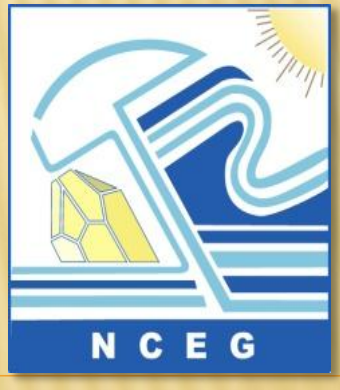
EARTHQUAKE HAZARDS IN HIMALAYAN REGION

By

Khaista Rehman

National Centre of Excellence in Geology, University of Peshawar (February 12, 2013)



EARTHQUAKE

An Earthquake is a sudden, rapid shaking of the earth caused by the breaking and shifting of rocks beneath the earth surface. Over time, stresses build beneath the Earth's surface.

OR An earthquake is the result of a sudden release of energy in the Earth's crust that creates seismic waves.

Occasionally, stress is released resulting in the sudden, and sometime disastrous shaking we call an earthquake. The shaking could last seconds or minutes, and there may be several earthquakes over a period ranging from hours to weeks called foreshocks and after shocks, the later decreasing in magnitude with time.

BASIC DEFINITIONS

F: Focus or hypocentre

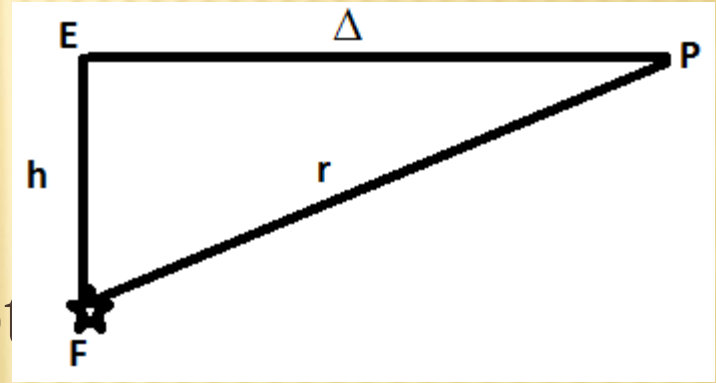
E: Epicentre

P: Point of Interest

H: Focal or hypocentral dept

R: Focal or hypocentral distance

Δ: Epicentral distance



MEASURING THE SHAKING

- Effects: Macroseismic Intensity (a measure of the effect of an earthquake upon natural objects, artificial structures, and human observers in a locality)
- Size: Magnitude (an absolute measure of earthquake size)
- Where: Location (world wide networks of seismograph, local microearthquake network)
- How Often: Seismic Hazard

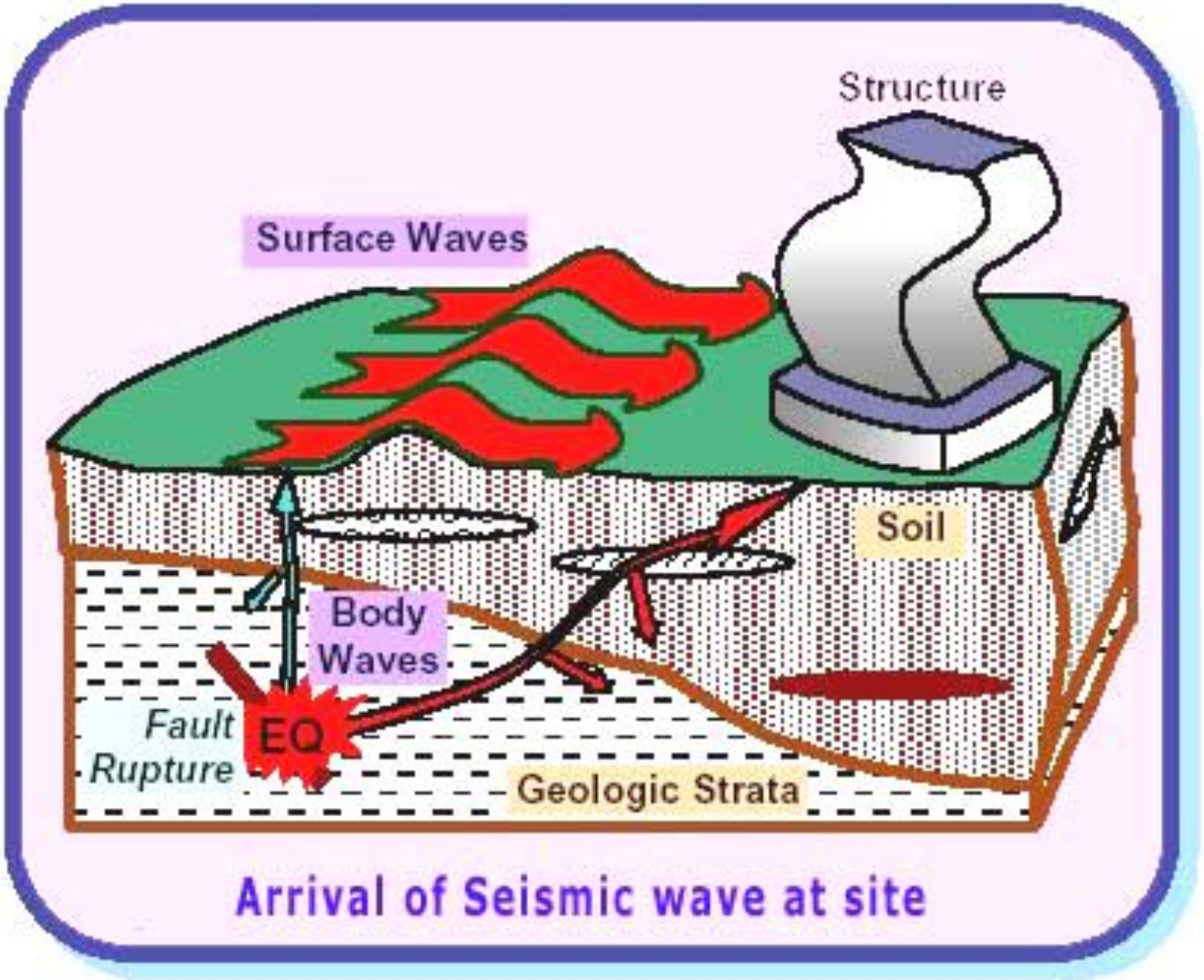
GLOBAL SEISMOGRAPHIC NETWORK

The Global Seismographic Network is a permanent digital network of state-of-the-art seismological and geophysical sensors connected by a telecommunications network, serving as a multi-use scientific facility and societal resource for monitoring, research, and education. Formed in partnership among the USGS, the National Science Foundation (NSF) and the Incorporated research Institutions for Seismology (IRIS), the GSN provides near-uniform, worldwide monitoring of the Earth, with over 150 modern seismic stations distributed globally.

