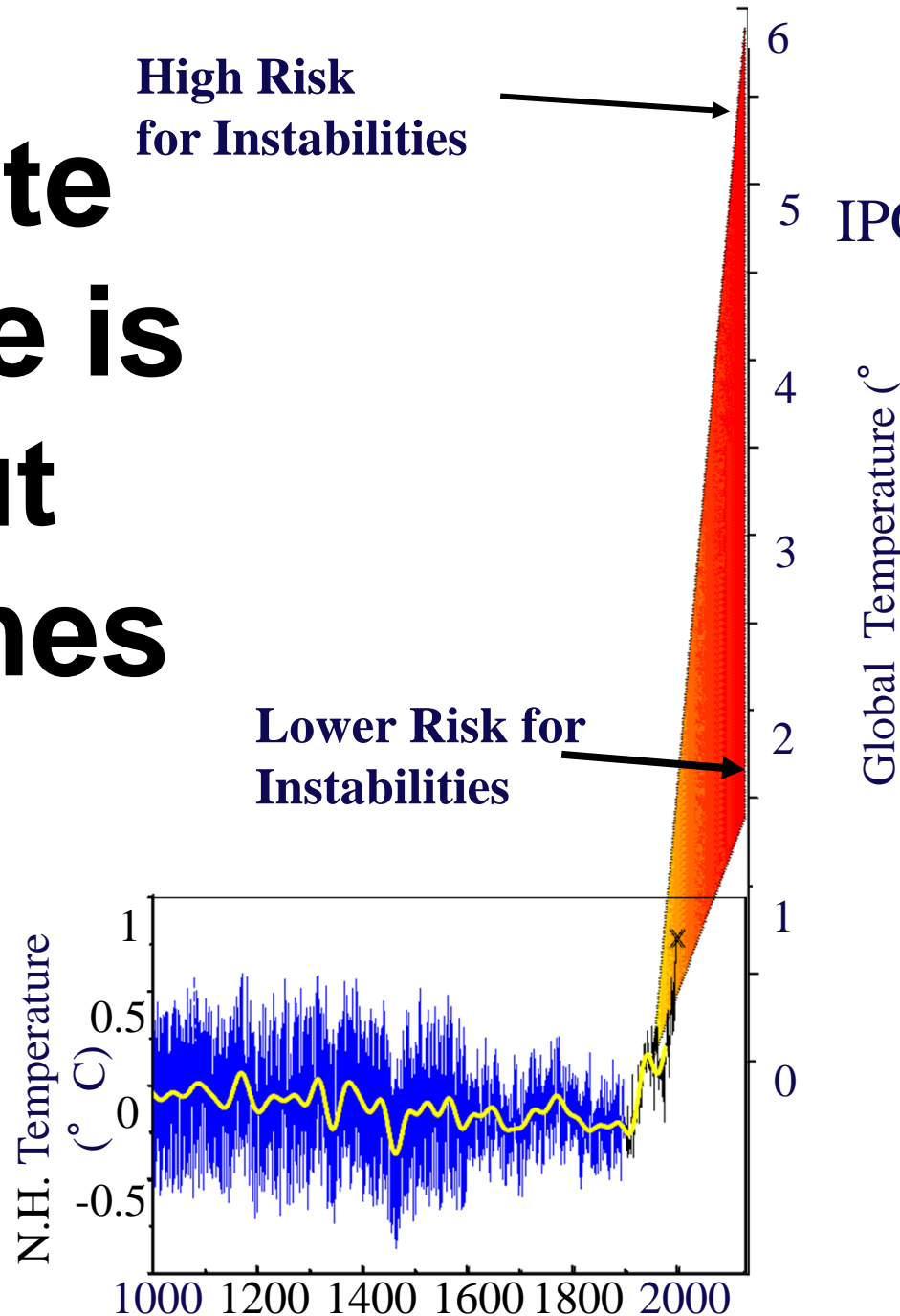
Climate Change is about Extremes

!!

High Risk
for Instabilities

Lower Risk for
Instabilities

IPCC Projections
2100 AD

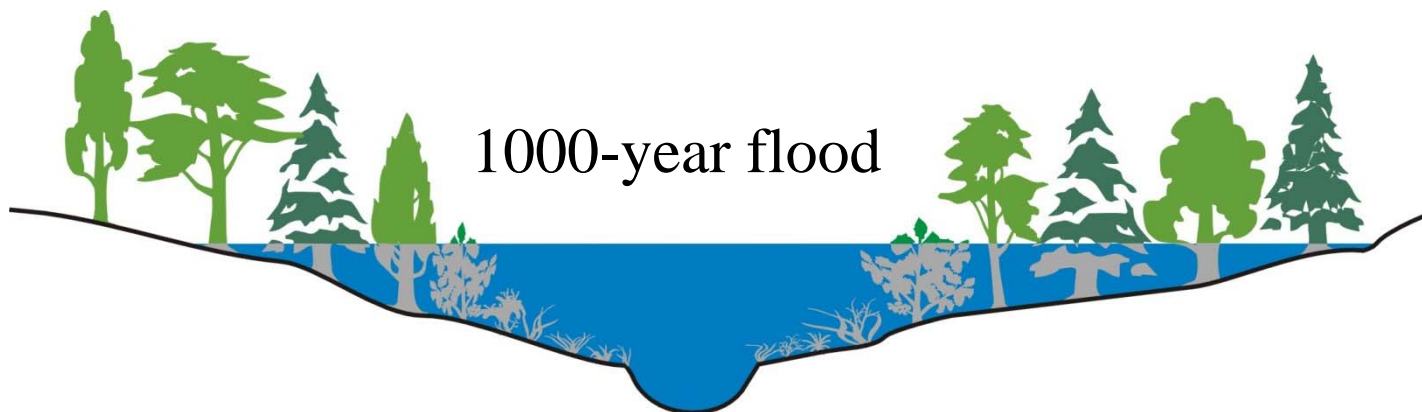


Reasons for changes in flood risk and vulnerability

| | |
|--|---|
| (i) Changes in socio-economic systems | Land-use change, increasing exposure and damage potential – floodplain development, growing wealth in flood-prone areas, changing risk perception |
| (ii) Changes in terrestrial systems | Land-cover change - urbanization, deforestation, elimination of natural inundation areas (wetlands, floodplains), river regulation – channel straightening and shortening, embankments), damming rivers, adverse changes of conditions of transformation of precipitation into runoff |
| (iii) Changes in climate and atmospheric system | Holding capacity of the atmosphere, intense precipitation, seasonality, circulation patterns |

