Use of Remote Sensing and GIS Techniques in Post-Earthquake Damage Identification and Assessment

Syed Jamil H. Kazmi

Professor & Chairman
Department of Geography
University of Karachi
Karachi - Pakistan

Background

Remote Sensing Applications

Earthquake in Pakistan (Geological & Historical Context)

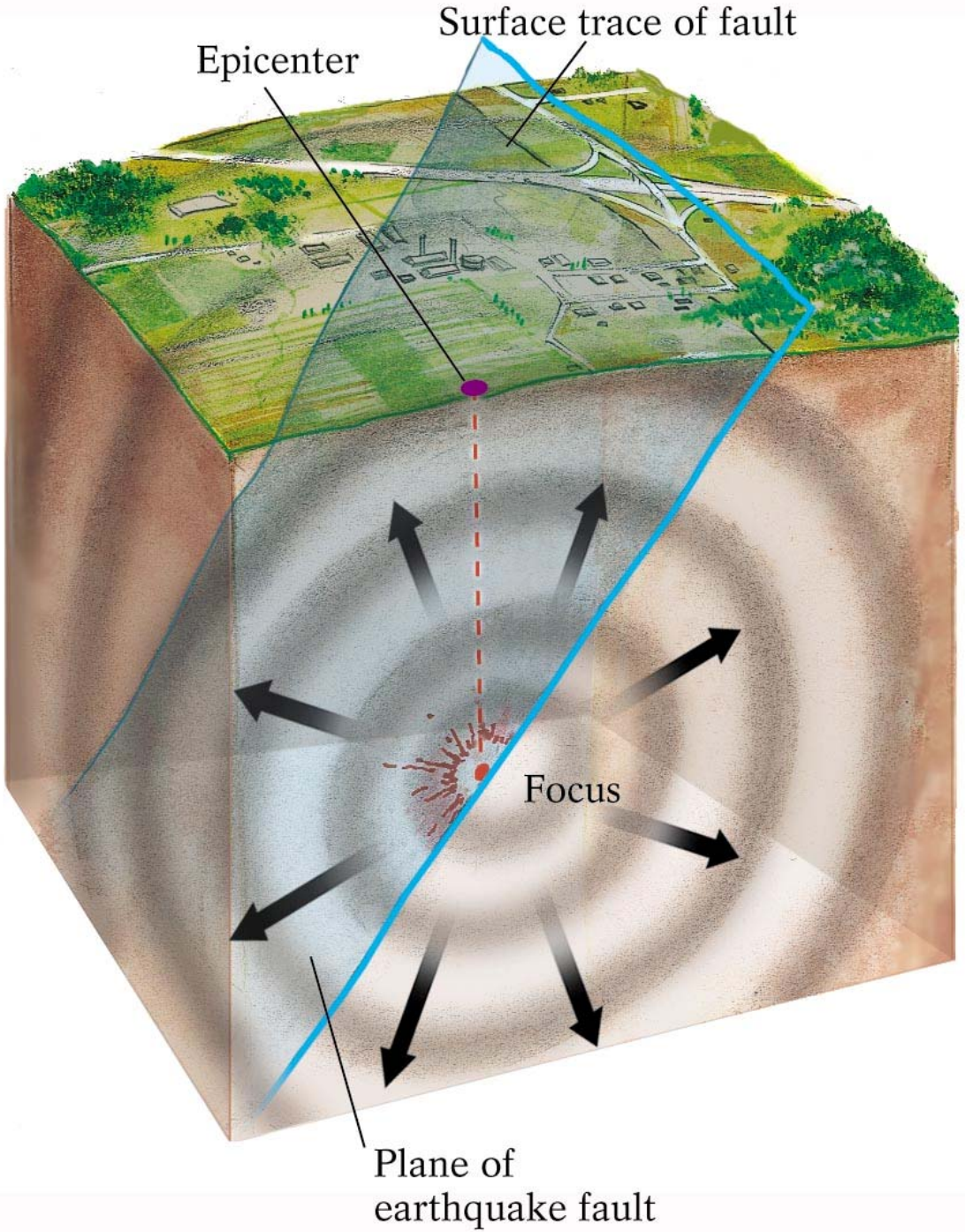
GIS Based Risk Zones Mapping

Evidence of Gigantic Devastation

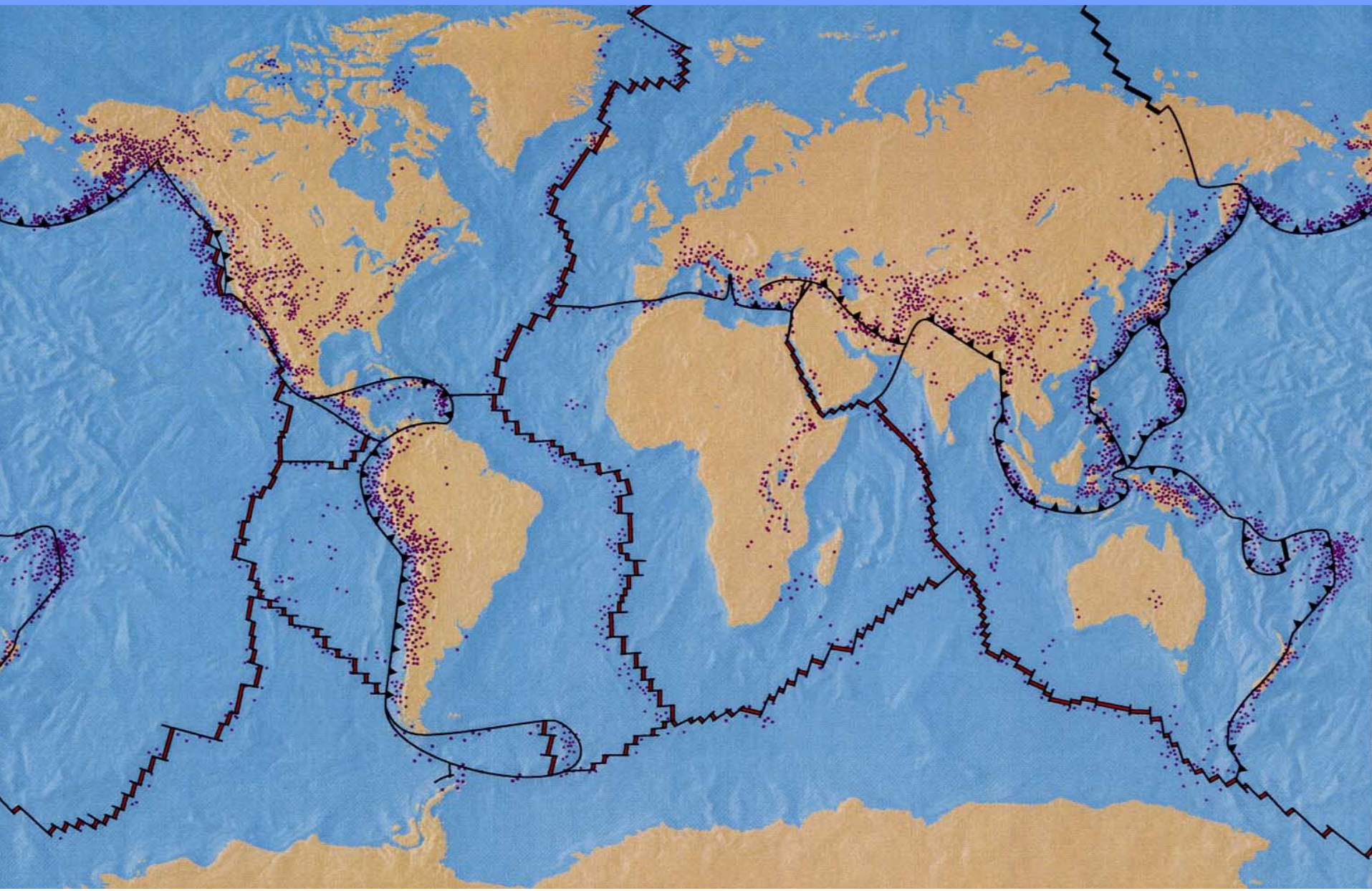
RS Applications in Pakistan

Field Visit

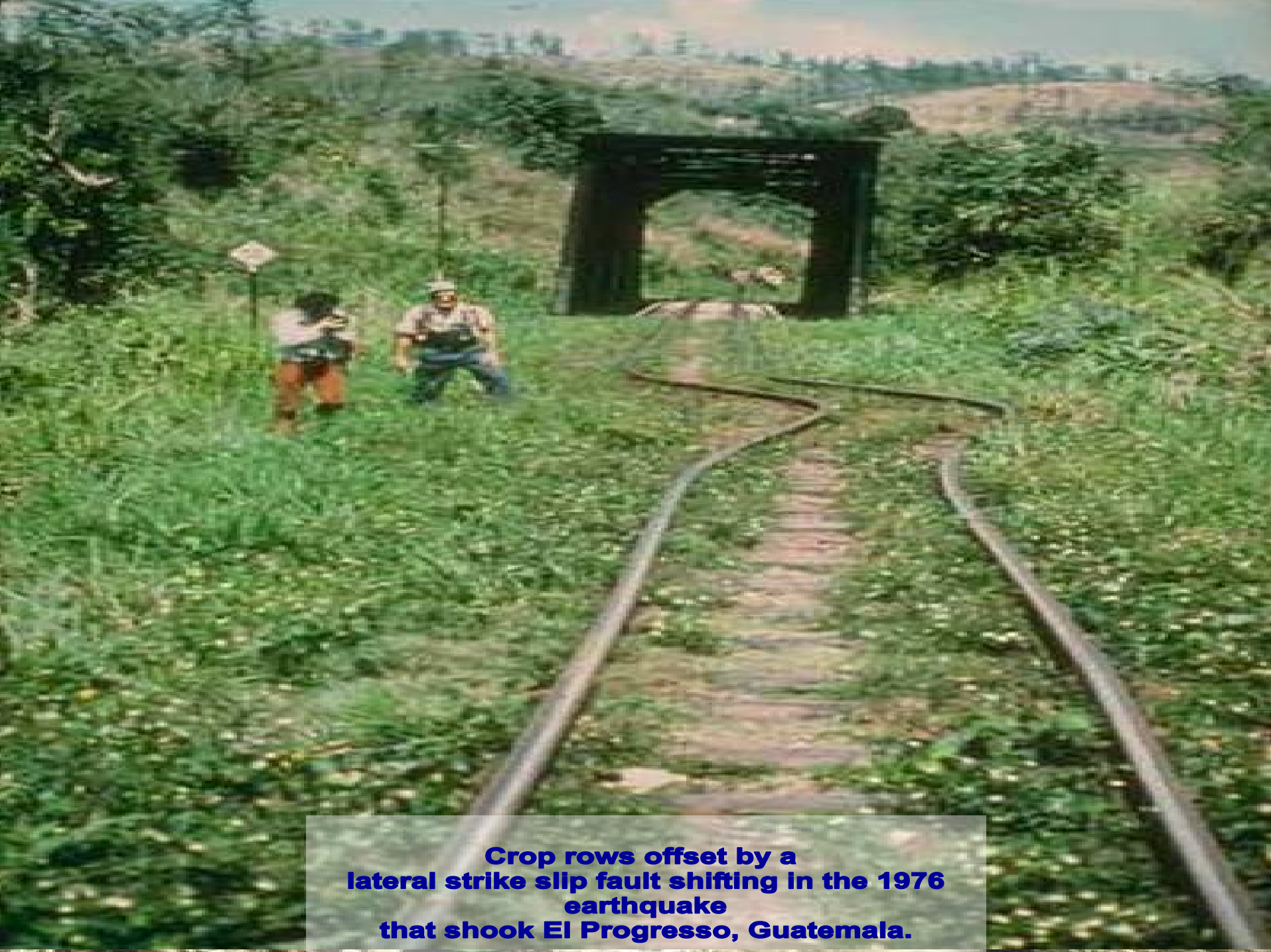
Conclusion


Surface trace of fault
Epicenter
Focus
Plane of
earthquake fault

Worldwide distribution of earthquakes



Kobe 1995



Crop rows offset by a
lateral strike slip fault shifting in the 1976
earthquake
that shook El Progresso, Guatemala.