HOW THE GROUND SHAKES?

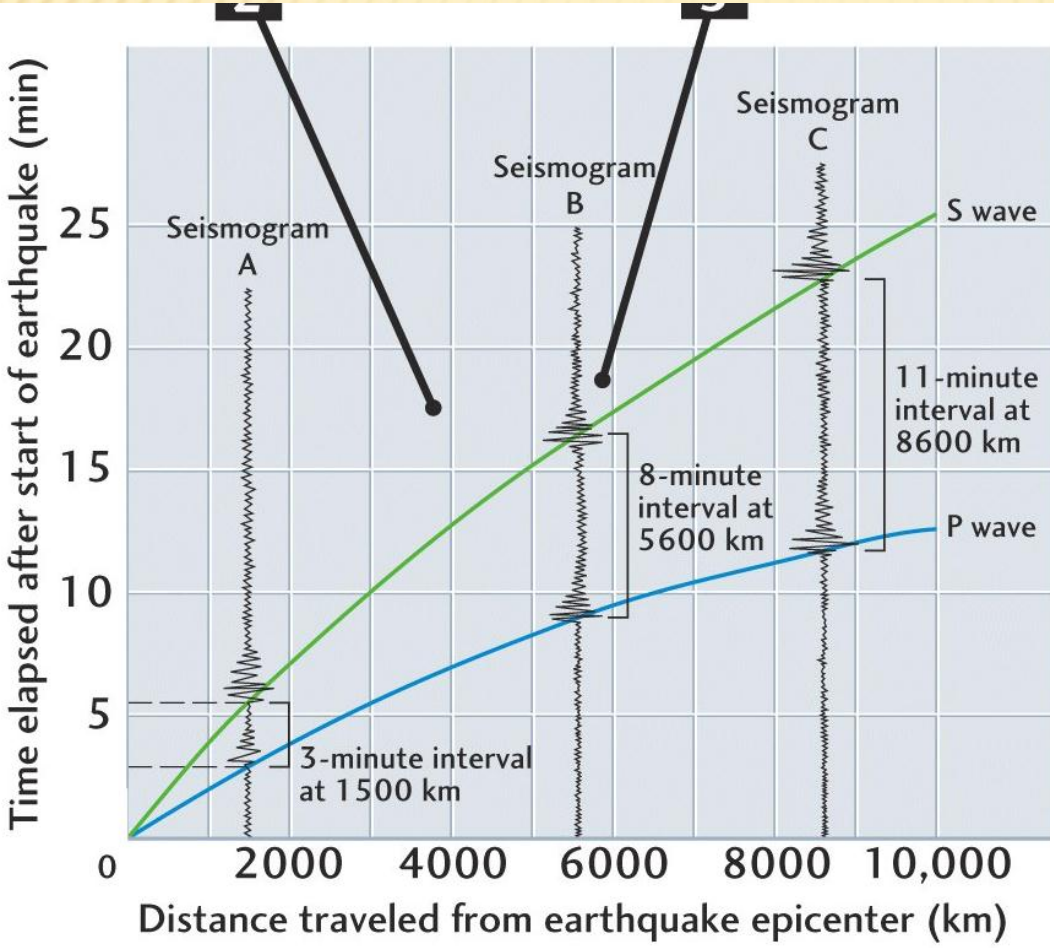
- Seismic Waves

Large strain energy released during an earthquake travels as seismic waves in all directions through the Earth's layers, reflecting and refracting at each interface. These waves are of two types -body waves and surface waves; the latter are restricted to near the Earth's surface. Body waves consist of Primary Waves (P-waves) and Secondary Waves (S-waves), and surface waves consist of Love waves and Rayleigh waves.

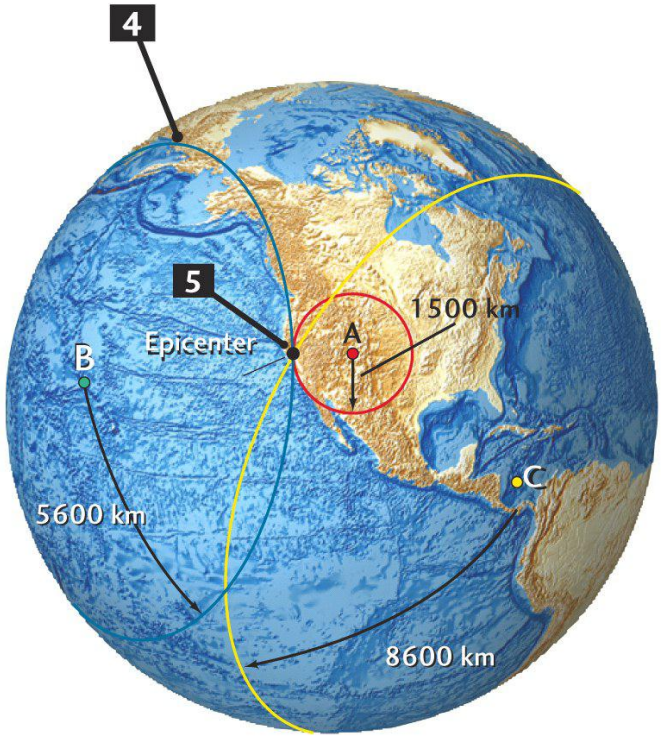

Structure
Surface Waves
Soil
Body
Waves
Fault
Rupture
EQ
Geologic Strata
Arrival of Seismic wave at site

LOCATION OF EPICENTRE:

THE ARRIVAL TIME DIFFERENCE OF P- AND S-WAVES MEASURED AT THREE SEISMOGRAPHIC STATIONS REVEALS THE LOCATION OF THE EPICENTER BY SMALL CIRCLES INTERSECTION