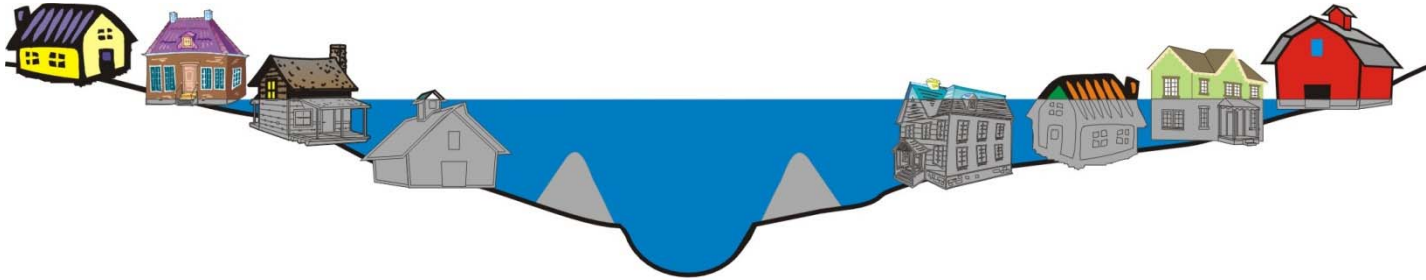
Source: Kundzewicz & Schellnhuber, 2004

Natural Systems



Changes in Socio-economic Systems

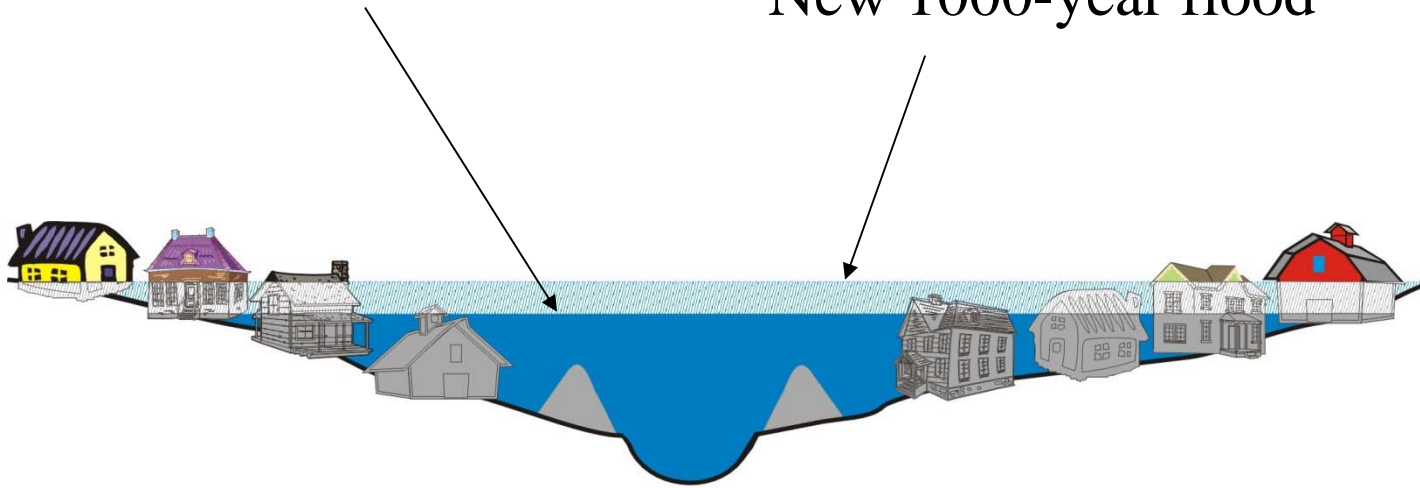
1000-year flood



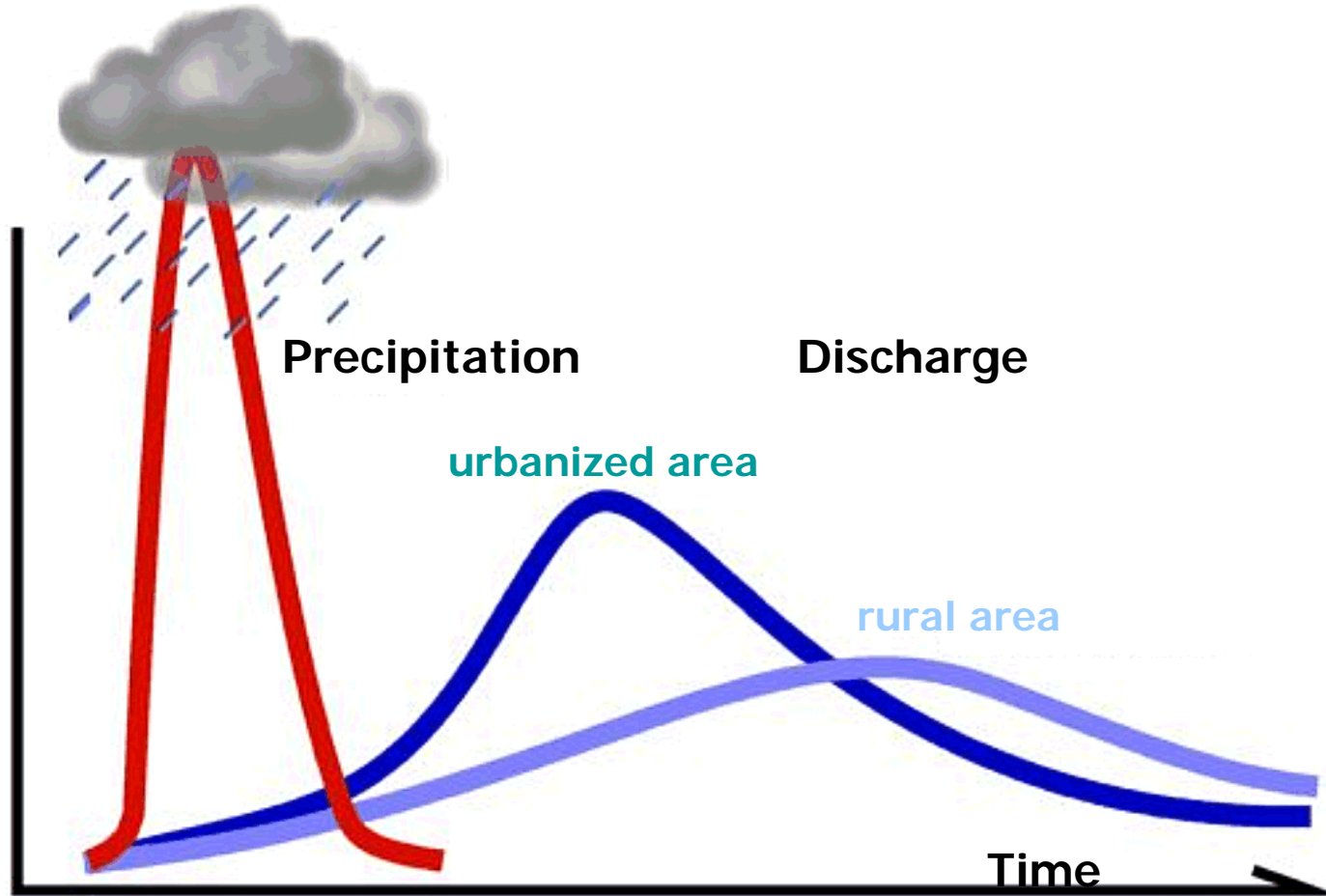
Changes in Climate and Atmospheric System

Old 1000-year flood

New 1000-year flood



Impacts of Land-use Change on Floods



Flood protection and management strategies modify either **flood waters**, or **susceptibility** to flood damage and **impact** of flooding.

Protect

[Absolute protection does not exist. Japan – superdikes]

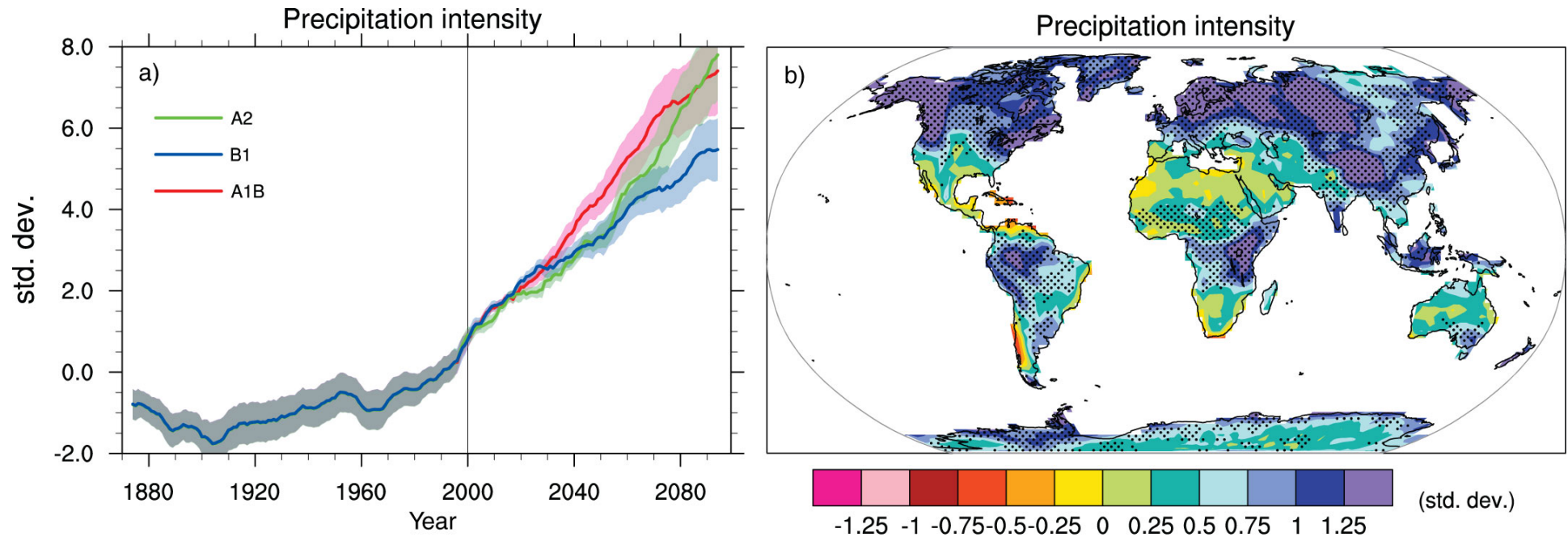
Accommodate

[Living with floods, learning from them]

Retreat

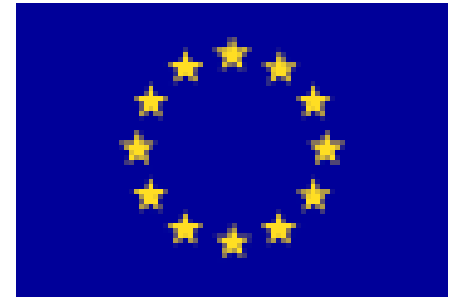
[The state/province purchases land and property in flood-prone areas]

Examples of measures: structural/technical protection measures - dikes, relief channels, enhanced water storage; watershed management (“keep water where it falls” and reduce surface runoff and erosion), or increase of system resistance: flood forecasting and warning; regulation through planning, legislation and zoning; flood insurance; relocation of population living in flood-risk areas; flood proofing on location.



