Climate Change in Gilgit-Baltistan: impacts on humans and hazards

David Petley
Wilson Professor of Hazard and Risk
Executive Director, Institute of Hazard, Risk and Resilience
Durham University, United Kingdom

Durham University

http:daveslandslideblog.blogspot.com

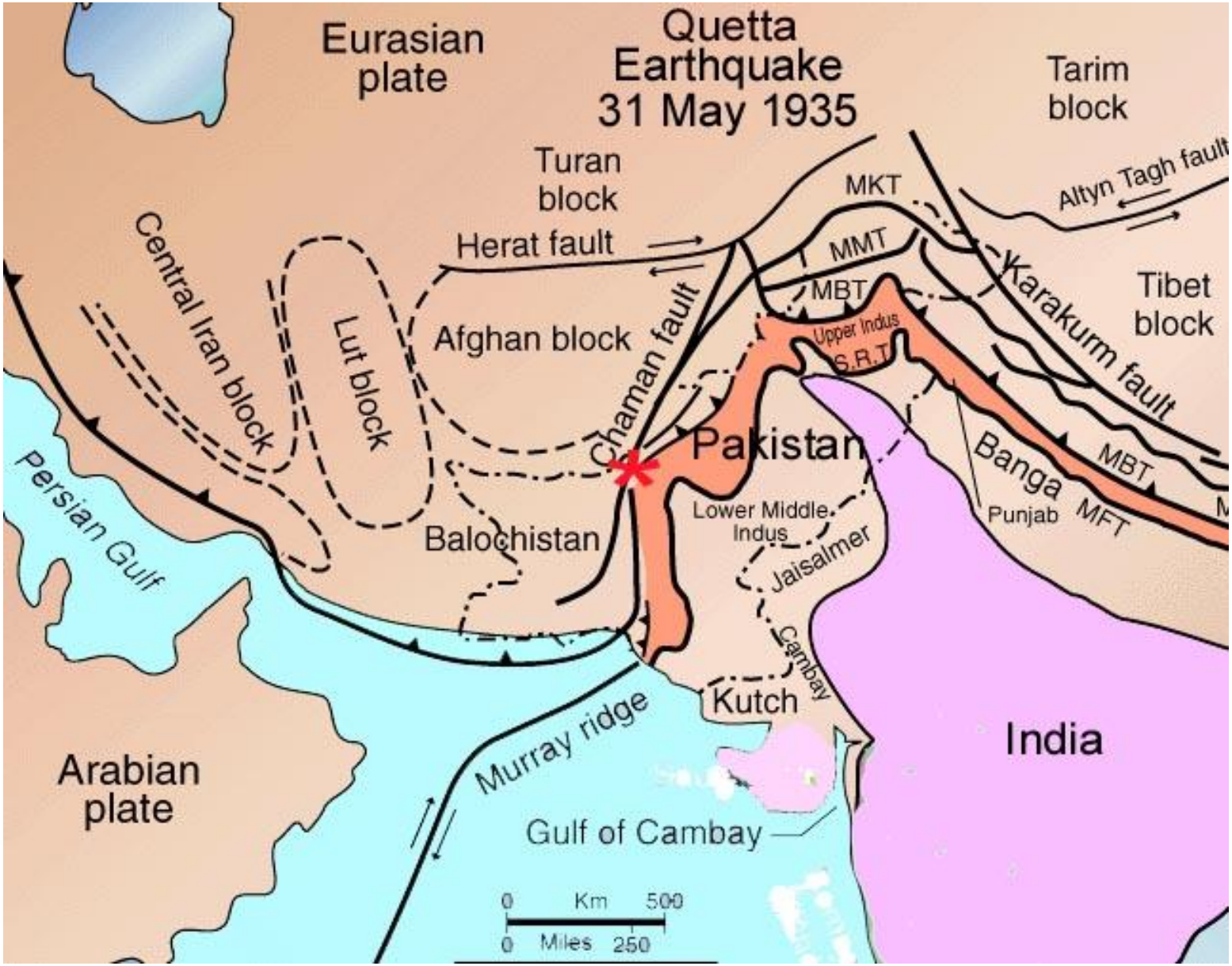
The Boulby Geoscience Facility

Gilgit-Baltistan is very hazard prone

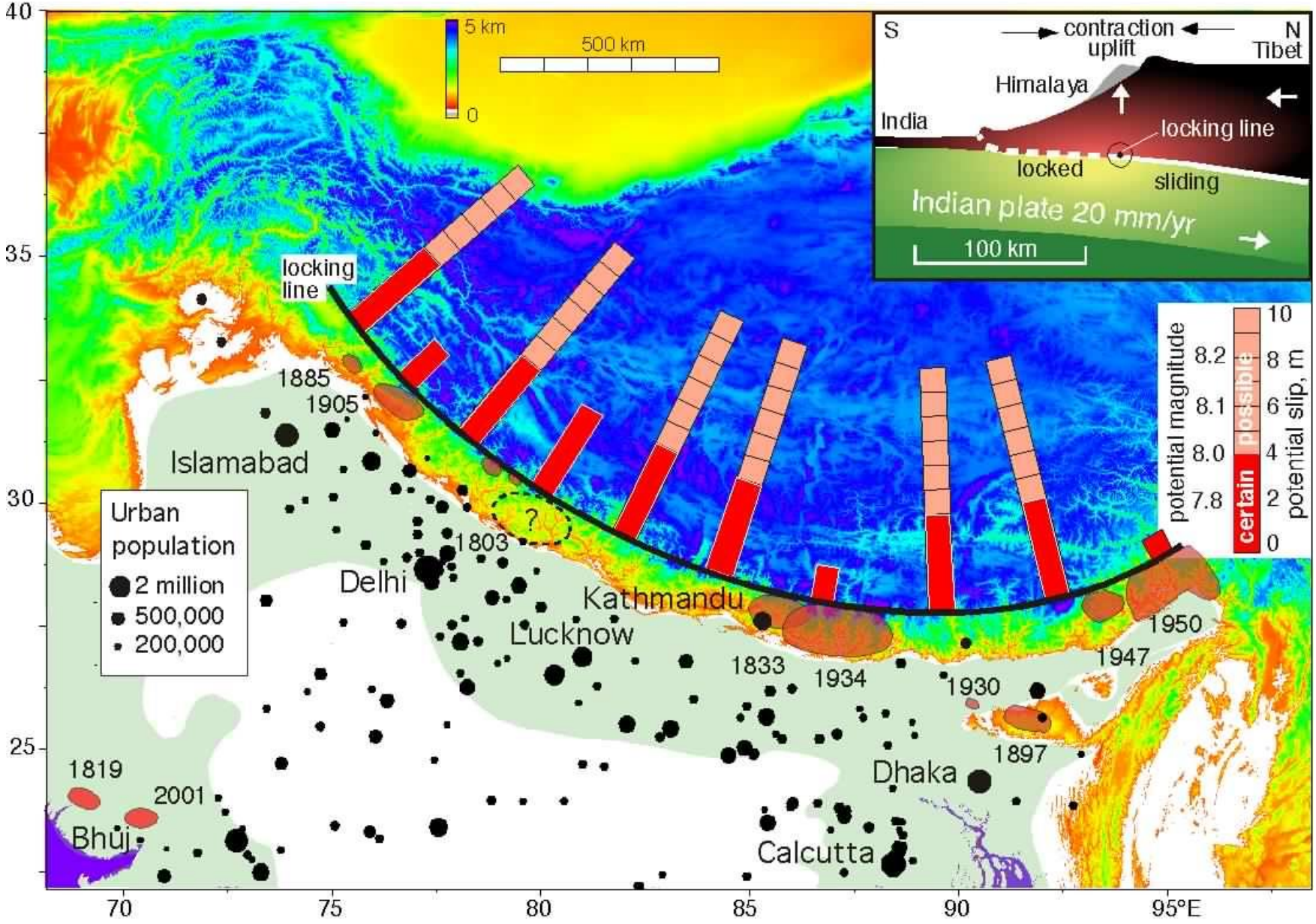
- Earthquakes
- Glacial lake floods
- Melting permafrost
- Drought
- Landslides
- Avalanches
- Floods