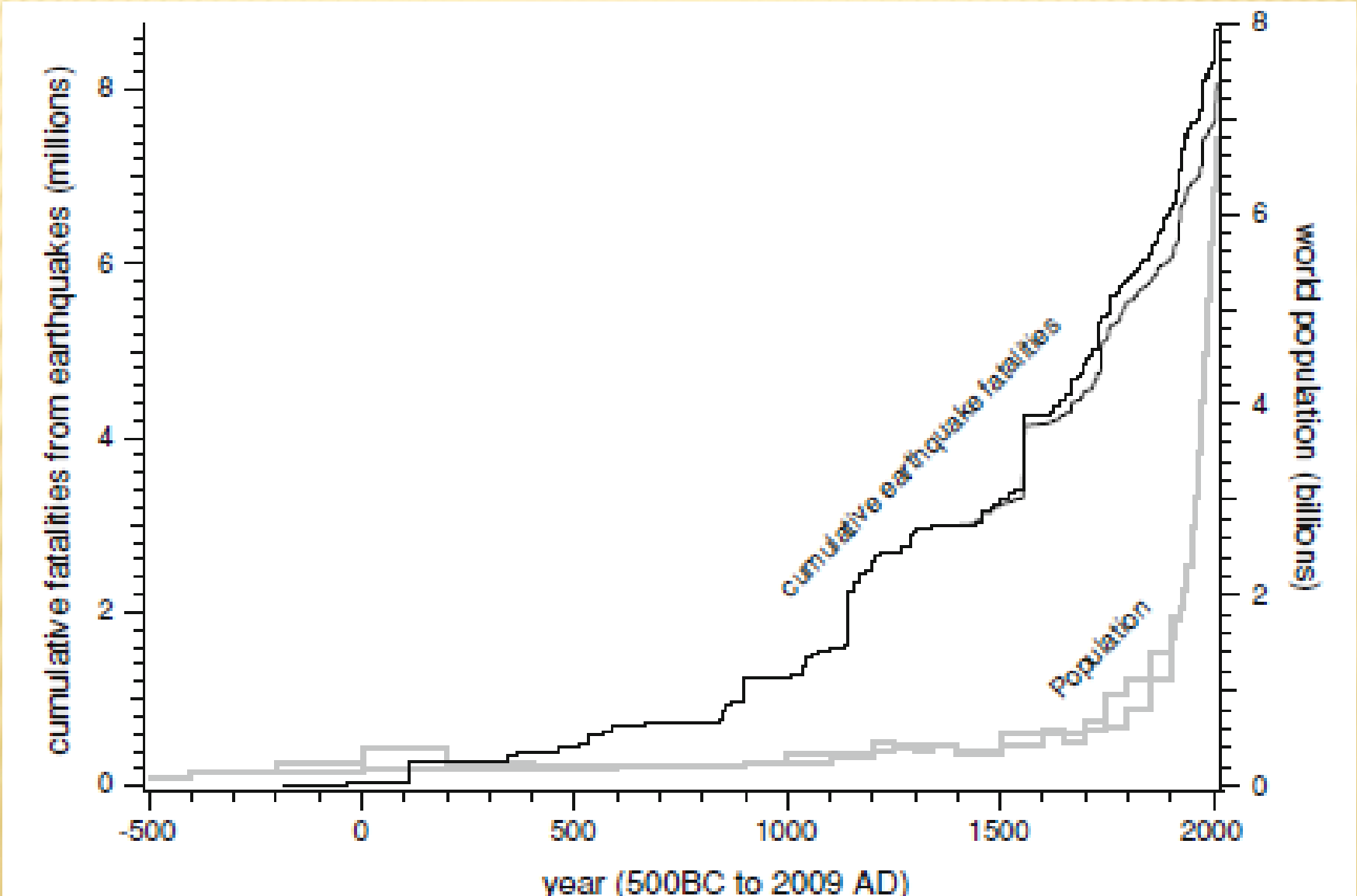


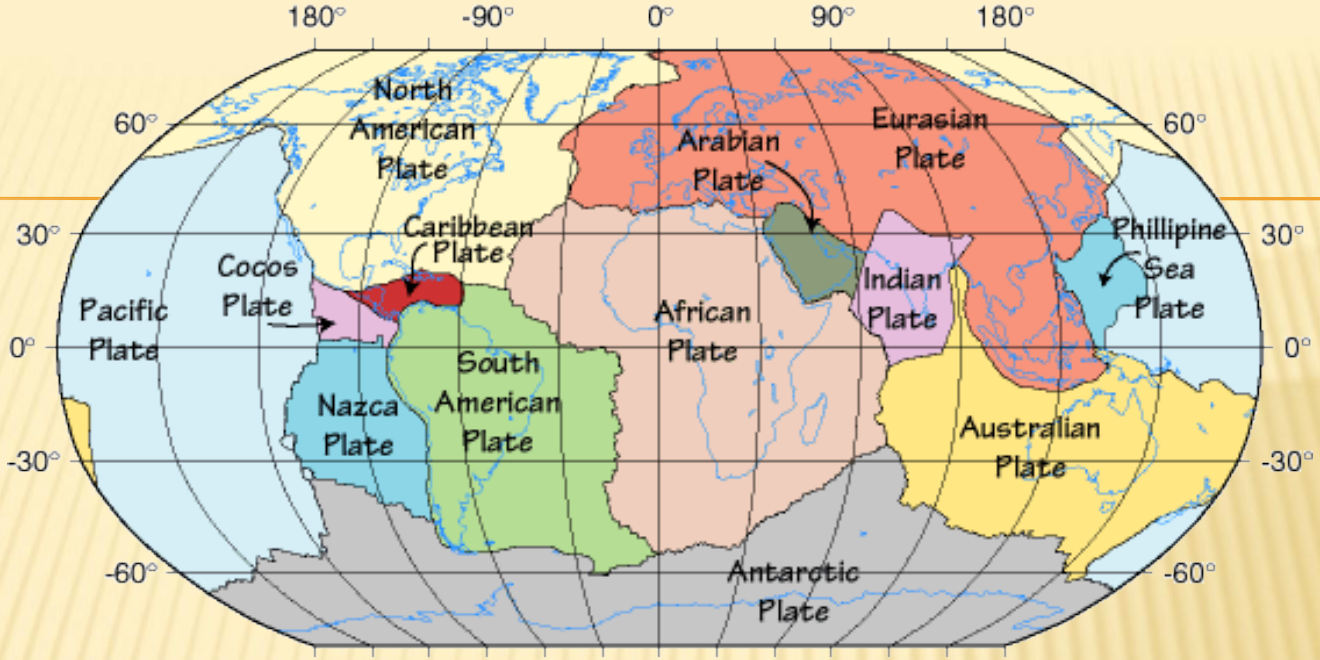
READINGS AT DIFFERENT SEISMOGRAPHIC STATIONS REVEAL THE LOCATION OF THE EARTHQUAKE EPICENTER