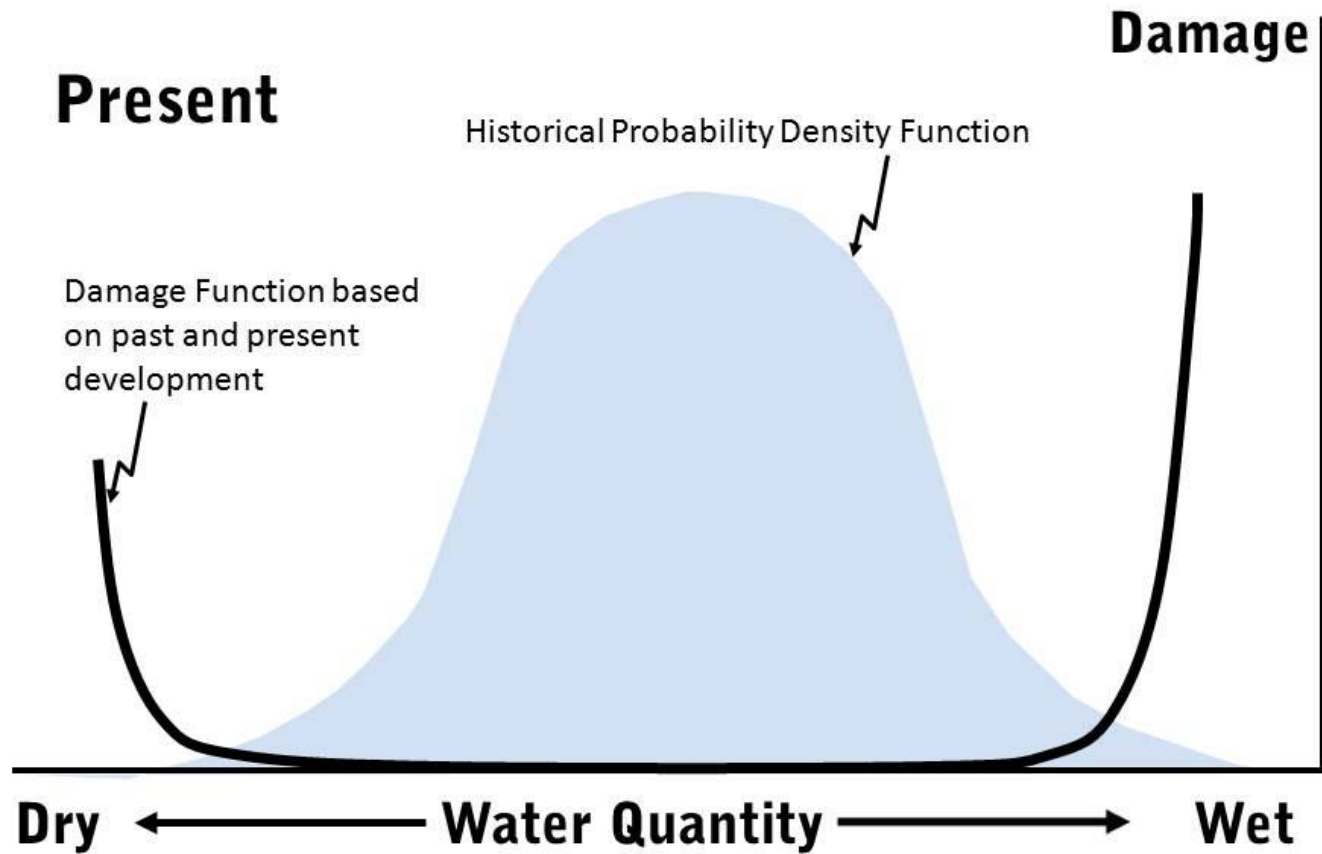
Changes in extremes based on multi-model simulations from nine global coupled climate models. L) Globally averaged changes in precipitation intensity (defined as the annual total precipitation divided by the number of wet days) for three scenarios. R) Changes of spatial patterns of precipitation intensity based on simulations between two 20-year means (2080–2099 minus 1980–1999) for the A1B scenario. (IPCC AR4)

European Union Floods Directive

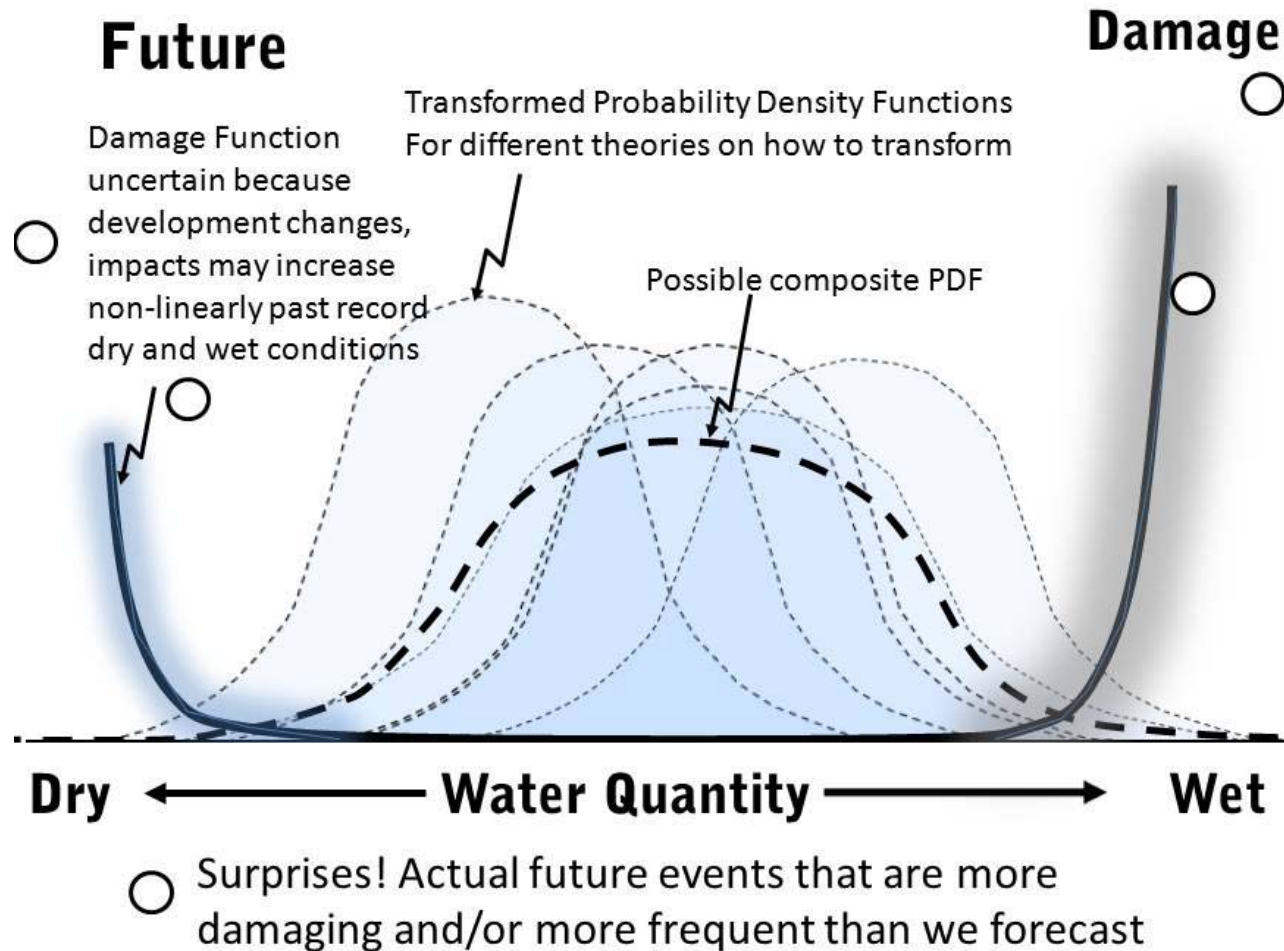


- Preliminary flood risk assessment (including assessment of the projected impact of climate change trends; forecast of estimated consequences of future floods, ...).
- Preparation of flood maps and indicative flood damage maps, covering the geographical areas which could be flooded with a high probability (return period of **10 years**); with a medium probability (**100 years**), and with a low probability (**extreme events**).
- Preparation and implementation of flood risk management plans, aimed at achieving the required levels of protection.