Dynamic but poor population means that risk is exacerbated and resilience is low

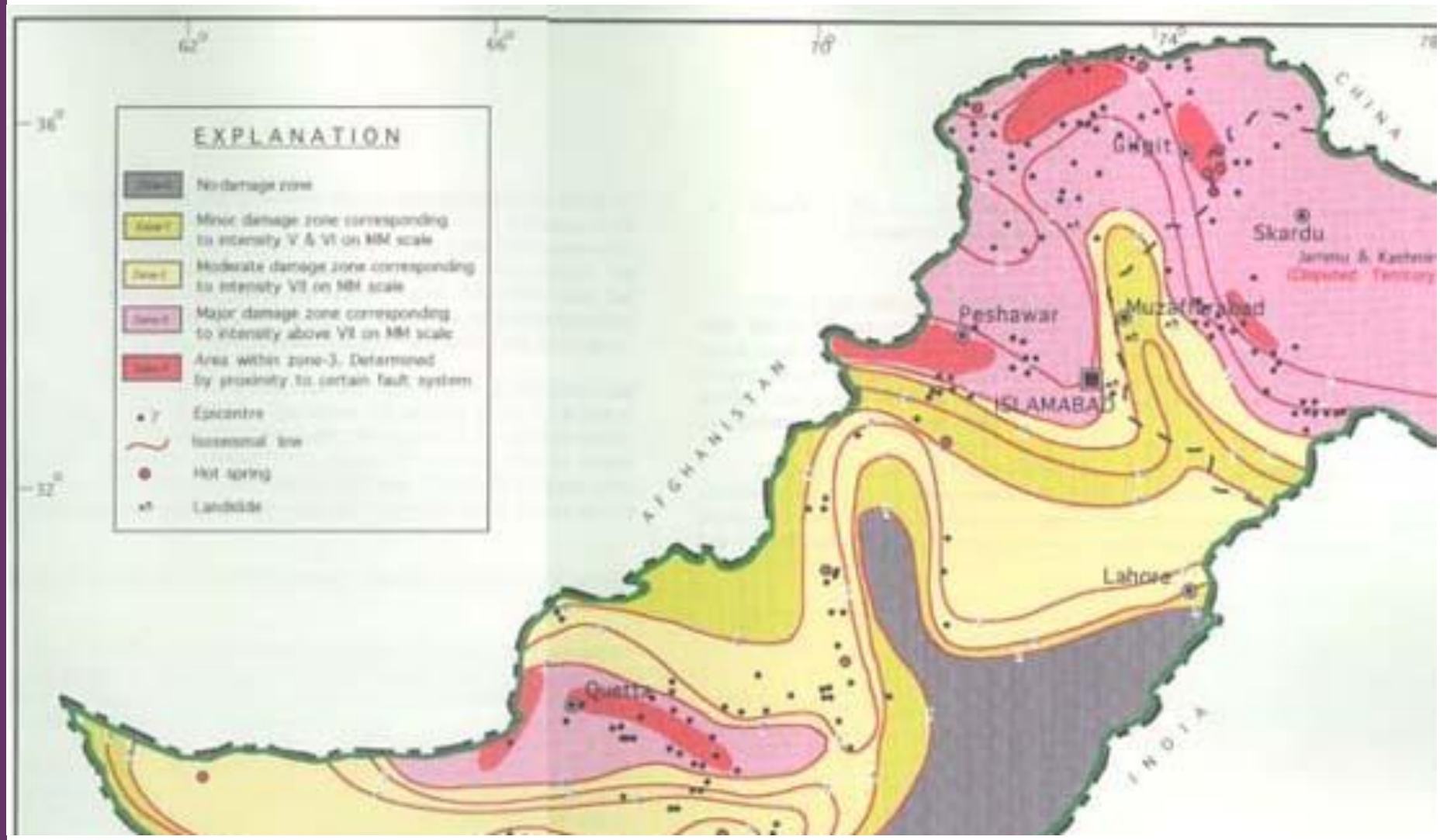
Major faults in Pakistan (George Pararas-Carayannis)



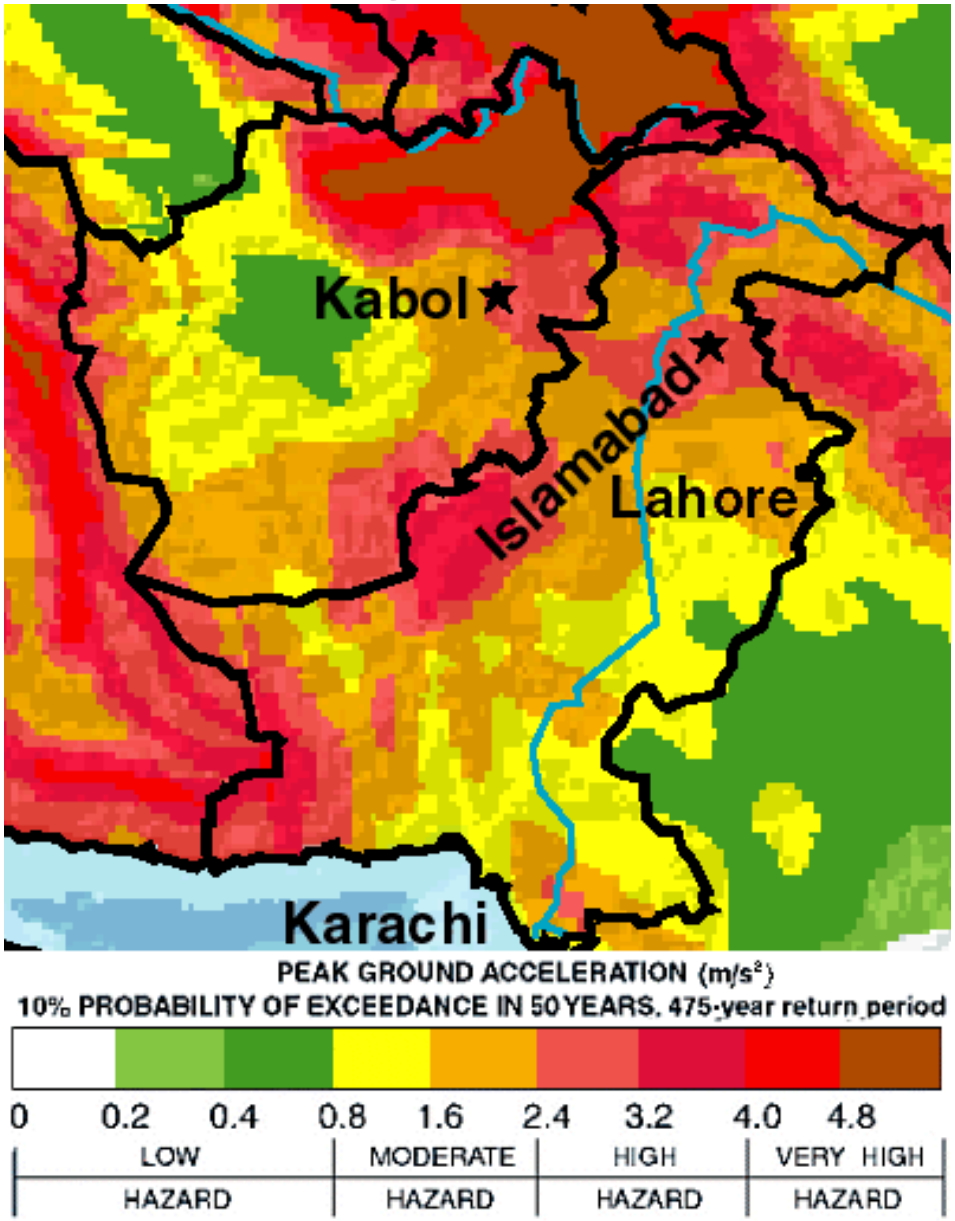
Himalayan Seismic Hazard (Bilham 2001)



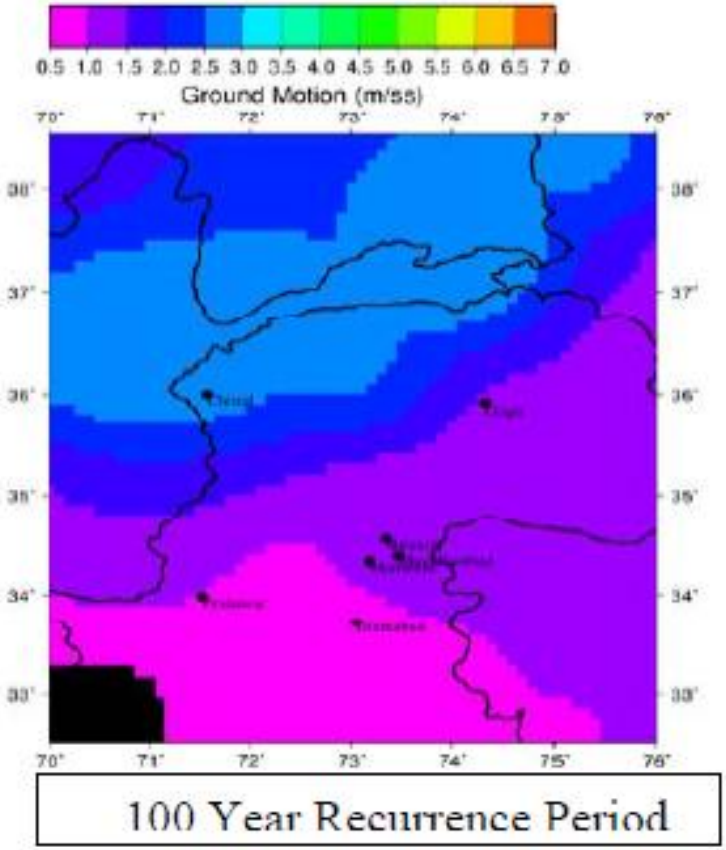
Pakistan seismic hazard map (before 2005)



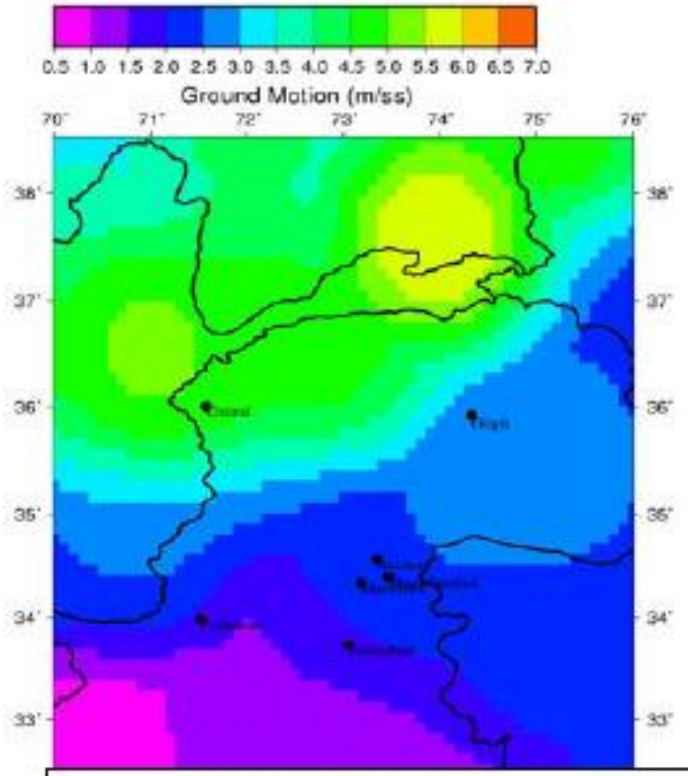
GSHAP seismic hazard model: Pakistan and Afghanistan