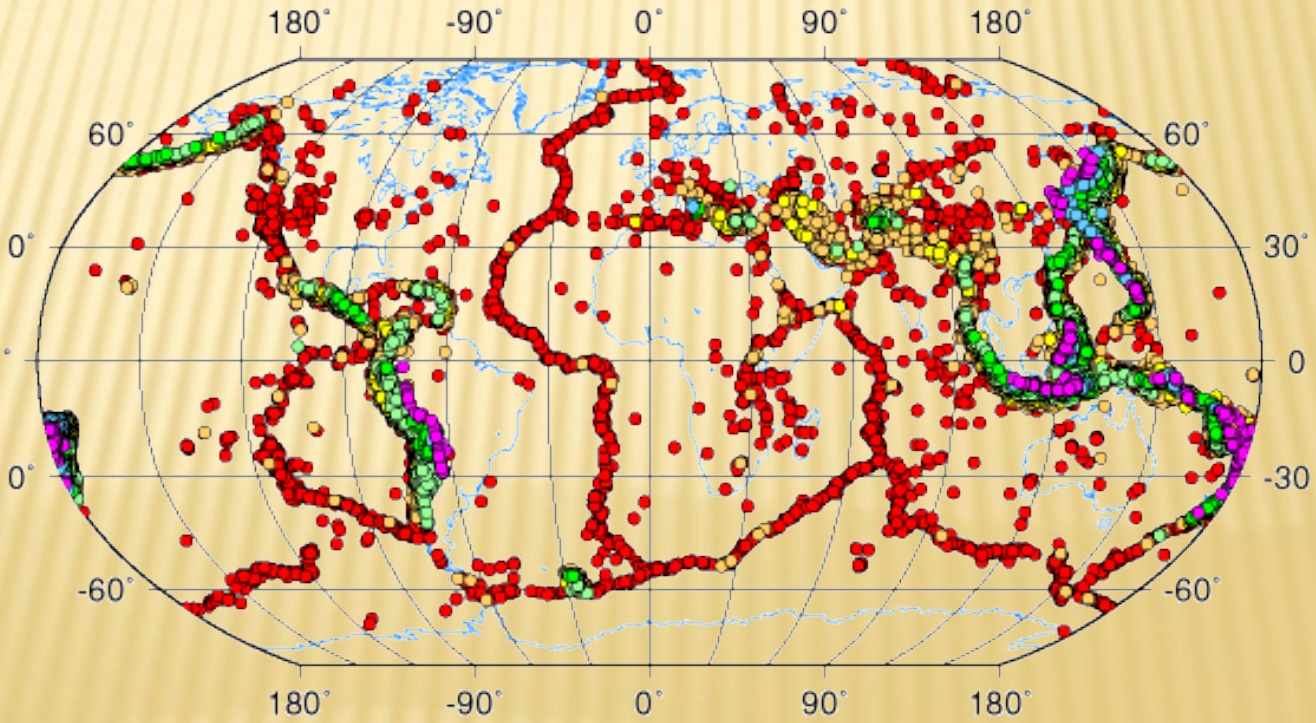


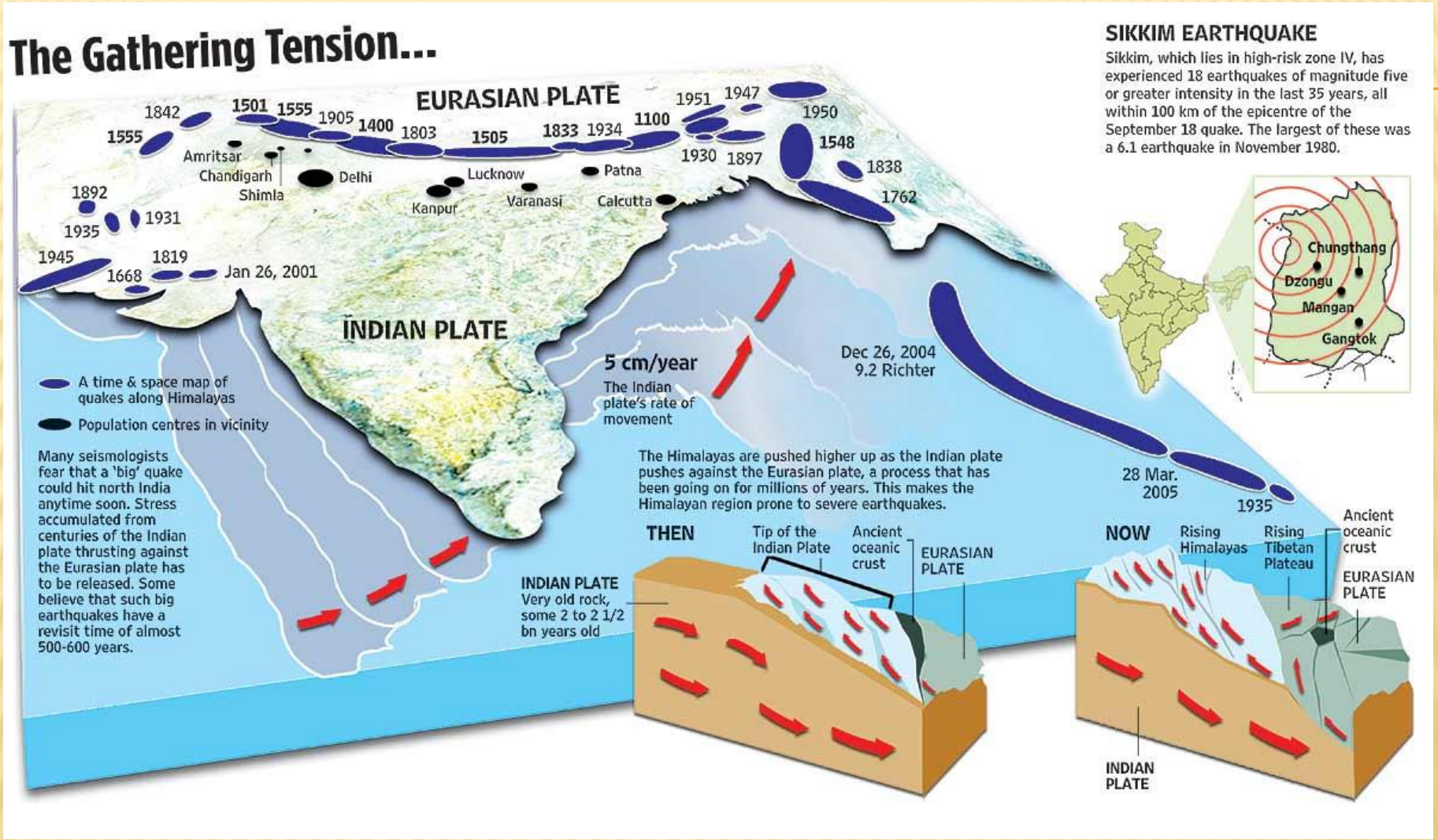
THE DIFFERENCE IN ARRIVAL TIME BETWEEN P AND S WAVES IS USED IN JAPAN FOR THE **EARLY WARNING SYSTEM**