When Static Management is OK



Adaptive Management addresses Uncertainty



FLOOD 2010

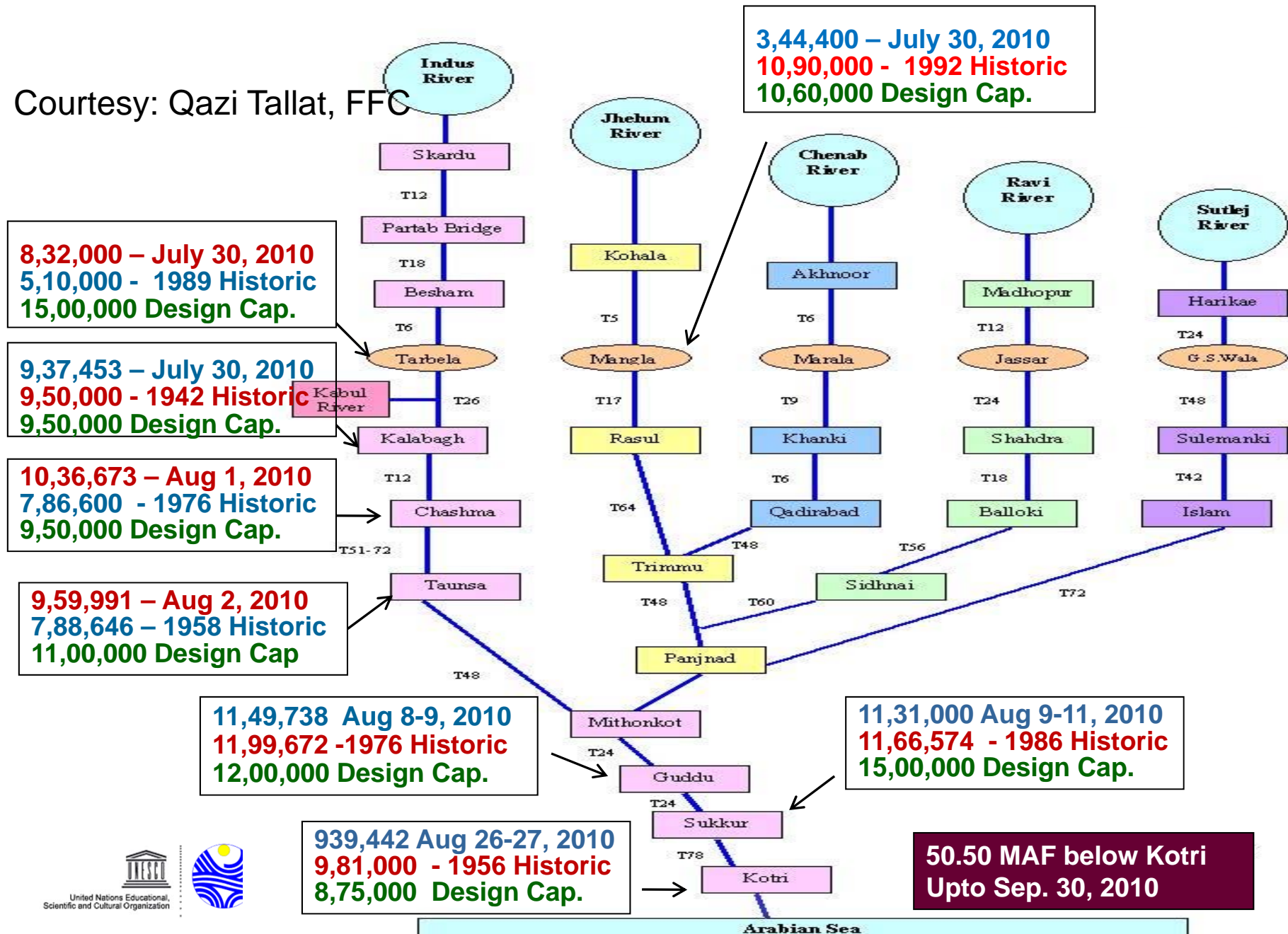
Photos: Courtesy of Pakistan Colleague – Education Workshops at NUST



A man marooned by flood waters, alongside his livestock, waves towards an Army helicopter for relief handouts in the Rajanpur district of Punjab province on August 9, 2010.

FLOOD PEAKS INDUS RIVER SYSTEM-2010 VS HISTORIC PEAKS

Courtesy: Qazi Tallat, FFC





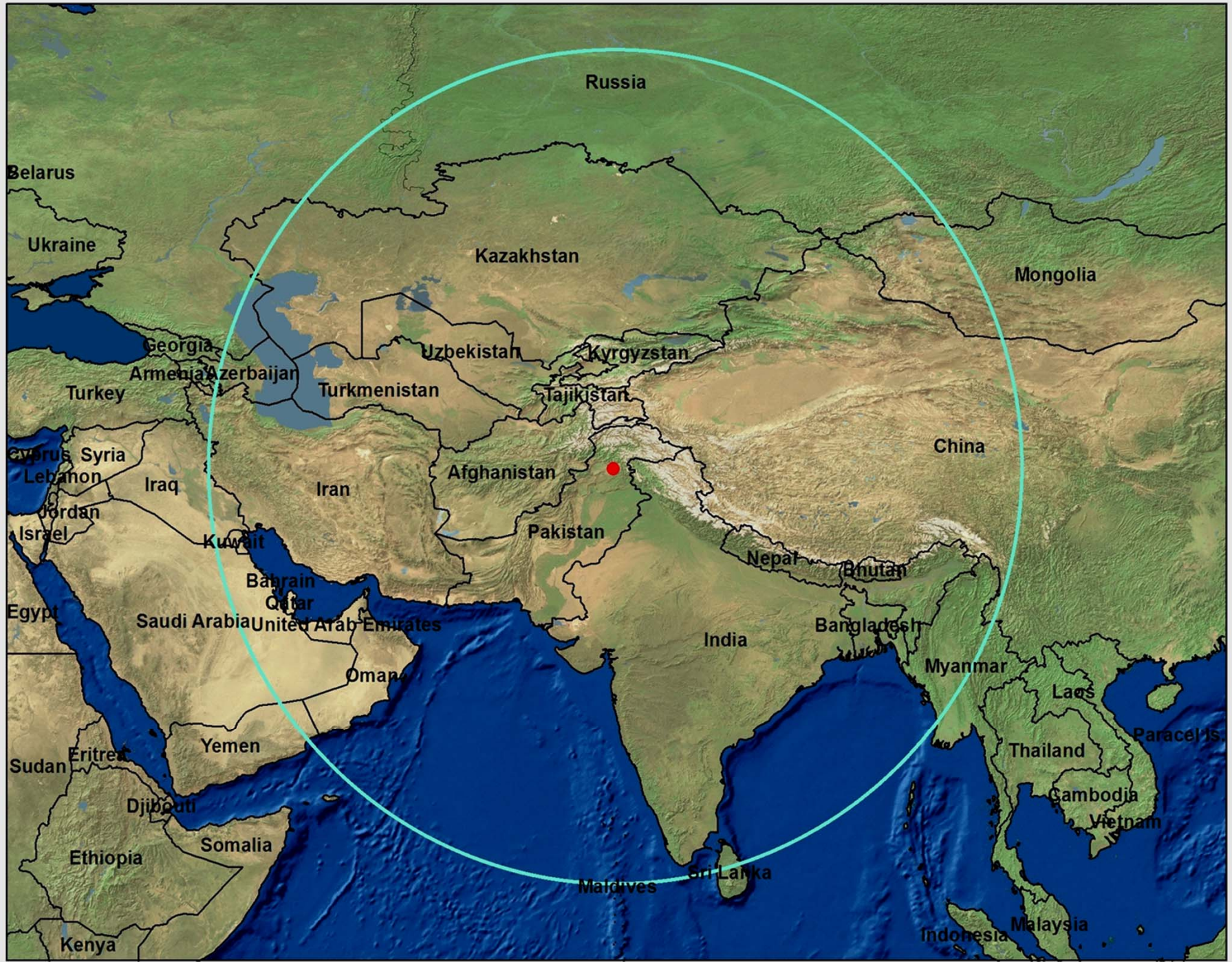
Pakistan Floods 2010: Is it related to Climate Change?