PAKMET 2006 seismic hazard map for N. Pakistan

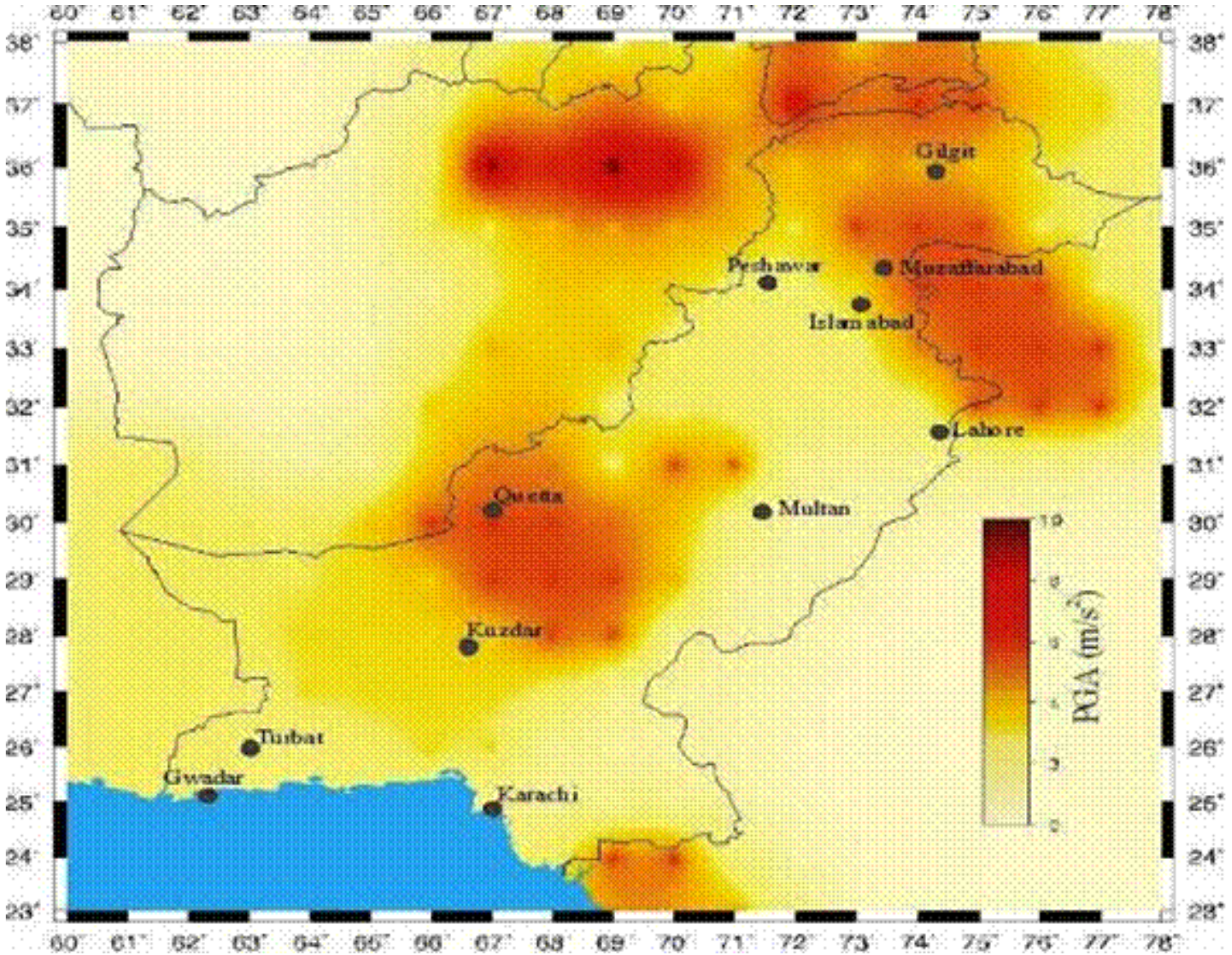


100 Year Recurrence Period

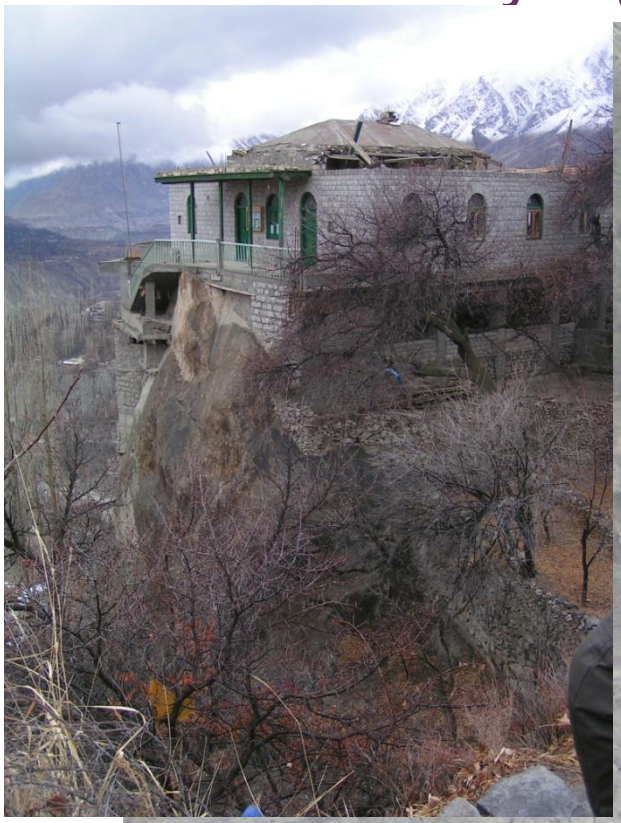


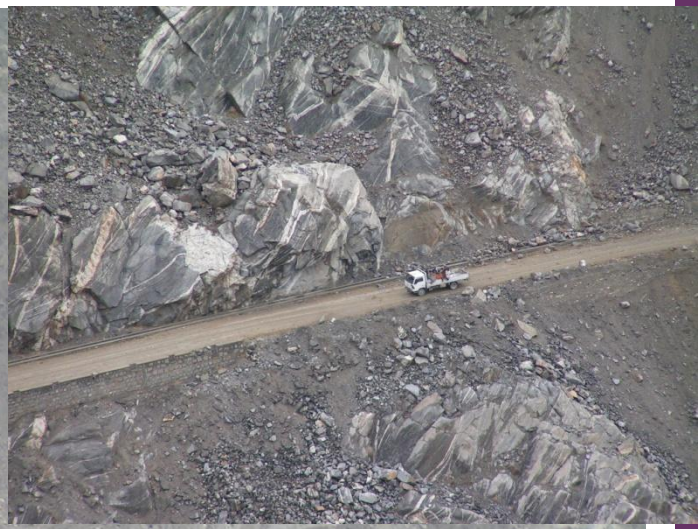
500 Year Recurrence Period

Latest Pakmet seismic hazard map



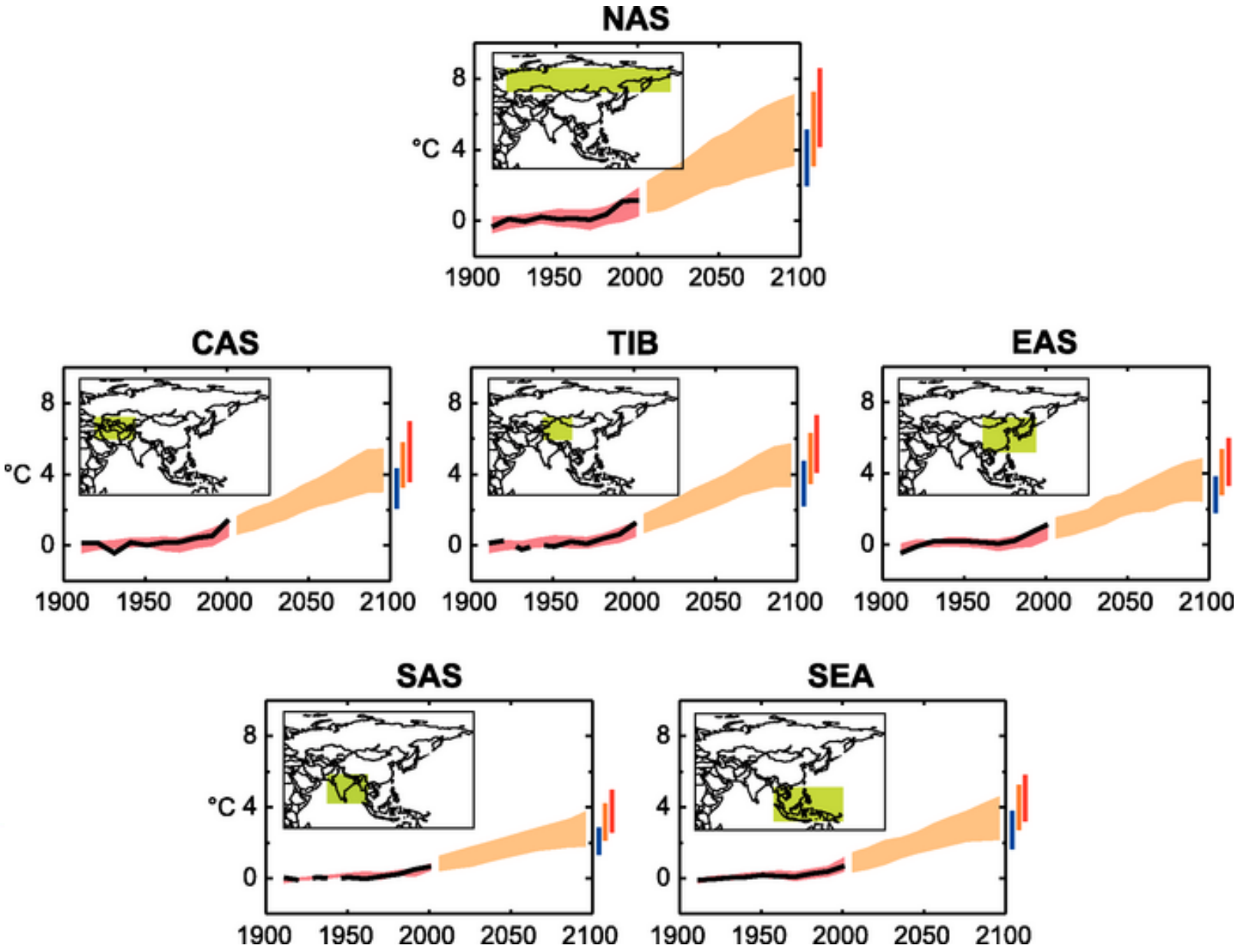
Very high levels of vulnerability



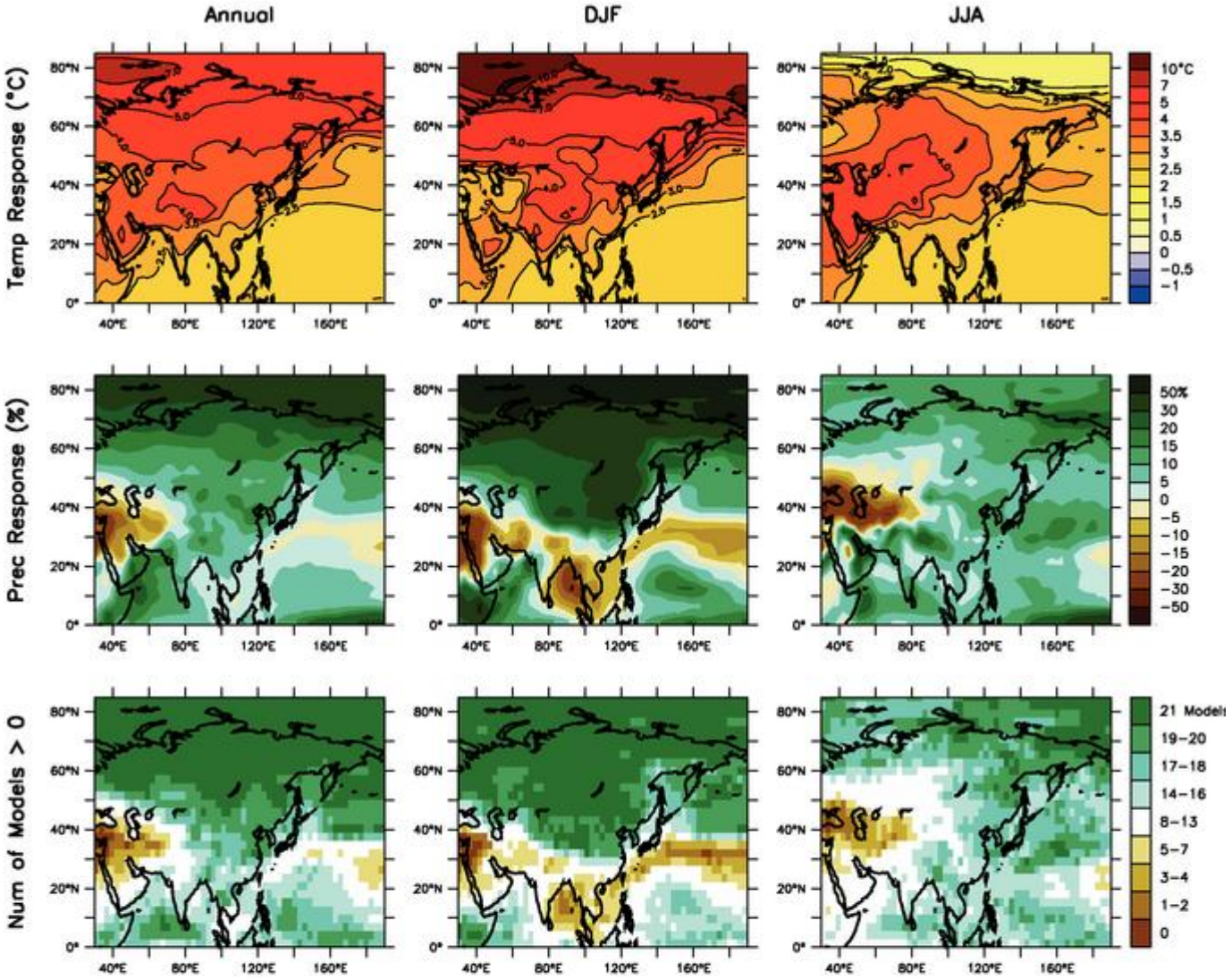