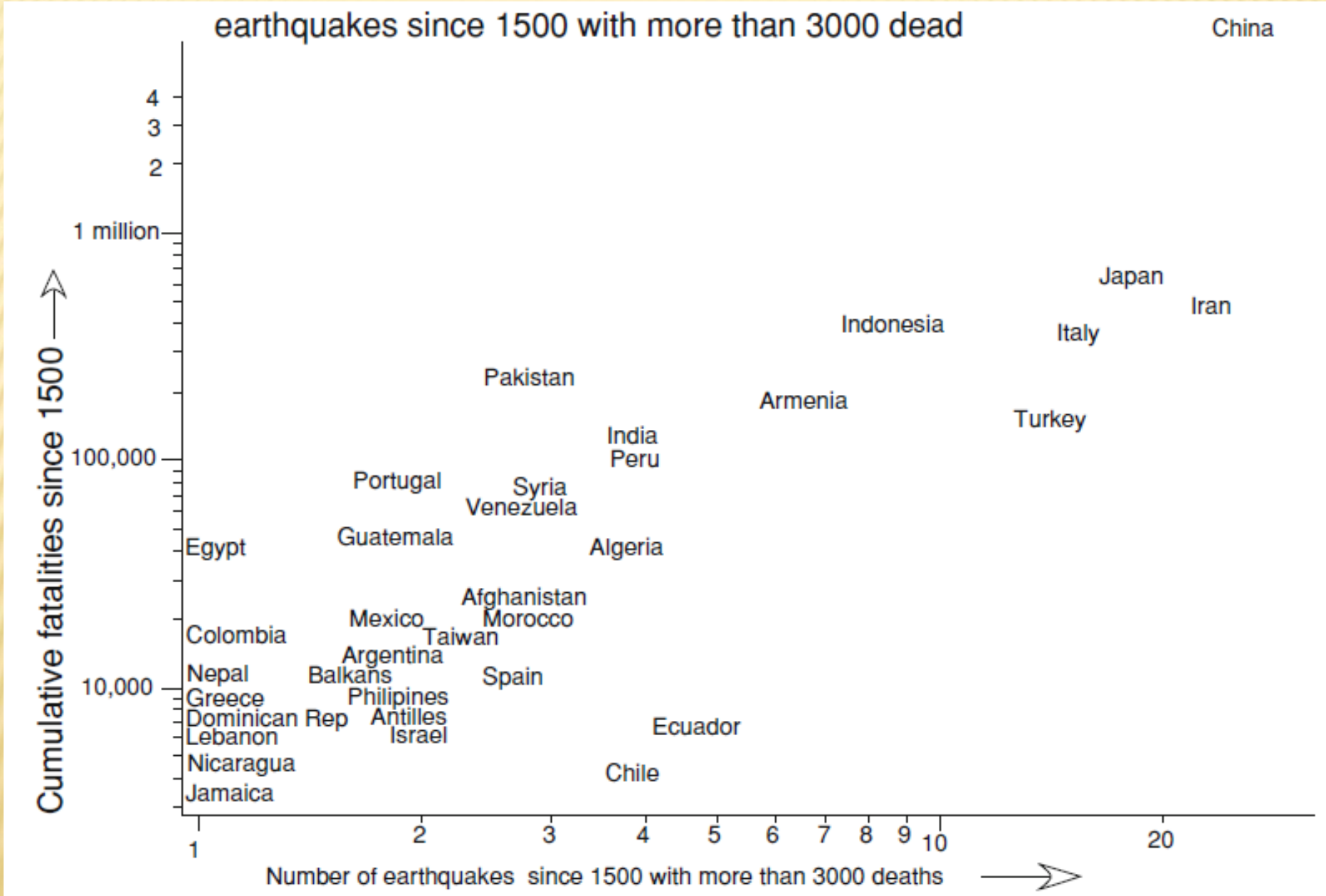
EARTHQUAKE FATALITIES SINCE 500 BC COMPARED TO ESTIMATED GLOBAL POPULATIONS (IT GREY).