Aggravated the Monsoon activity by the la Niña phenomenon in the Pacific Ocean, according to World Meteorological Organization (WMO)

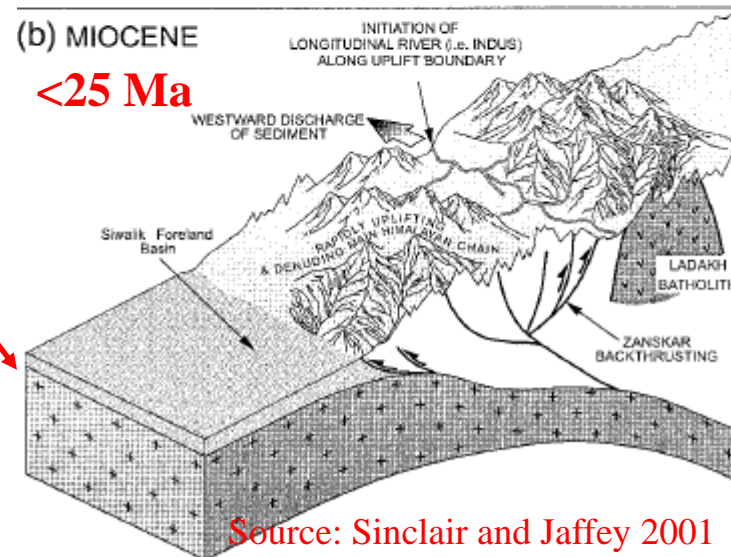
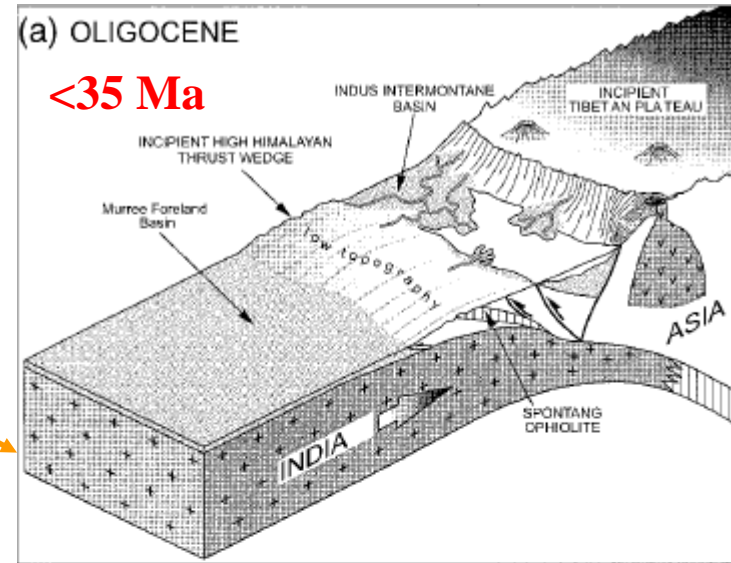
Scientific projections show the association between intense extreme weather events and global warming, however, longer time investigations required to establish whether an individual event is attributable to climate change!

Until the science finds absolute relationship, in the meanwhile, however, we can protect the globe from carbon-emitting industries!

Source: WMO. http://www.wmo.int/pages/mediacentre/news/extremeweathersequence_en.html



Unique Indus System: A Super Market of Disasters



Source: Sinclair and Jaffey 2001

Monsoon 2010 : Extreme Rainfall - Flood

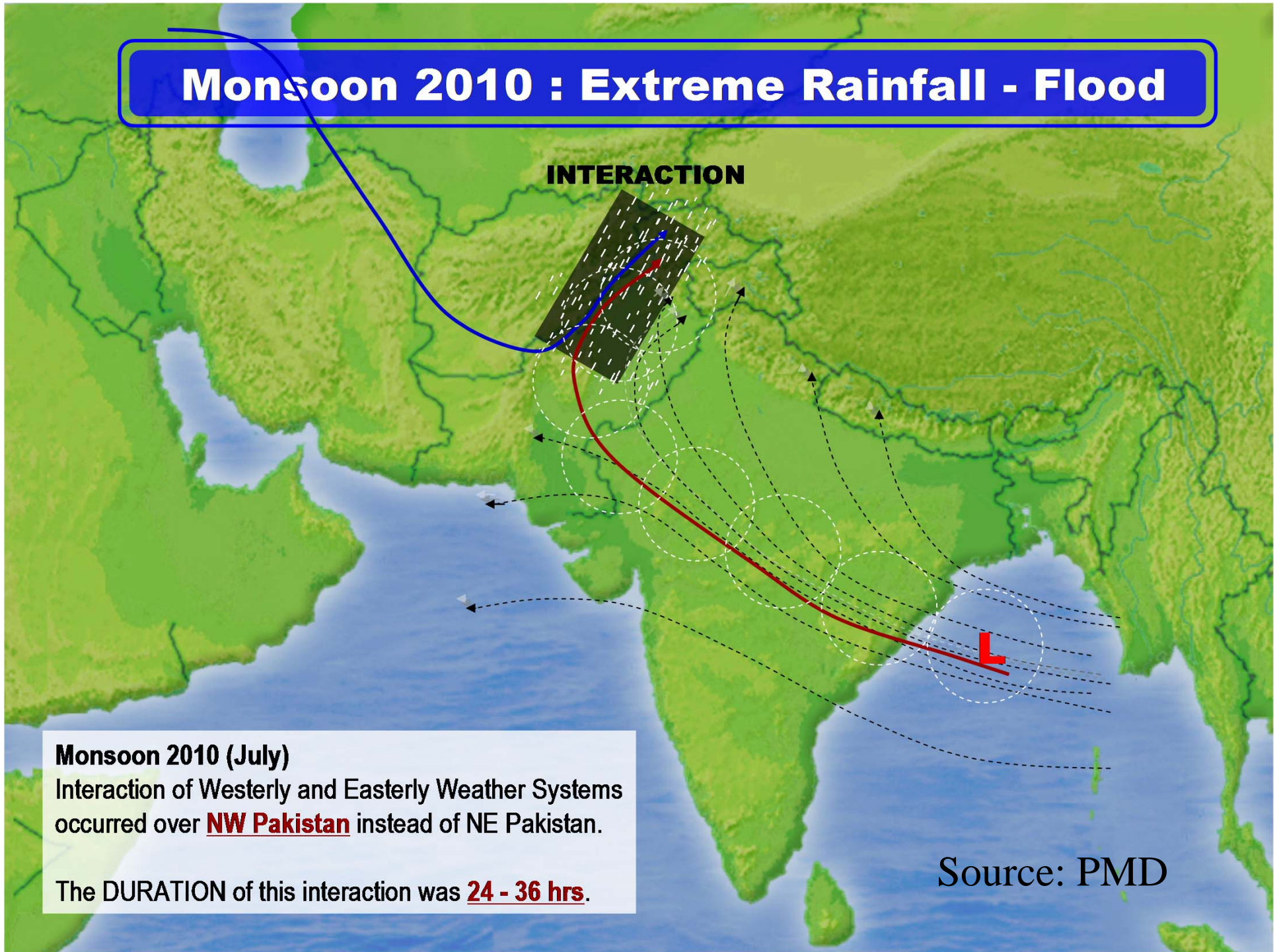
INTERACTION

Monsoon 2010 (July)