Difficulties in providing assistance

Climate forecasts (IPCC 2007)



IPCC 2007 forecast temperature and precipitation for 2099



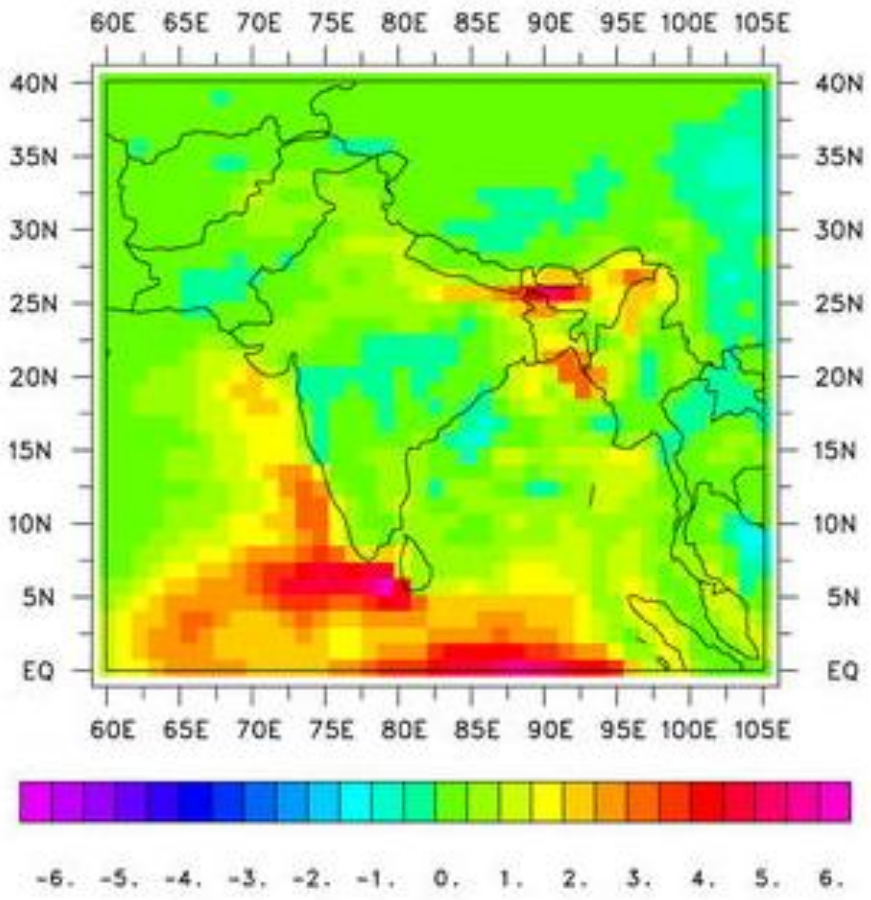
Forecast warming is 3.3 C (S. Asia) to 3.7 C (Tibet)

Also increased extreme precipitation, but maybe less overall

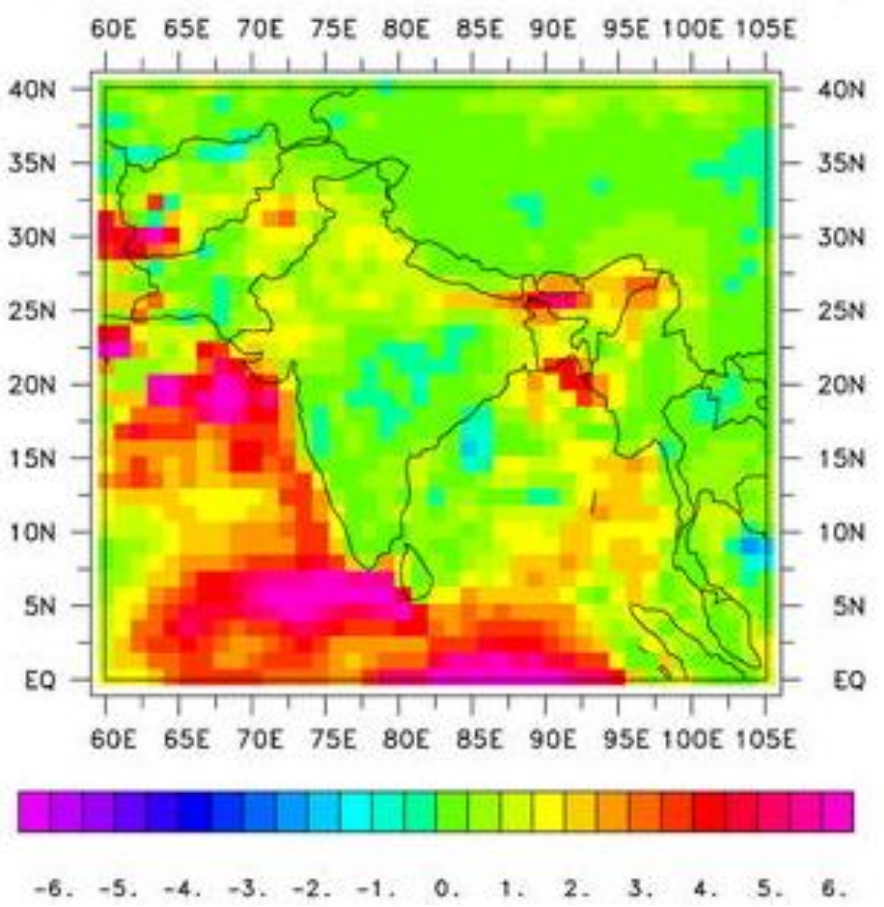
Likely impacts of warming Gilgit-Baltistan