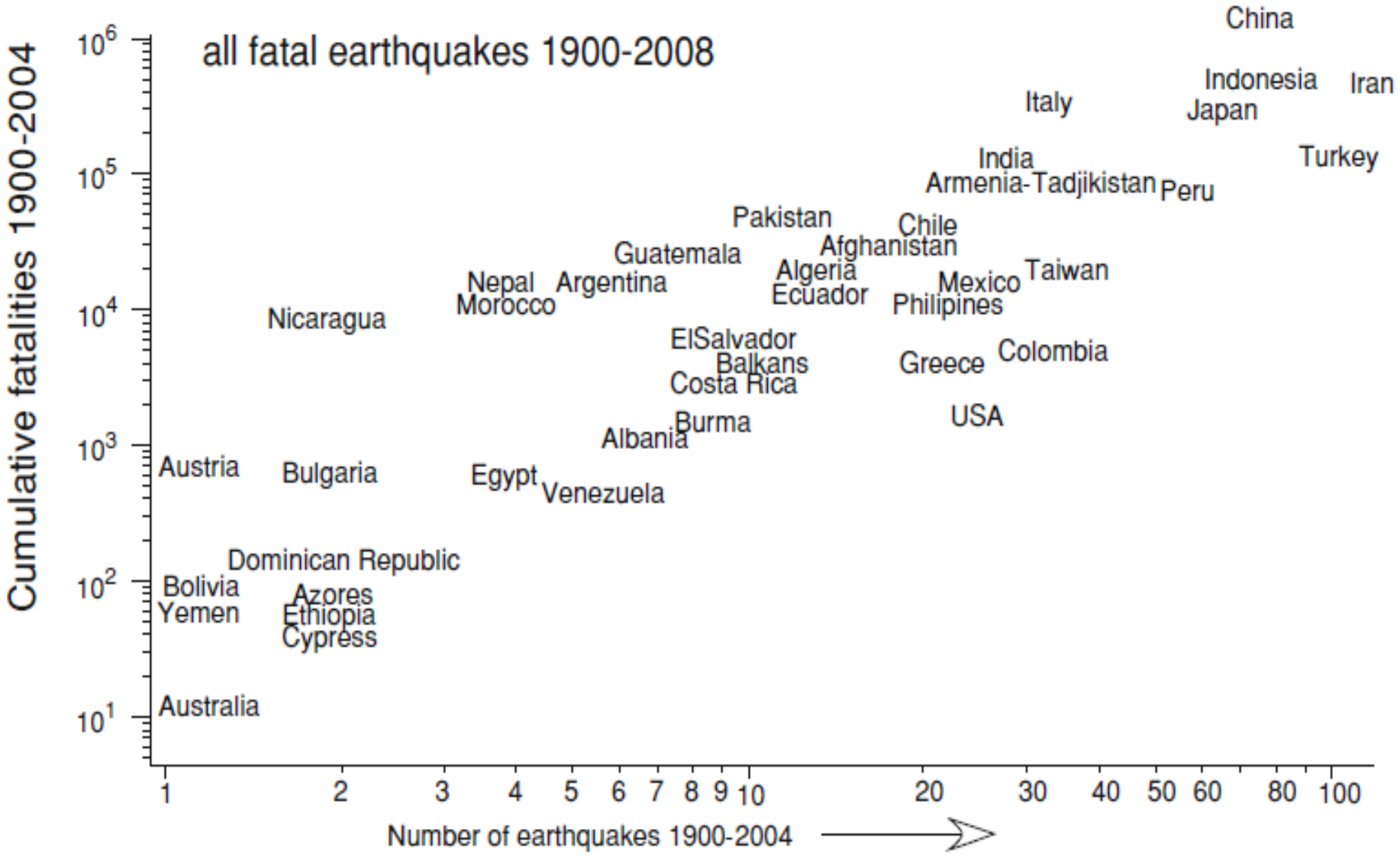


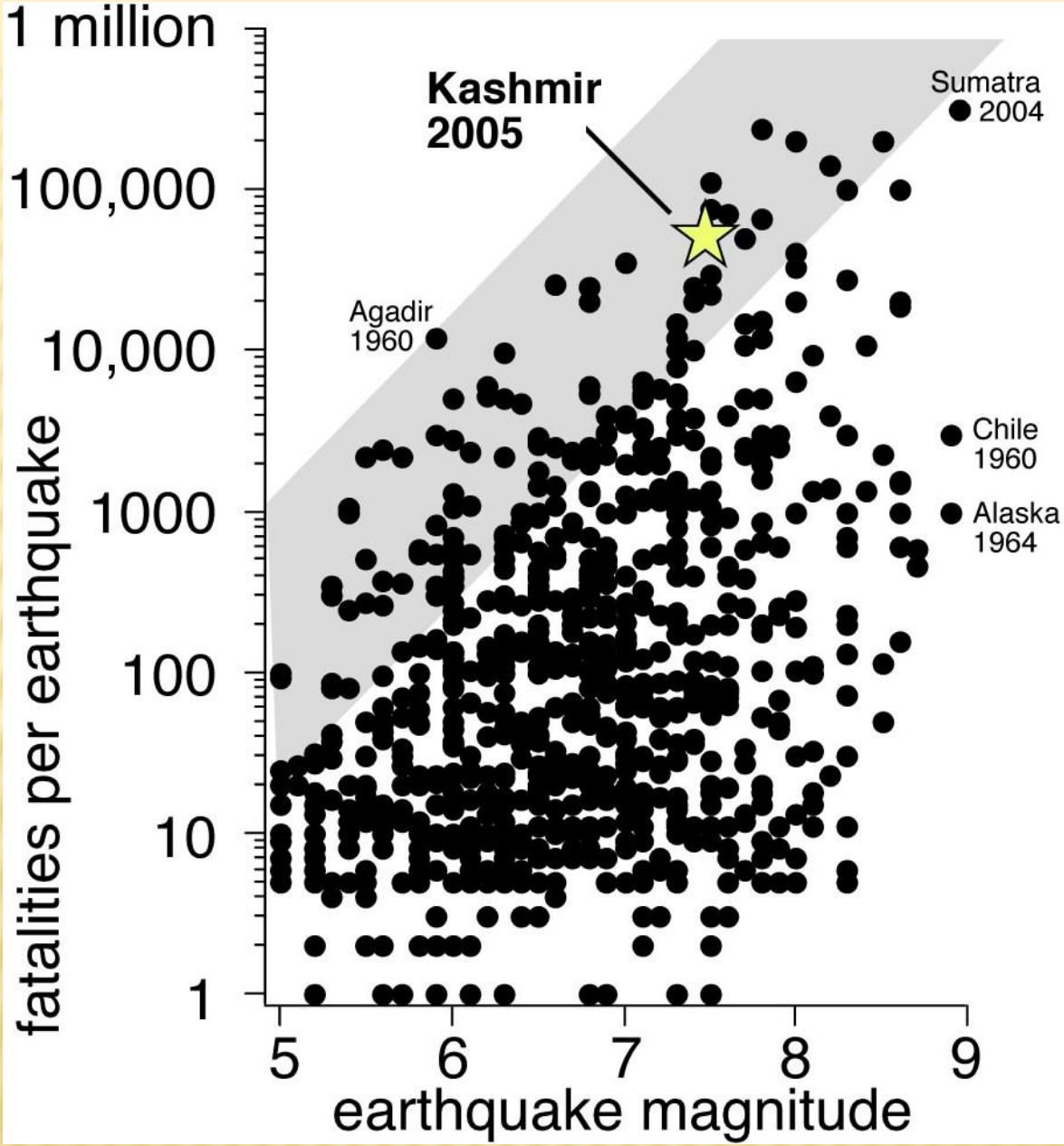

180°
-90°
0°
90°
180°
60°
30°
0°
-30°
-60°
North American Plate
Eurasian Plate
Arabian Plate
Caribbean Plate
Phillipine Sea Plate
Cocos Plate
Pacific Plate
Indian Plate
African Plate
South American Plate
Nazca Plate
Australian Plate
Antarctic Plate


180°
-90°
0°
90°
180°
60°
30°
0
-30
-60°


The Gathering Tension...
EURASIAN PLATE
INDIAN PLATE
1842
1555
1501
1555
1905
1400
1803
1505
1833
1934
1100
1951
1947
1950
1548
1838
1762
1930
1897
Amritsar
Chandigarh
Shimla
Delhi
Lucknow
Kanpur
Varanasi
Patna
Calcutta
1892
1935
1931
1945
1668
1819
Jan 26, 2001
A time & space map of quakes along Himalayas
Population centres in vicinity
Many seismologists fear that a 'big' quake could hit north India anytime soon. Stress accumulated from centuries of the Indian plate thrusting against the Eurasian plate has to be released. Some believe that such big earthquakes have a revisit time of almost 500-600 years.
5 cm/year
The Indian plate's rate of movement
Dec 26, 2004
9.2 Richter
28 Mar. 2005
1935
The Himalayas are pushed higher up as the Indian plate pushes against the Eurasian plate, a process that has been going on for millions of years. This makes the Himalayan region prone to severe earthquakes.
THEN
Tip of the Indian Plate
Ancient oceanic crust
EURASIAN PLATE
INDIAN PLATE
Very old rock, some 2 to 2 1/2 bn years old
NOW
Rising Himalayas
Rising Tibetan Plateau
Ancient oceanic crust
EURASIAN PLATE
INDIAN PLATE
SIKKIM EARTHQUAKE
Sikkim, which lies in high-risk zone IV, has experienced 18 earthquakes of magnitude five or greater intensity in the last 35 years, all within 100 km of the epicentre of the September 18 quake. The largest of these was a 6.1 earthquake in November 1980.
Chungthang
Dzongu
Mangan
Gangtok