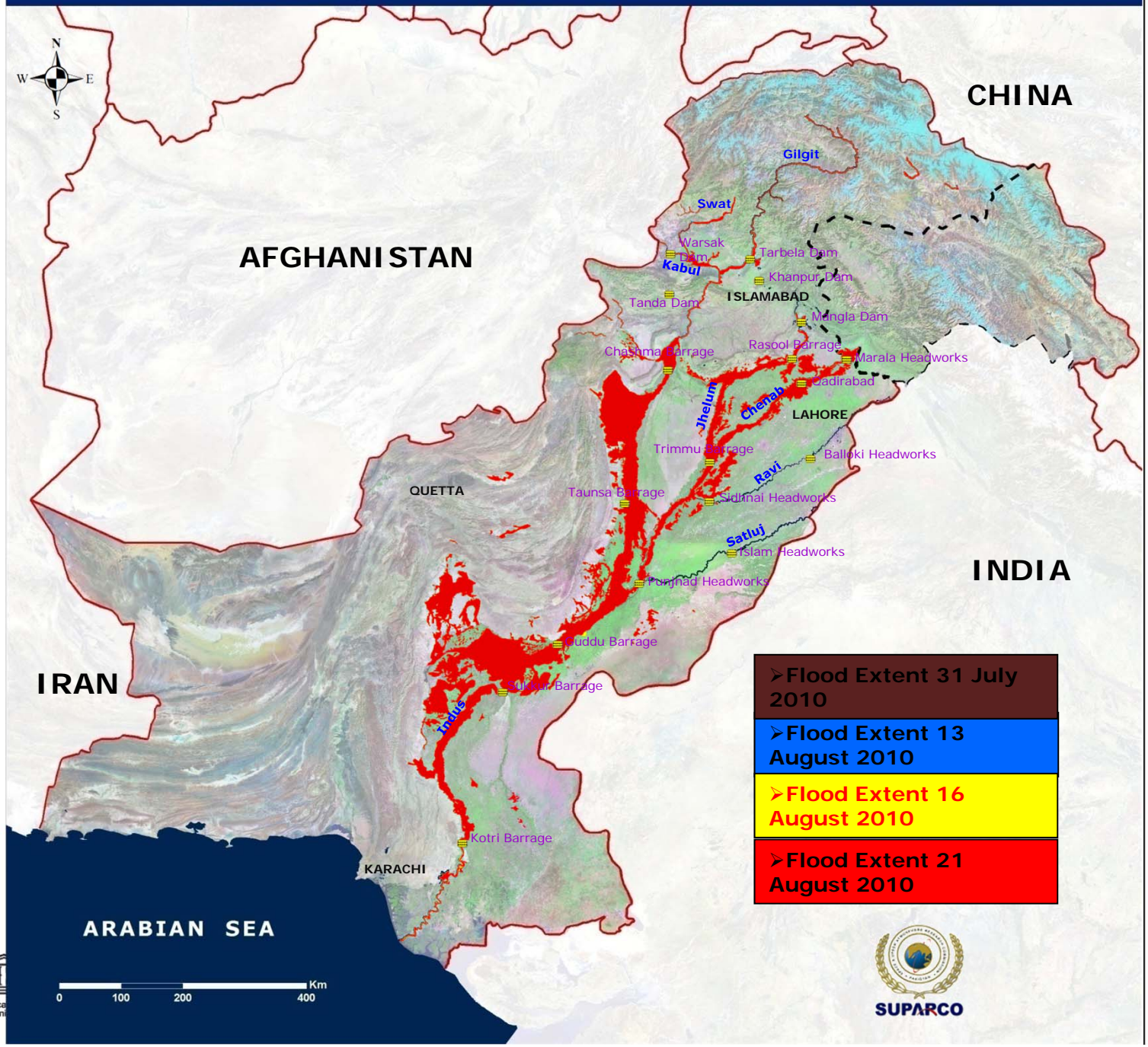
Interaction of Westerly and Easterly Weather Systems occurred over **NW Pakistan** instead of NE Pakistan.

The DURATION of this interaction was **24 - 36 hrs.**

Source: PMD



PAKISTAN: FLOOD/RAIN 2010



- Flood Extent 31 July 2010
- Flood Extent 13 August 2010
- Flood Extent 16 August 2010
- Flood Extent 21 August 2010

Pakistan: Flood / Rain 2010

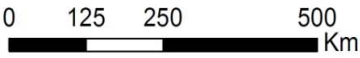


These statistics are outcome of preliminary analysis based on rapid mapping



- Dams & Barrages
- Affected Road
- Affected Railway Line
- Affected Settlement
- District Boundary
- Flood Extent

| | |
|----------------------------|-------------|
| Total Flooded Area: | 67903 Sq Km |
| Affected Roads: | 10522 Km |
| Affected Railway Line: | 1630 Km |
| Affected Settlement: | 13777 |
| Affected Agriculture Area: | 19409 Sq Km |
| Affected Houses: | 450610 |
| Except Gilgit Baltistan | |



UNESCO Missions to Pakistan

To define areas of cooperation with Pakistani authorities to reinforce the country's capacity in:

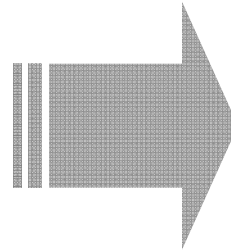
- integrated flood and watershed management
- groundwater resources for emergency situations
- landslides and ground instability especially for relocation of affected population.



Problem revealed by the flood 2010 and counter measures taken in this project

Upper Indus

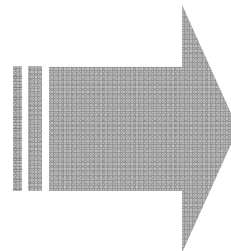
There was limited or no flood forecasting ability for the areas severely damaged by the floods



Flood forecasting including upper-Indus will be introduced by a new system utilizing satellite data (A1)