- More drought, for longer periods
- Challenges in agricultural productivity
- Increased flood potential
- Increased landslide / rockfall potential
- Need for adaptation

Global warming and the monsoon



Change in daily rainfall (mm/day)



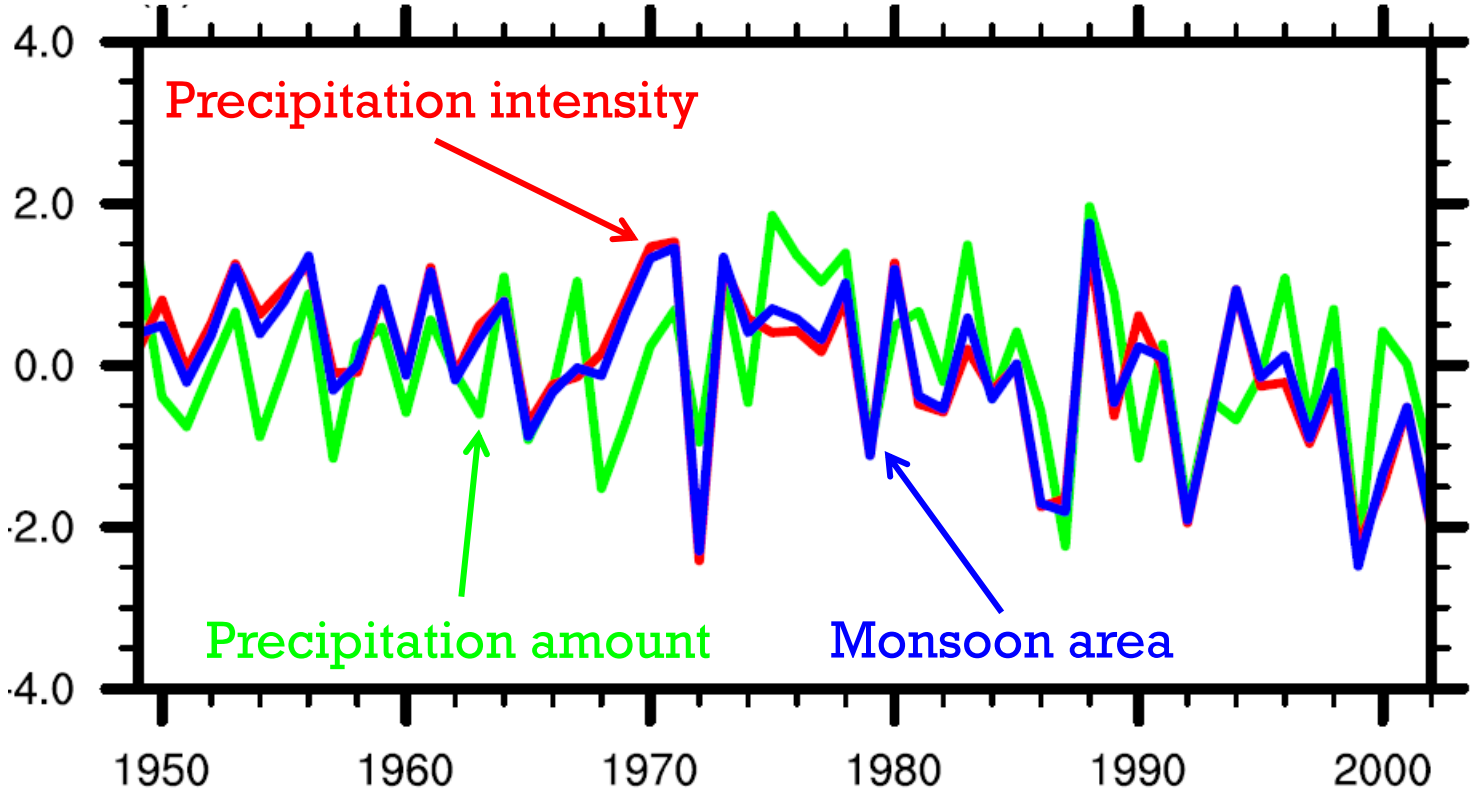
Change in monsoon daily rainfall (mm/day)

Scenario = Doubling of CO_2

From: May 2004

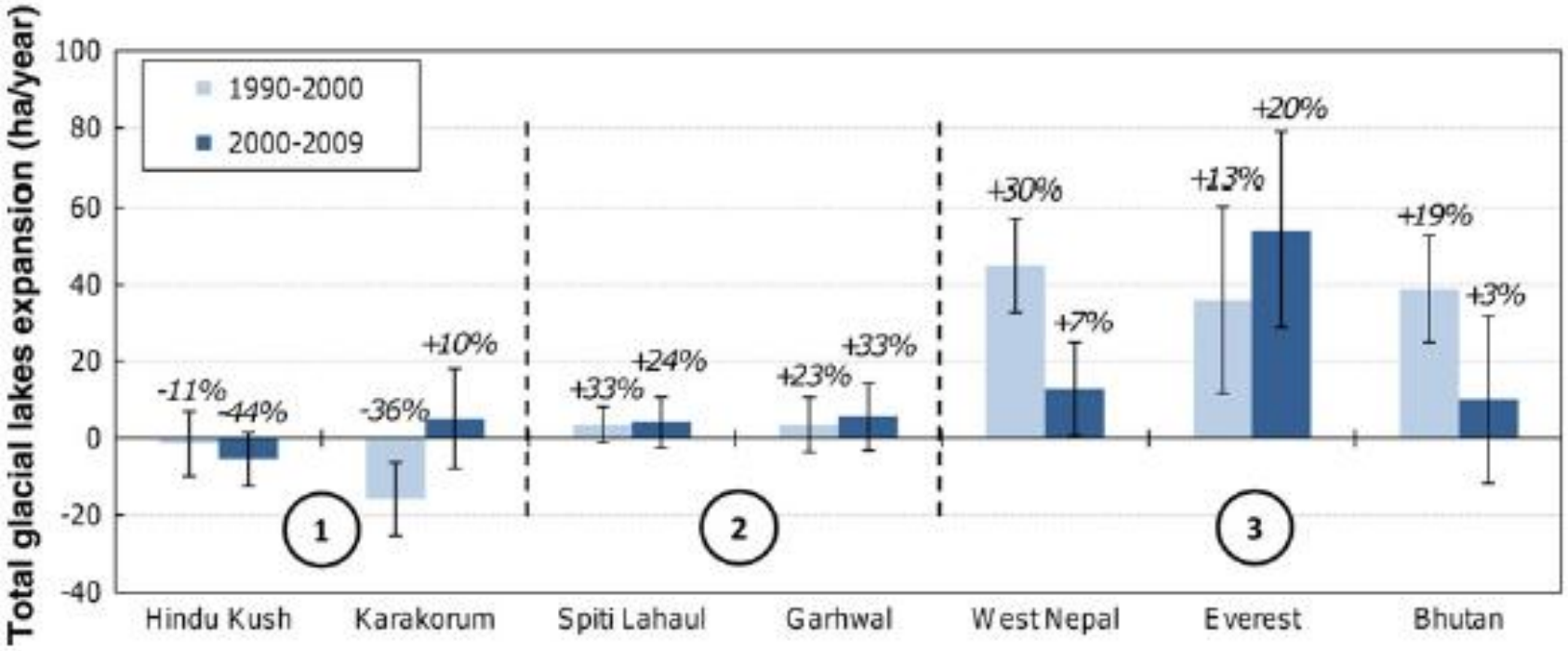
Summary of S. Asian monsoon and climate change

- During warming over the last 50 years, monsoon rainfall has reduced
- Possible increase in drought risk