Principles of damage detection

Multi – temporal analysis

- high accuracy of interpretation
- detection of typical soft storey damage

before

after

Example of a soft story damage in Boumerdes, Algeria, after May 21th earthquake, 2003

Observed change between the May and June images

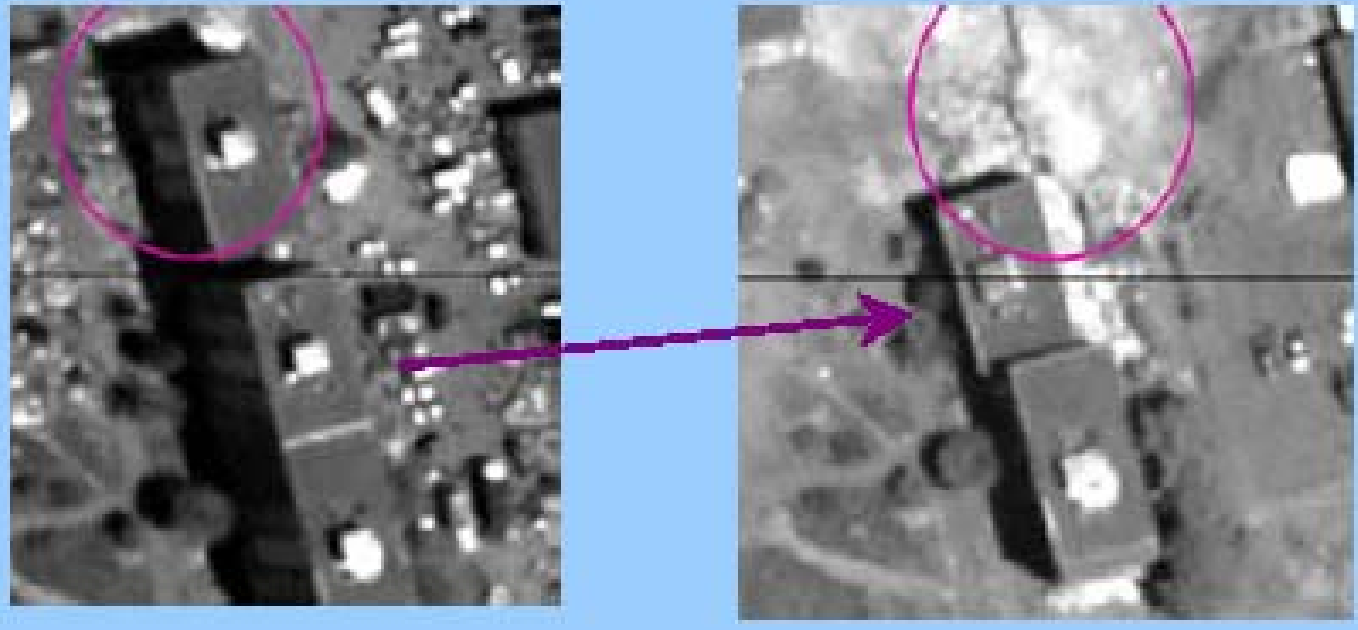
23rd May

18th June

Additional damage was observed on the image from June. Note the difference in the look angle as well.

before

after



08 Oct 2005(PAKISTAN)

Most destructive earthquake in the history of Pakistan which killed 75,000 people, injured 70,000. and made 3.5 million people homeless.

Magintude at Richterscale was 7.6

Epicenter was 95 km away from Islamabad in between Attock and Hazara division.