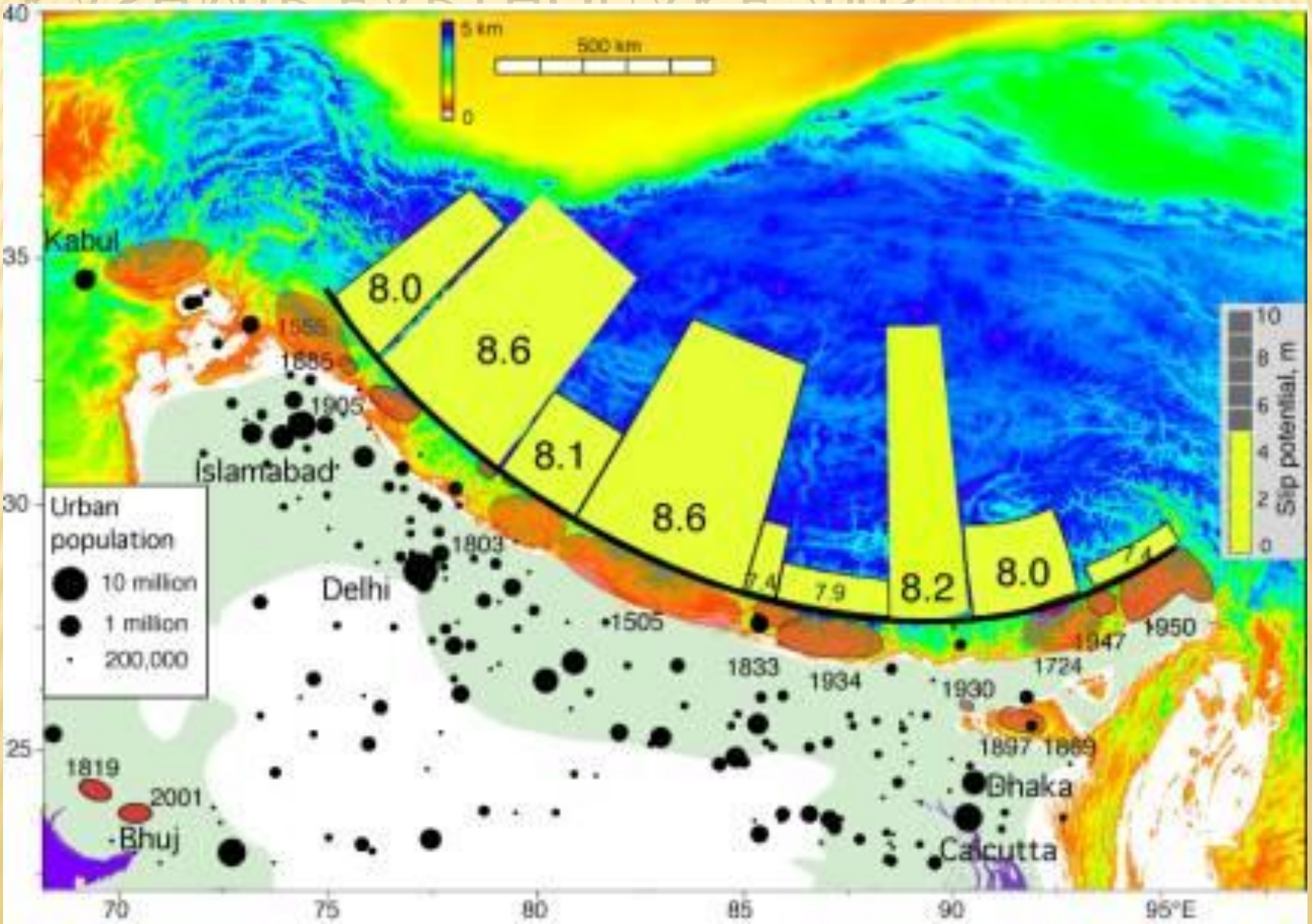

earthquakes since 1500 with more than 3000 dead
China
4
3
2
1 million
100,000
10,000
Cumulative fatalities since 1500
Japan
Iran
Indonesia
Italy
Pakistan
Armenia
Turkey
India
Peru
Portugal
Syria
Venezuela
Guatemala
Egypt
Algeria
Afghanistan
Mexico
Morocco
Colombia
Taiwan
Argentina
Nepal
Balkans
Spain
Greece
Philipines
Dominican Rep
Antilles
Lebanon
Israel
Ecuador
Nicaragua
Chile
Jamaica
1
2
3
4
5
6
7
8
9
10
20
Number of earthquakes since 1500 with more than 3000 deaths


all fatal earthquakes 1900-2008
Cumulative fatalities 1900-2004
Number of earthquakes 1900-2004
10^6
10^5
10^4
10^3
10^2
10^1
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
80
100
China
Indonesia
Iran
Italy
Japan
India
Turkey
Armenia-Tadjikistan
Peru
Pakistan
Chile
Afghanistan
Guatemala
Algeria
Taiwan
Nepal
Argentina
Ecuador
Mexico
Morocco
Philipines
Nicaragua
ElSalvador
Colombia
Balkans
Greece
Costa Rica
USA
Burma
Albania
Austria
Bulgaria
Egypt
Venezuela
Dominican Republic
Bolivia
Azores
Yemen
Ethiopia
Cypress
Australia