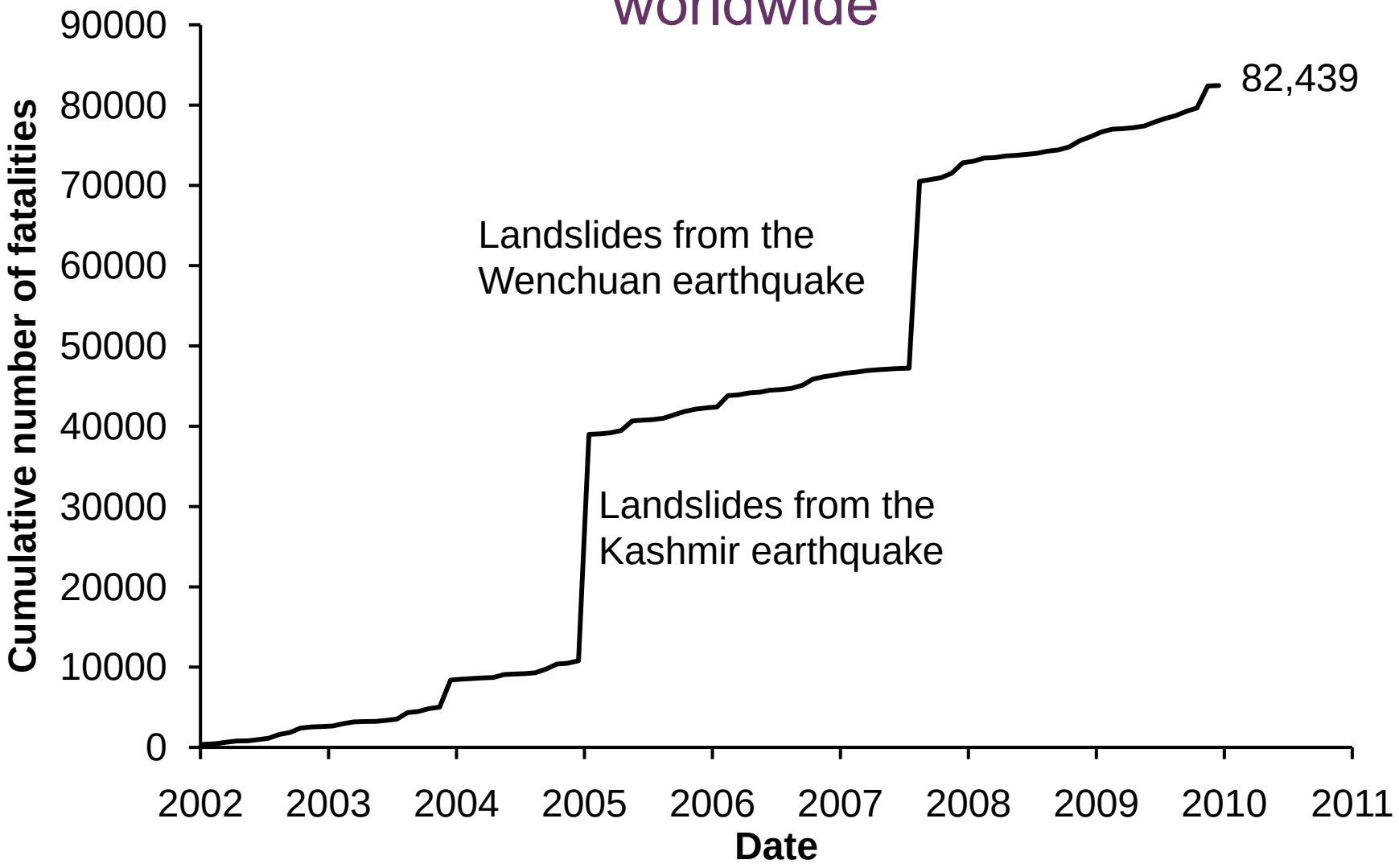


From: Zhou *et al.* 2008

Impact on glacial lakes
Gardelle et al 2011



Climate hazards - the human cost of landslides worldwide

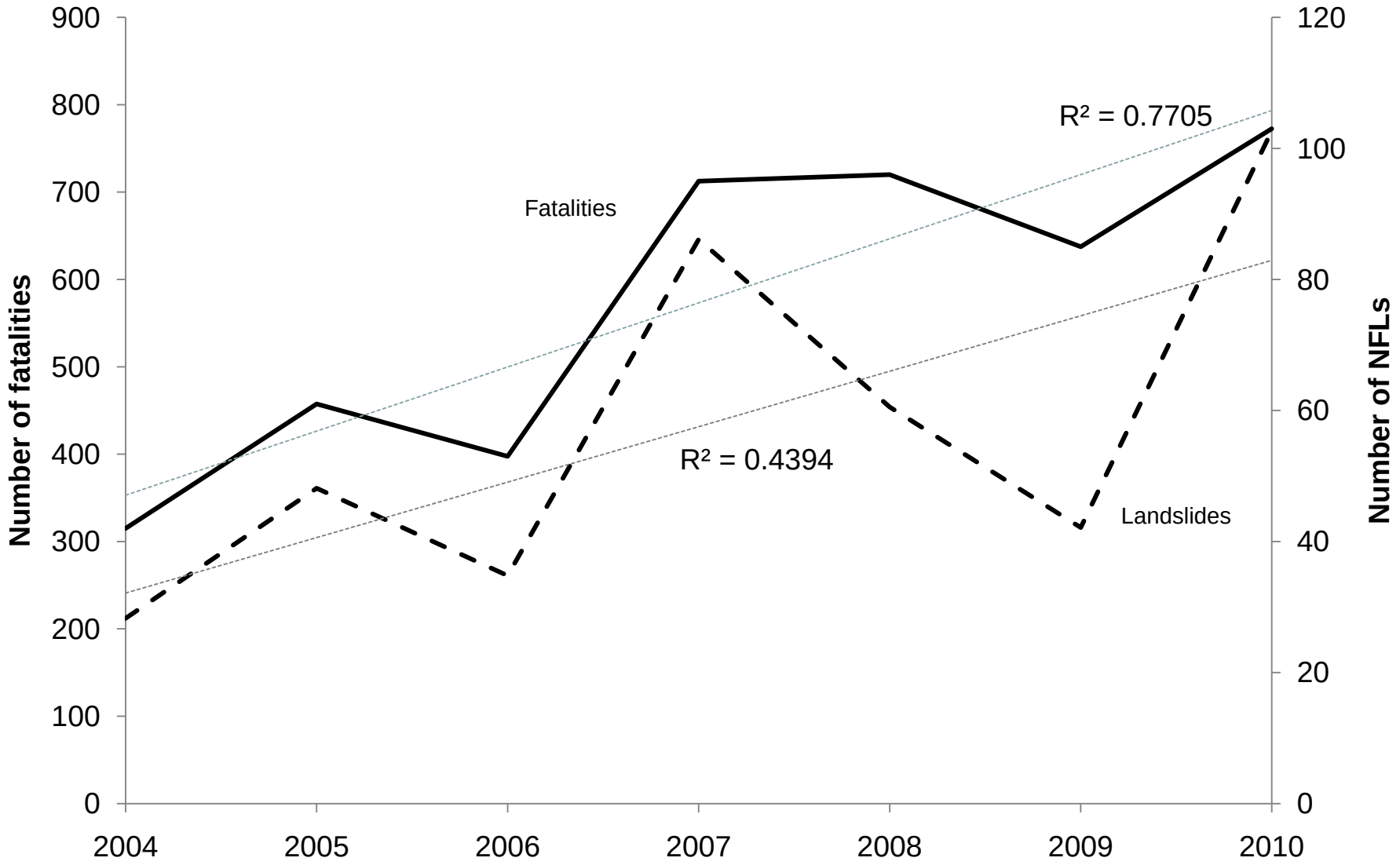


Other disasters 2002-2009 (CRED database)