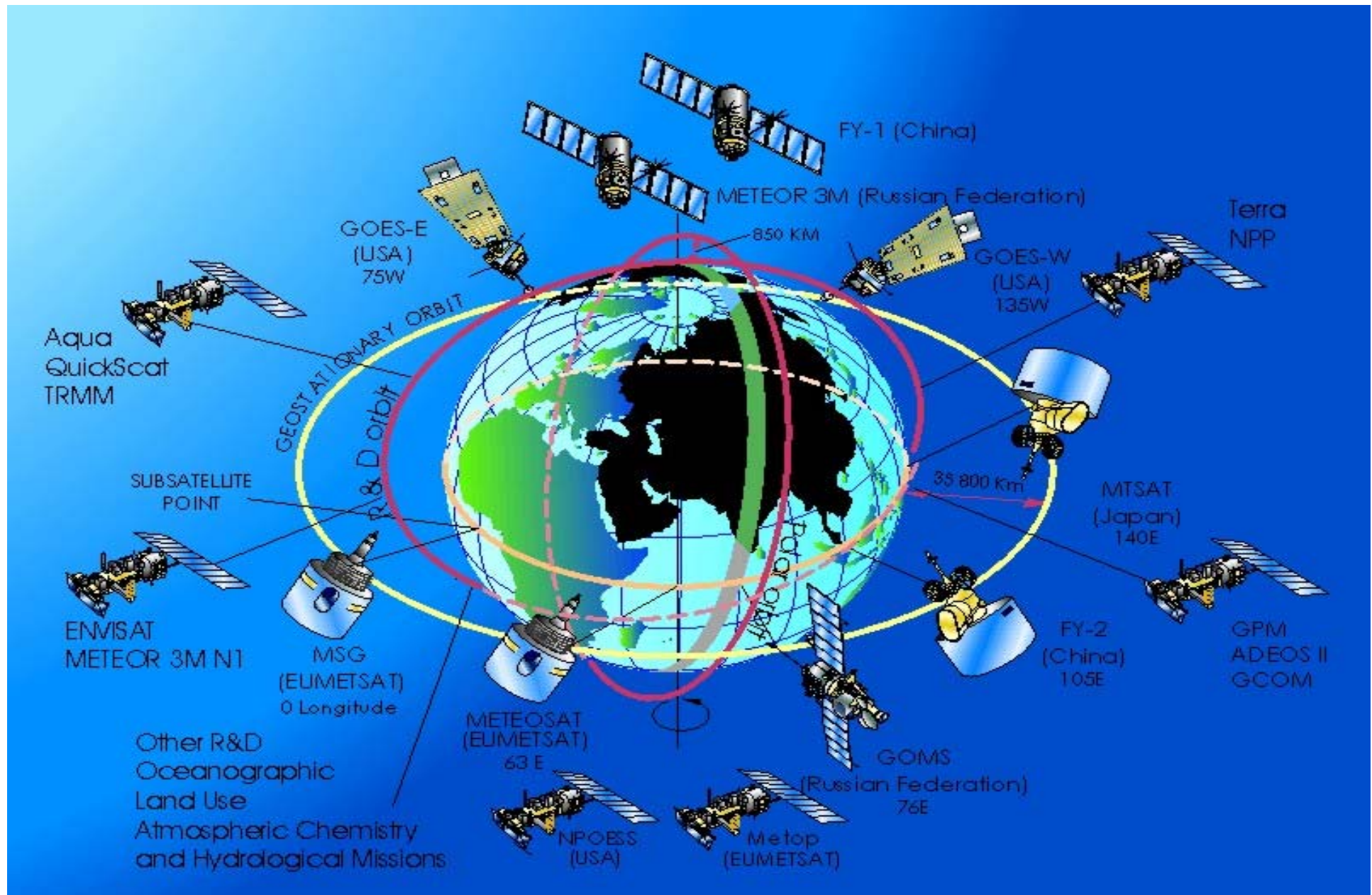
Lower Indus

The flood devastated the areas where had no inundation experience in the past



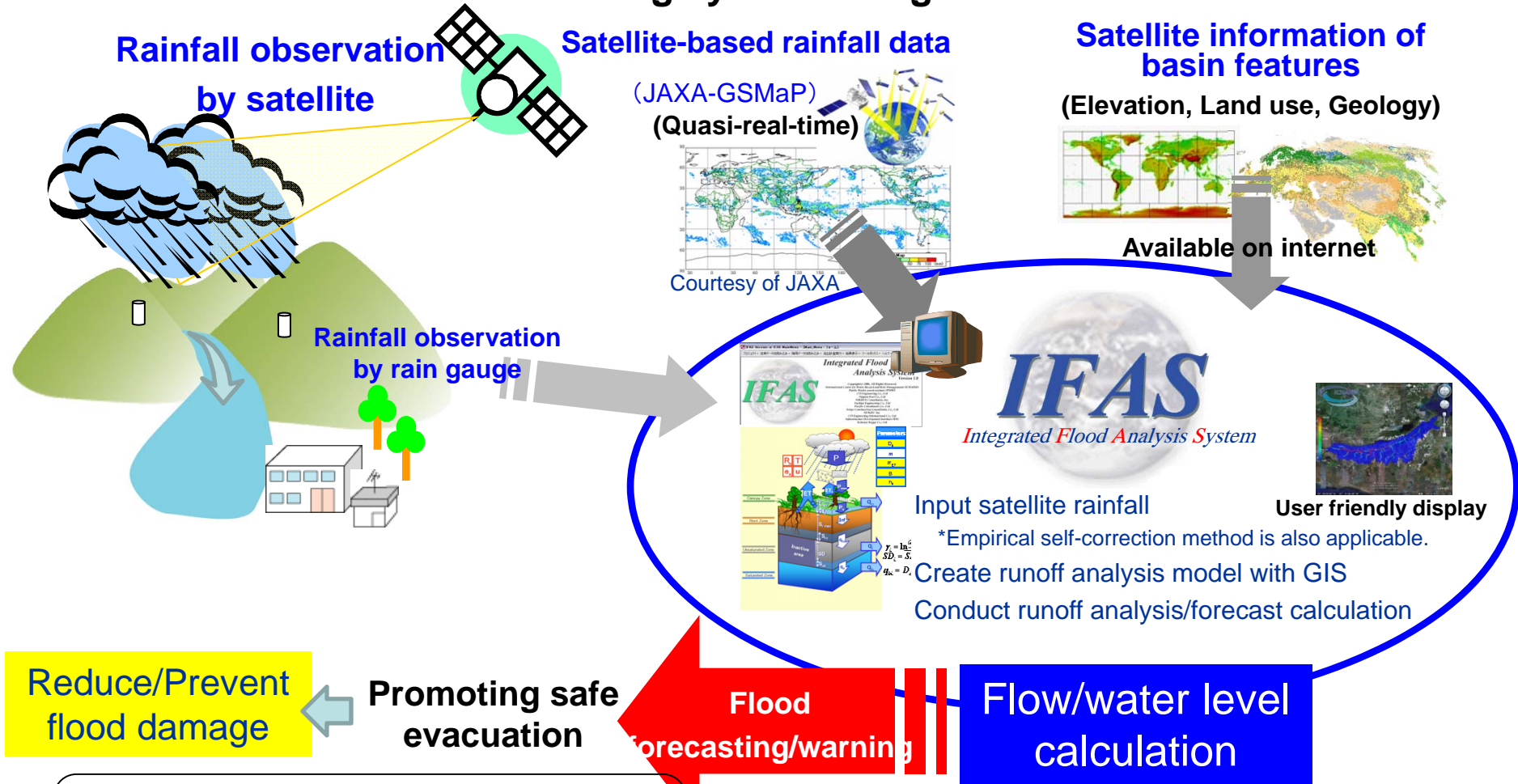
Updating flood hazard maps in lower Indus to cover the new inundated areas (A2)

Current Meteorological Satellites in Space



Integrated Flood Analysis System (IFAS)

Flood forecasting system using satellite data



Current situation in developing countries

Lack of rainfall data
Lack of river survey data
Lack of analysis tool

Costly and time-consuming
-> Difficult to approach system development

IFAS enables flood forecasting in areas even with insufficient ground-based observation facilities. **ICHARM** supports **engineers to improve accuracy** of IFAS by constructing and enhancing a ground-based observation network by degrees.

3

United Nations
Scientific and Cultural Organization

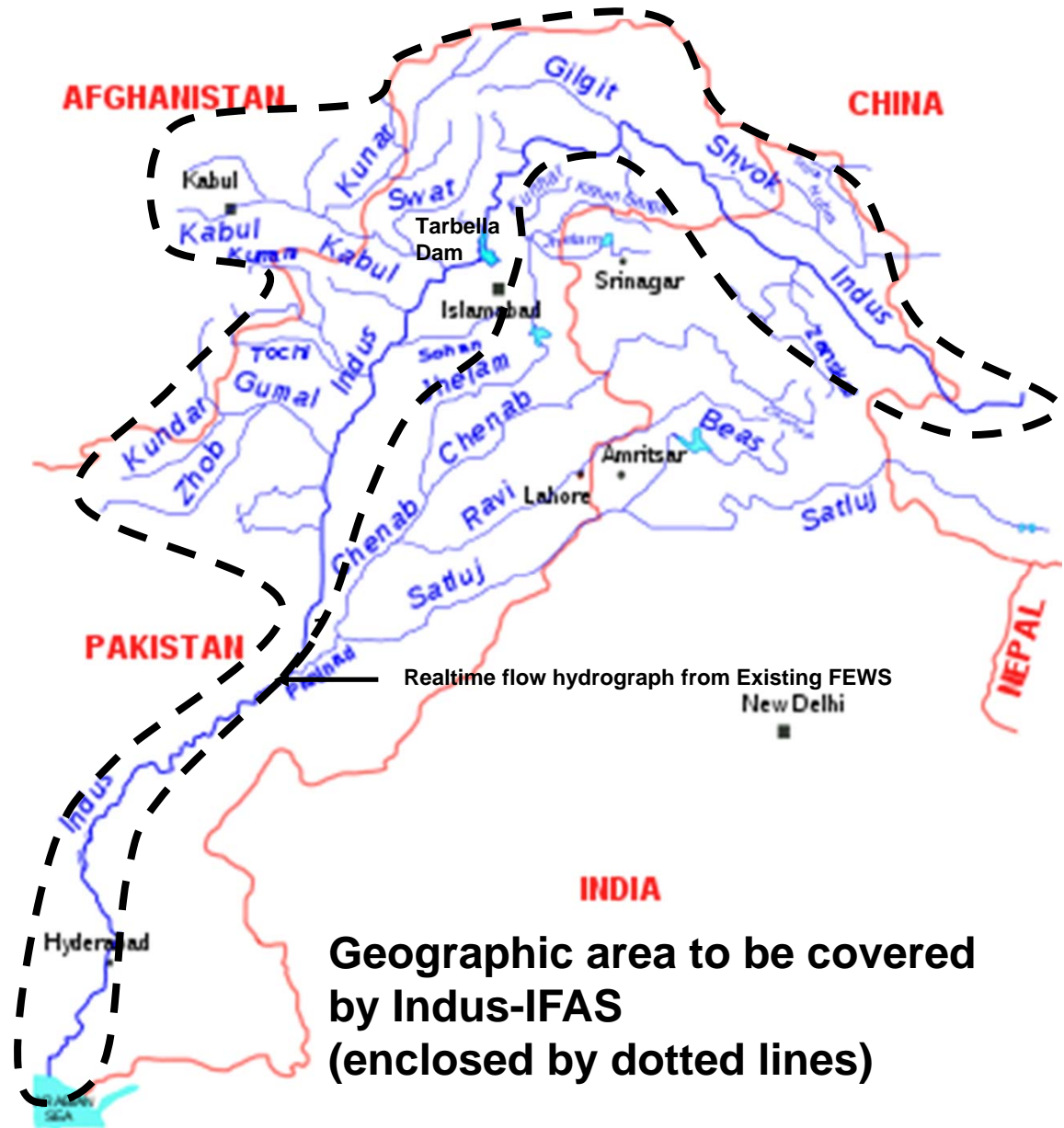
Implementing IFAS by ADB technical support project