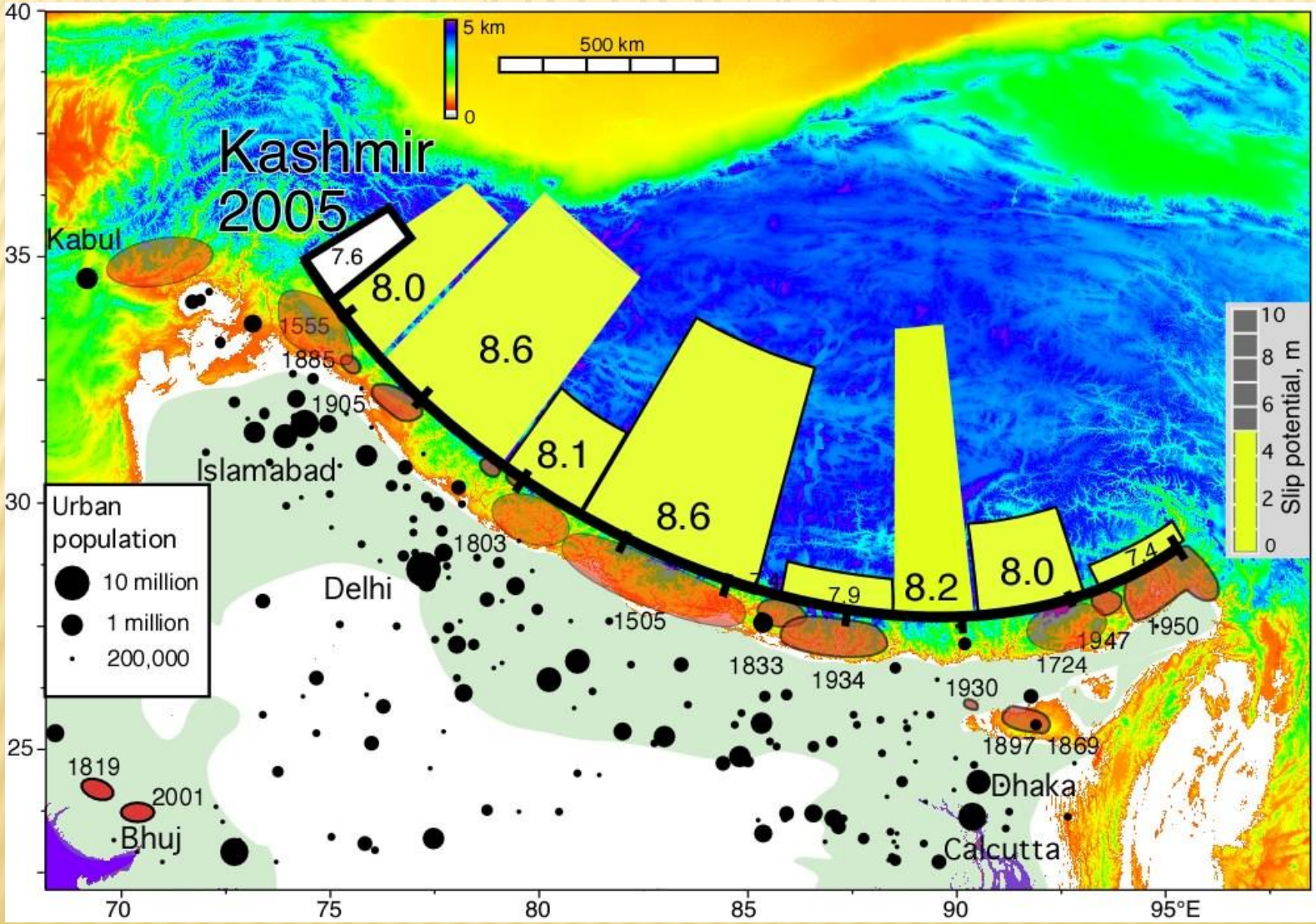


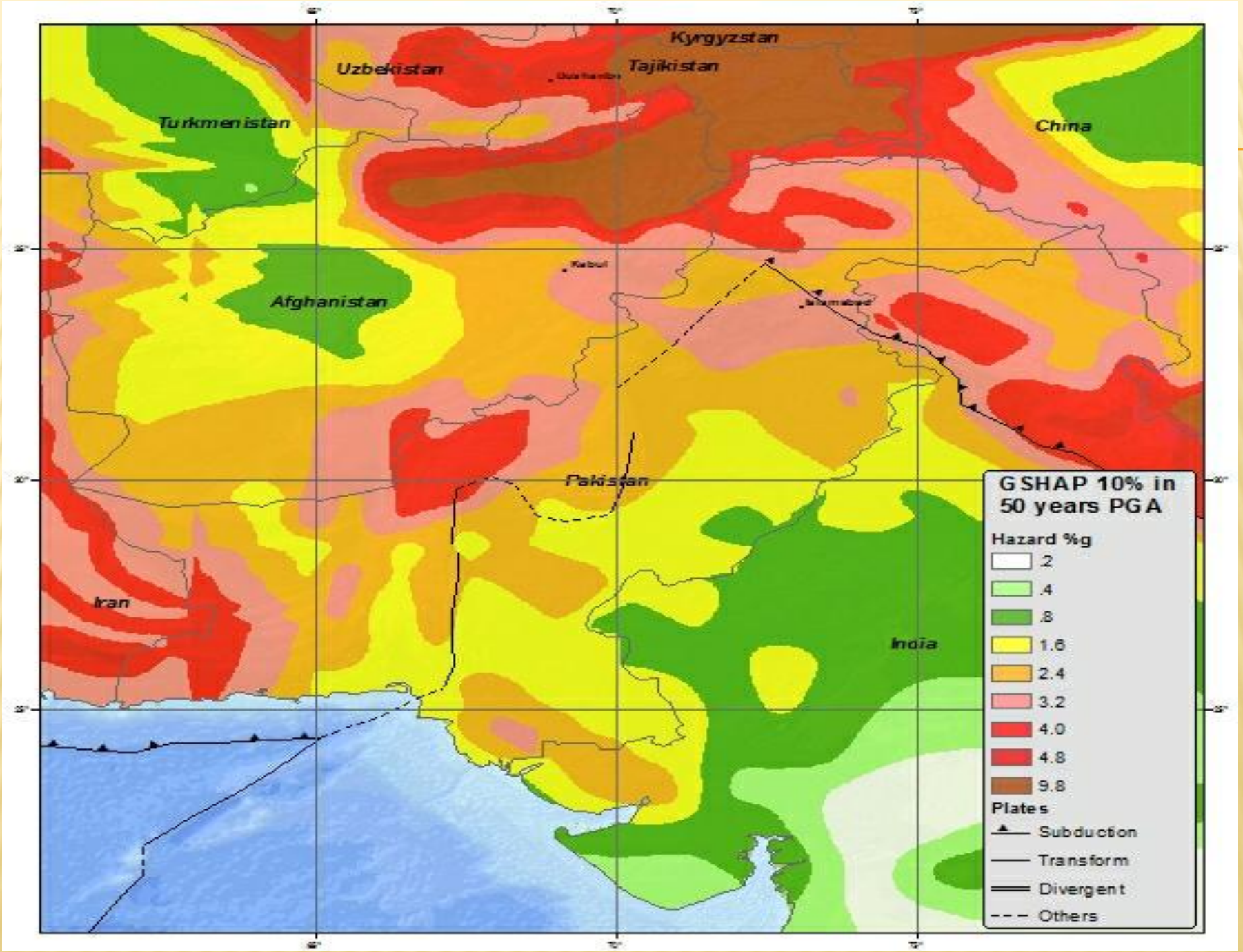
Relation between earthquake magnitude and numbers of fatalities for all earthquakes (worldwide) since 1900

HIMALAYAN EARTHQUAKES BEFORE KASHMIR EARTHQUAKE 2005



HIMALAYAN EARTHQUAKES AFTER KASHMIR EARTHQUAKE 2005




Kyrgyzstan
Uzbekistan
Tajikistan
Turkmenistan
China
Afghanistan
Kabul
Pakistan
Iran
India
GSHAP 10% in 50 years PGA
Hazard %g
.2
.4
.8
1.6
2.4
3.2
4.0
4.8
9.8
Plates
Subduction
Transform
Divergent
Others

Thank you