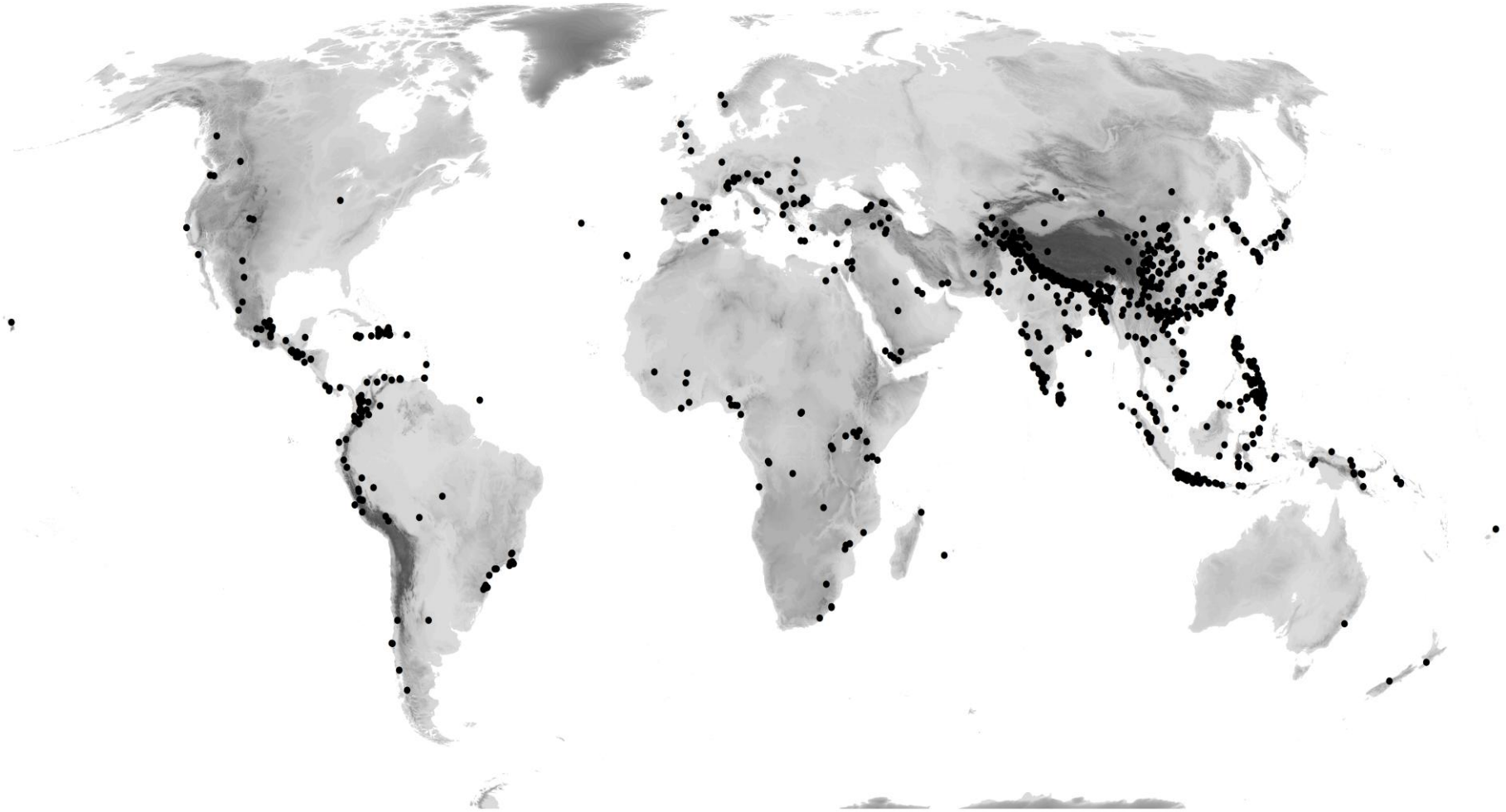
Earthquake: 429,877 River flood: 37,860

Storm: 166,410 Volcano: 221

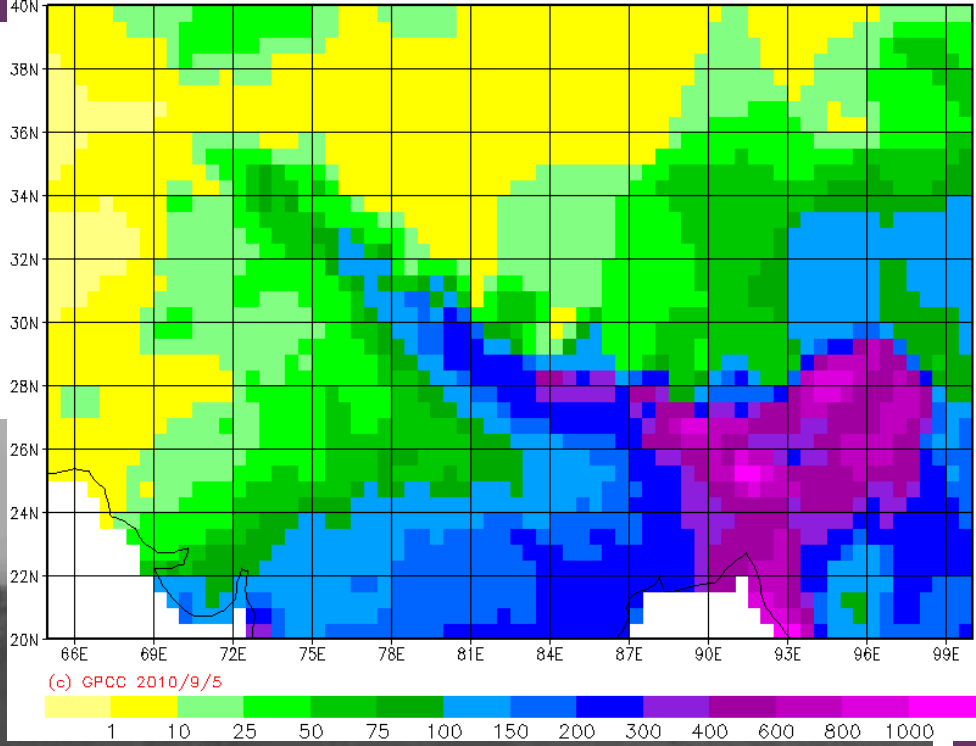
Trend in occurrence for the Himalaya region



Global fatal rainfall-induced landslides – 2006 to 2009



Himalayan Arc – 2004 to 2009



Attabad landslide – an example of a disaster in Gilgit-Baltistan

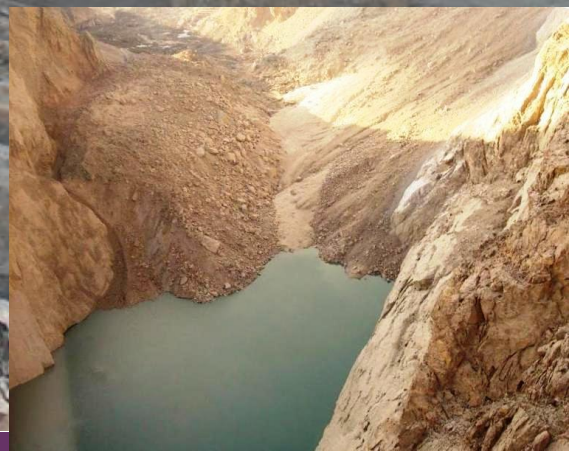
Slope identified as unstable in 2003

Durham University

1. Progressive failure over >7 years

2. Catastrophic failure event in Jan 2010 with no trigger

3. Emplacement of rockslide onto lake sediments triggered secondary high velocity mudflow event



1858 landslide dam

Wenchuan Risk Table
Yang *et al* 2010

Table 1 Standard for breach risk evaluation of Quake lakes

Influence factors	Risk level			
	Extremely high risk	High risk	Medium risk	Low risk
Endangered lives in downstream area (thousand)	>1000	500–1000	100–500	<100
Materials and structure of landslide dam	Mostly soils, loose structure	Soils with massive rubble, medium loose structure	Massive rubble with soils, dense structure	Mostly massive rubble, with gaps
Maximum probable storage capacity (1000 m^3)	10^5	10^4–10^5	10^3–10^4	<10^3
Quake lake catchment area (km^2)	>1000	100–1000	50–100	<50
Landslide dam height (m)	>100	50–100	25–50	<25

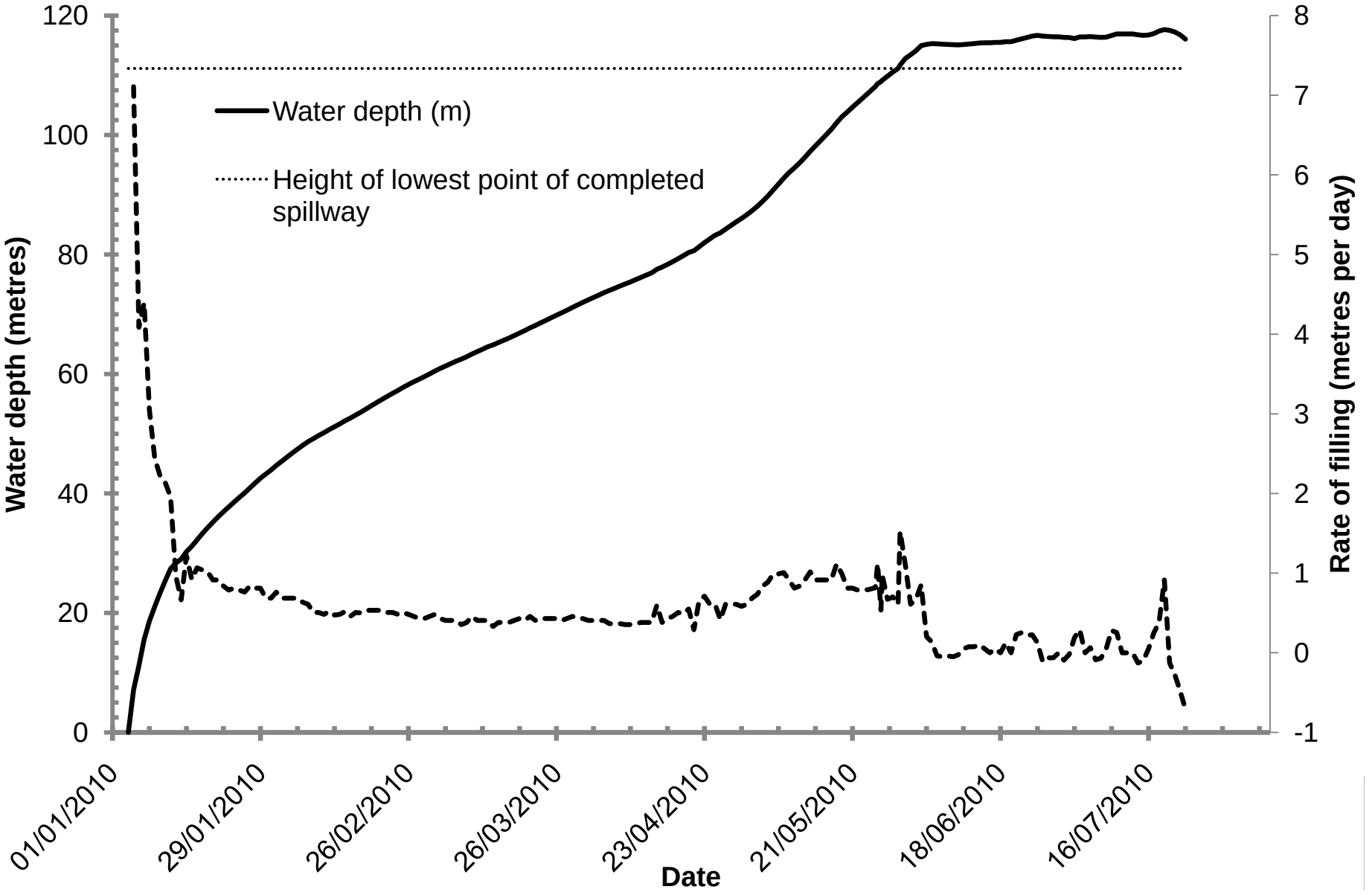
Management of the hazard

- Initial management response was the construction of a spillway.
  - Original intention: 30 metres deep
  - Actual depth at time of overtopping: 15 metres
  - Final spillway was very narrow and unlined