-Bengawan Solo River basin (to be completed in 2011)

200 people from 22 countries participated in the IFAS training at ICHARM

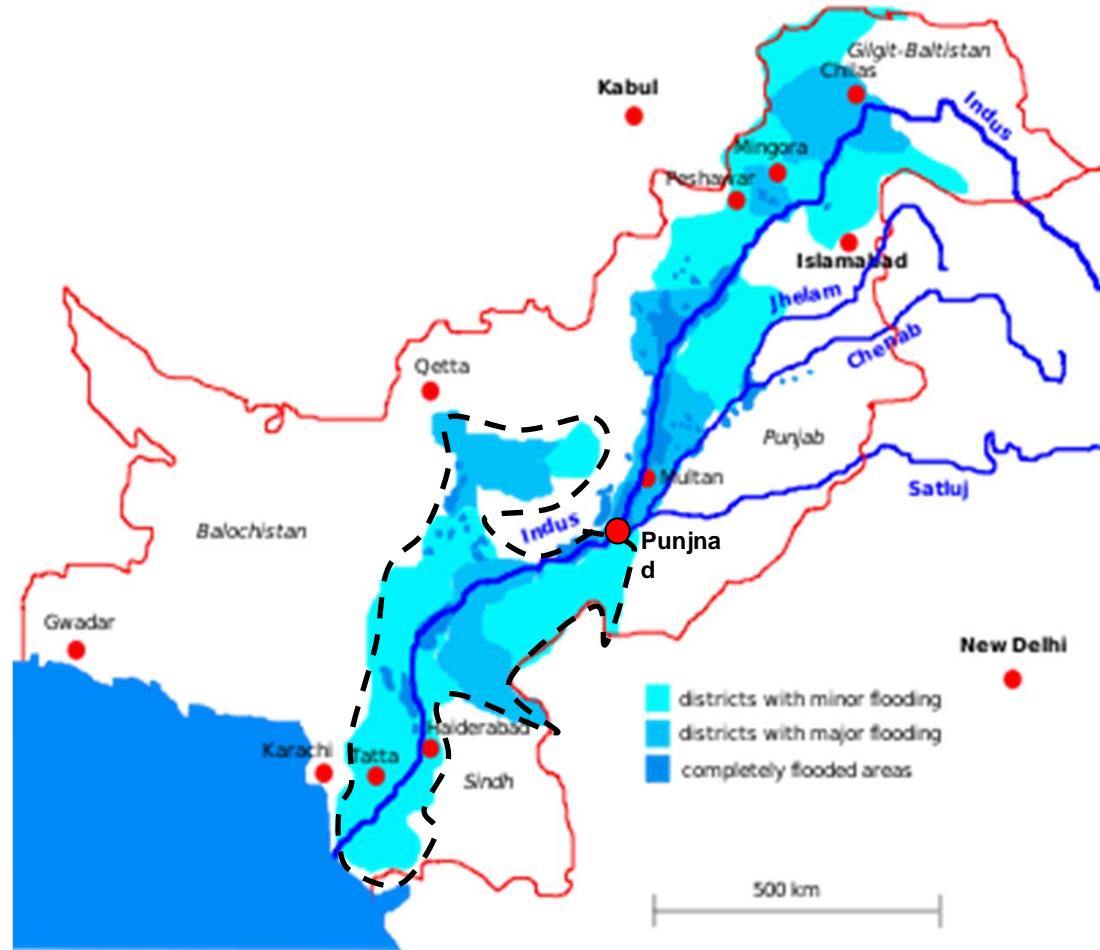
INDUS IFAS

- Indus-IFAS will be developed in collaboration with the government of Pakistan
- Test operation in 2012
- Validation and update in 2013



Flood Hazard Mapping

- Update flood hazard maps by using satellite and radar data
- Cover lower Indus including newly affected areas by the flood 2010



**Proposed Flood Hazard Mapping Area
(enclosed by dotted lines)**

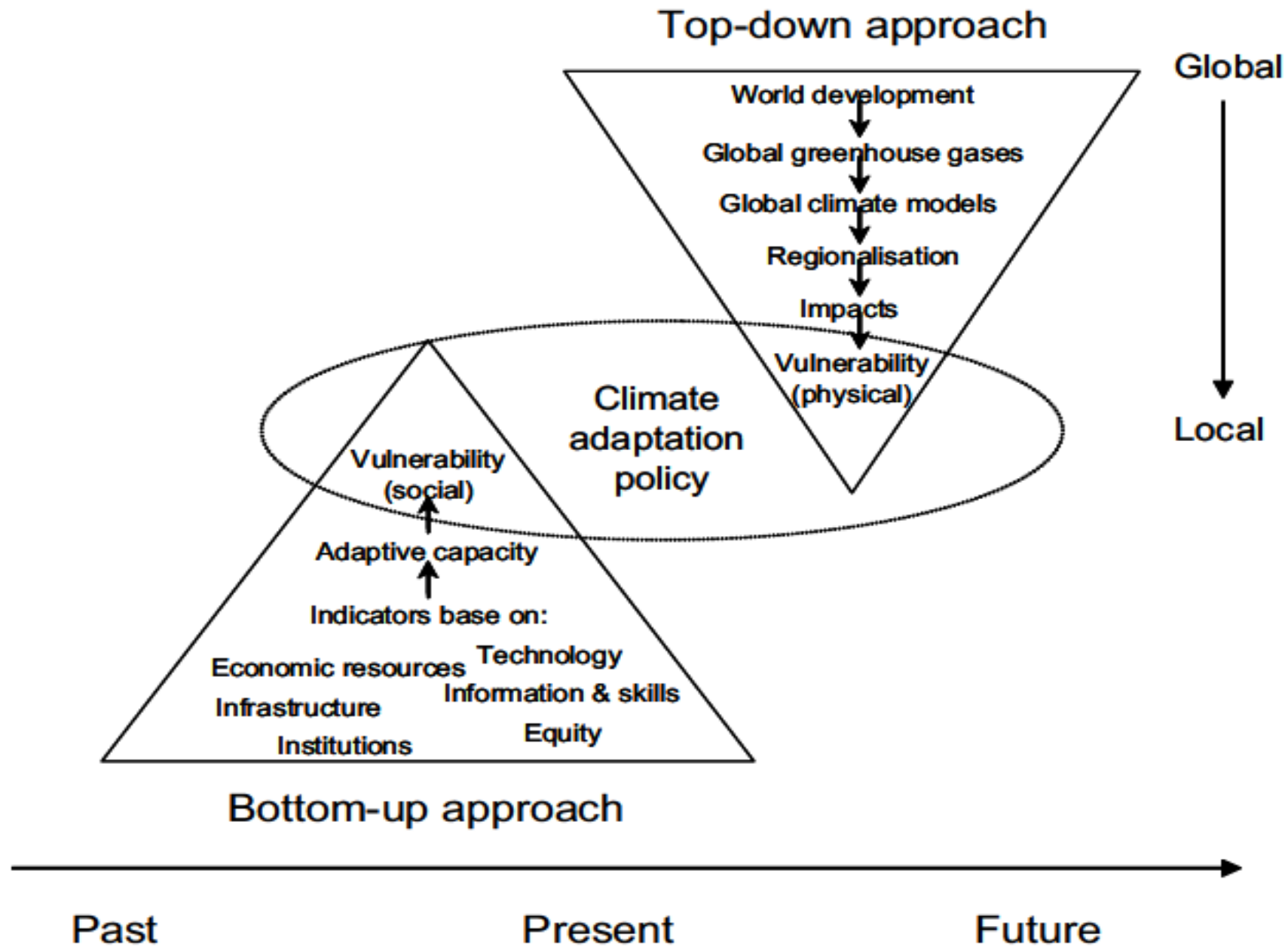


Figure 3.1. “Top-down” and “bottom-up” approaches used to inform adaptation to climate change (from Dessai and Hulme 2004).

Take Home Messages

- The impact of climate forcing on flood risk is complex and depends on the **flood generation mechanism**.
- Higher and **more intense precipitation** has been already observed and this trend is expected to strengthen in the warmer world, directly impacting on flood risk.
- It is difficult to disentangle the climatic change component from **strong natural variability** and **direct human impacts**.
- It is important to have **right legislation** promoting watershed management as part of climate and floods related strategies.
- There is need for **adaptive management** using a combination of appropriate **top-down and bottom-up approaches**.

- Further Information

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