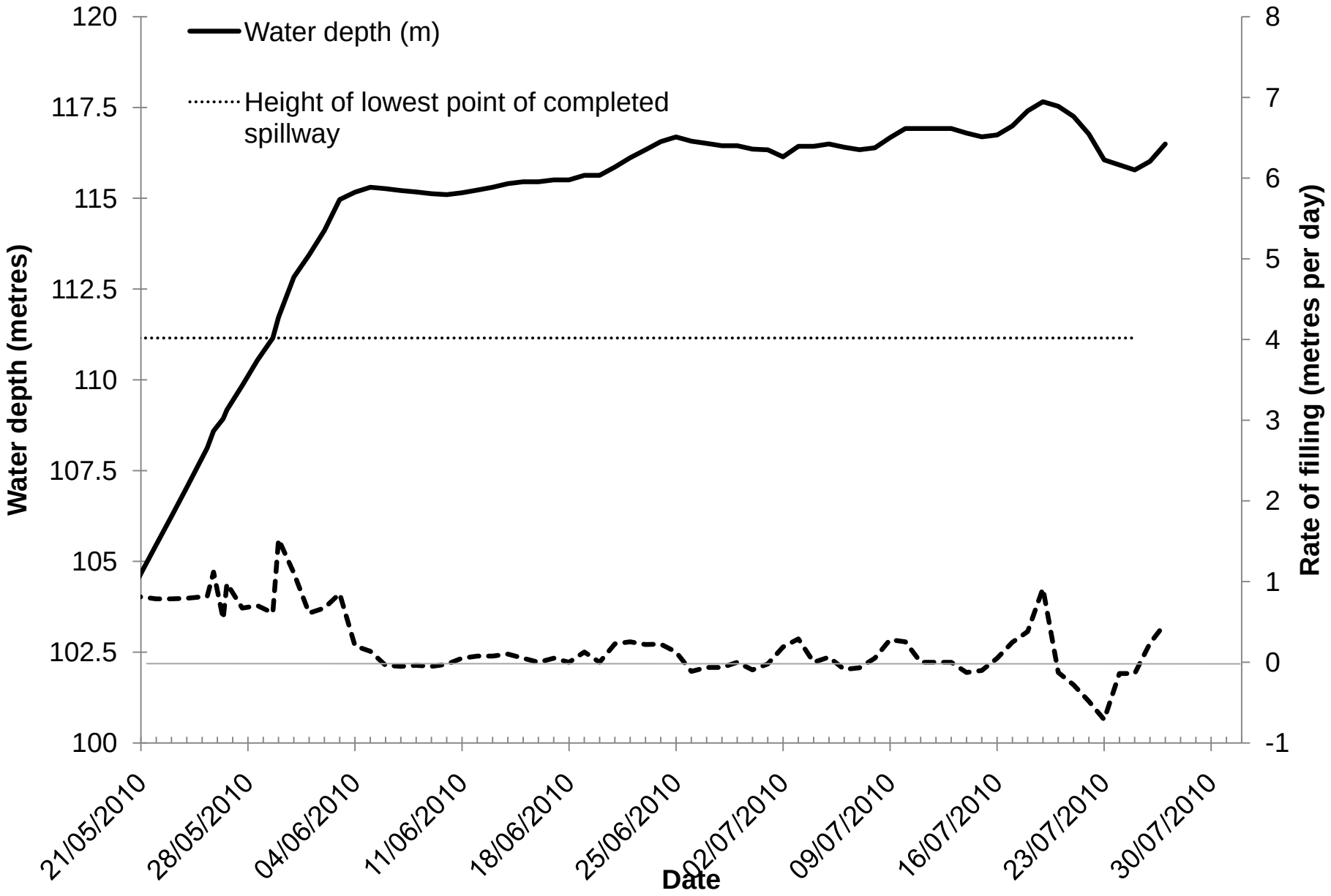
Evacuations

- After the landslide, Focus installed sirens in 15 villages
- People in most hazardous areas relocated into camps
- Boat service established on lake, but enormous hardship upstream
- One month before overtopping NDMA evacuated 15,000 people downstream of barrier

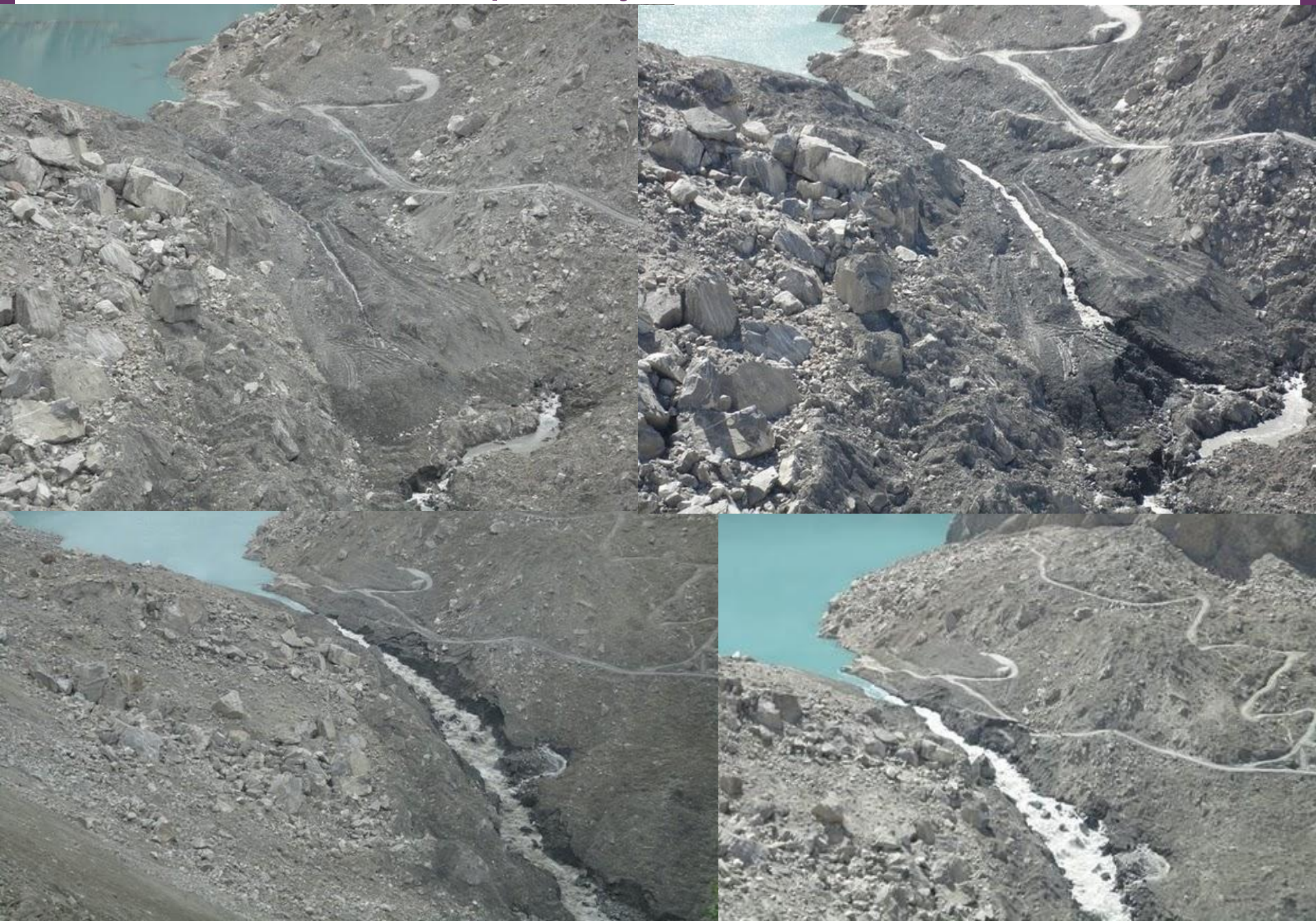
Water level rise



Overtopping behaviour



Spillway evolution

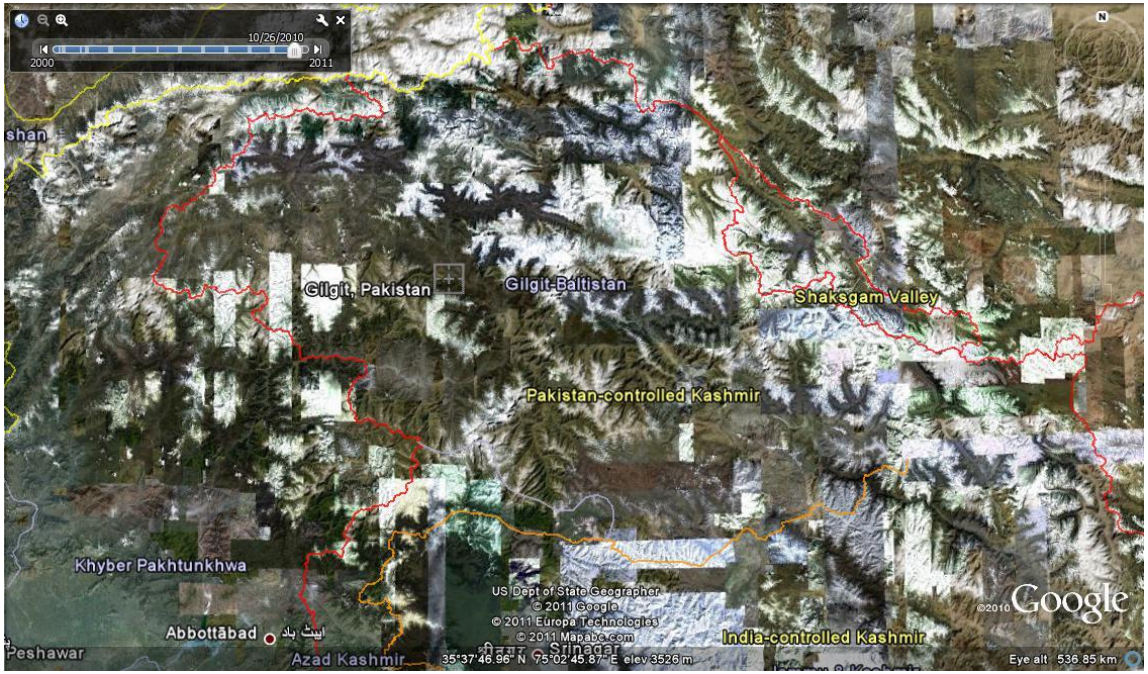


Management problems

- Karakoram Highway remains blocked
- After recent floods, Gilgit-Baltistan was cut off to north and south
- Loss of productive land
- Loss of cash crop markets
- Landslide hazard remains
  - Progressive failure
  - GLOF
  - Seismic event
  - Landslide into lake

Conclusions

- Earthquakes
- Glacial lake floods
- Melting permafrost
- Drought
- Landslides
- Avalanches
- Floods



Urgent need to:

- improve disaster risk reduction
- monitor and evaluate
- undertake basic research
- capacity build

Conclusions