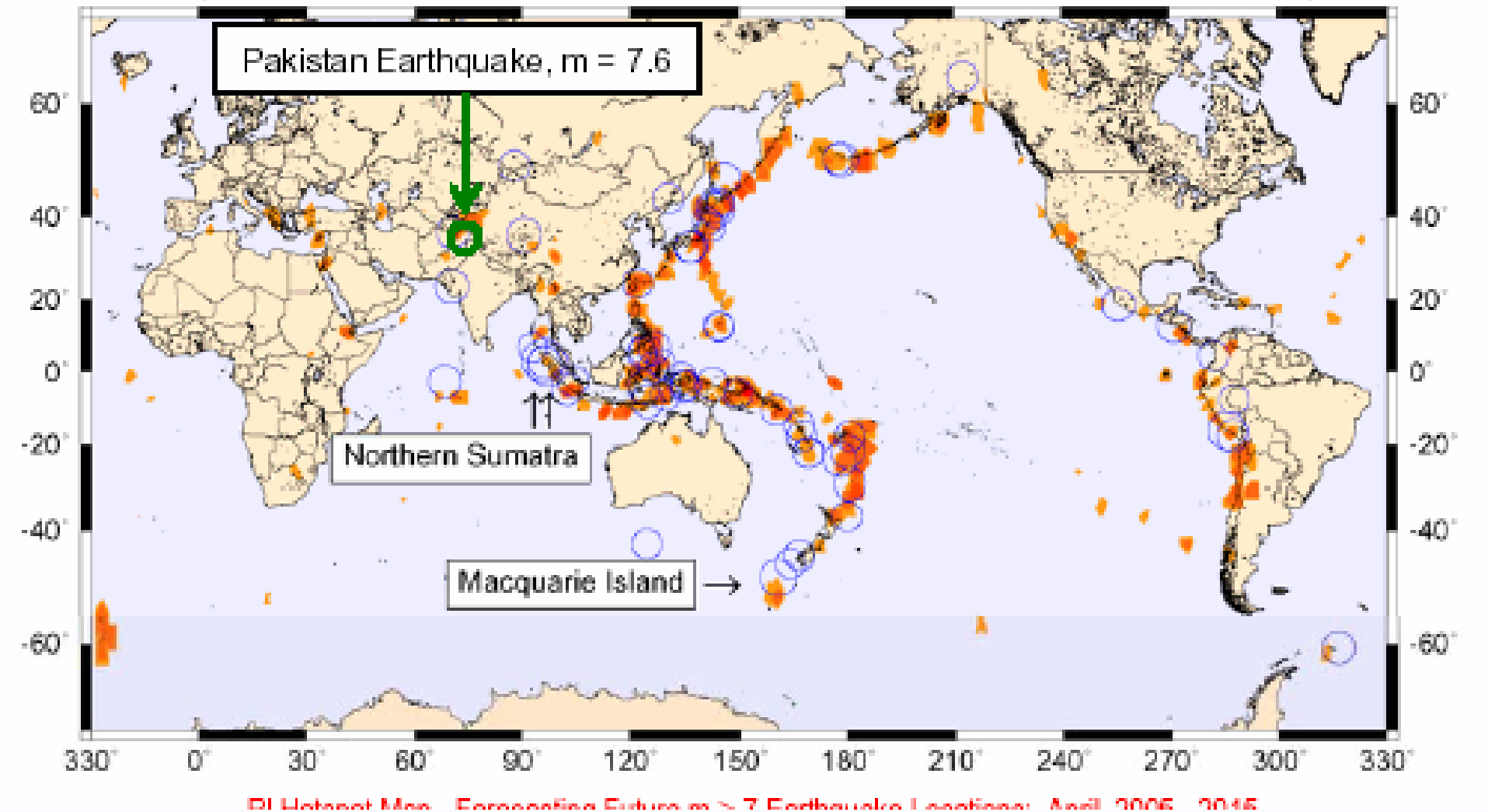
Indian plate subduction with Eurasian plate

It is the 4th major earthquake in the year of 2005.

Earthquake Statistics

- Dead: 75,000 persons?
  This includes over 18,000 children
- Injured: 70,000 persons?
- Overall affected: 3.2- 3.5 million persons
- Without Shelter: 2.8 million persons (approx.)
- Without adequate food: 2.3 million persons
- Employment loss: 325,000 persons (30%)
- Housing : 400153 shelter units destroyed or seriously damaged.
- Education : 4844 destroyed
  2647 damaged
- Health : 455 destroyed
  119 damaged
- Roads : 4429 km damaged (37%)

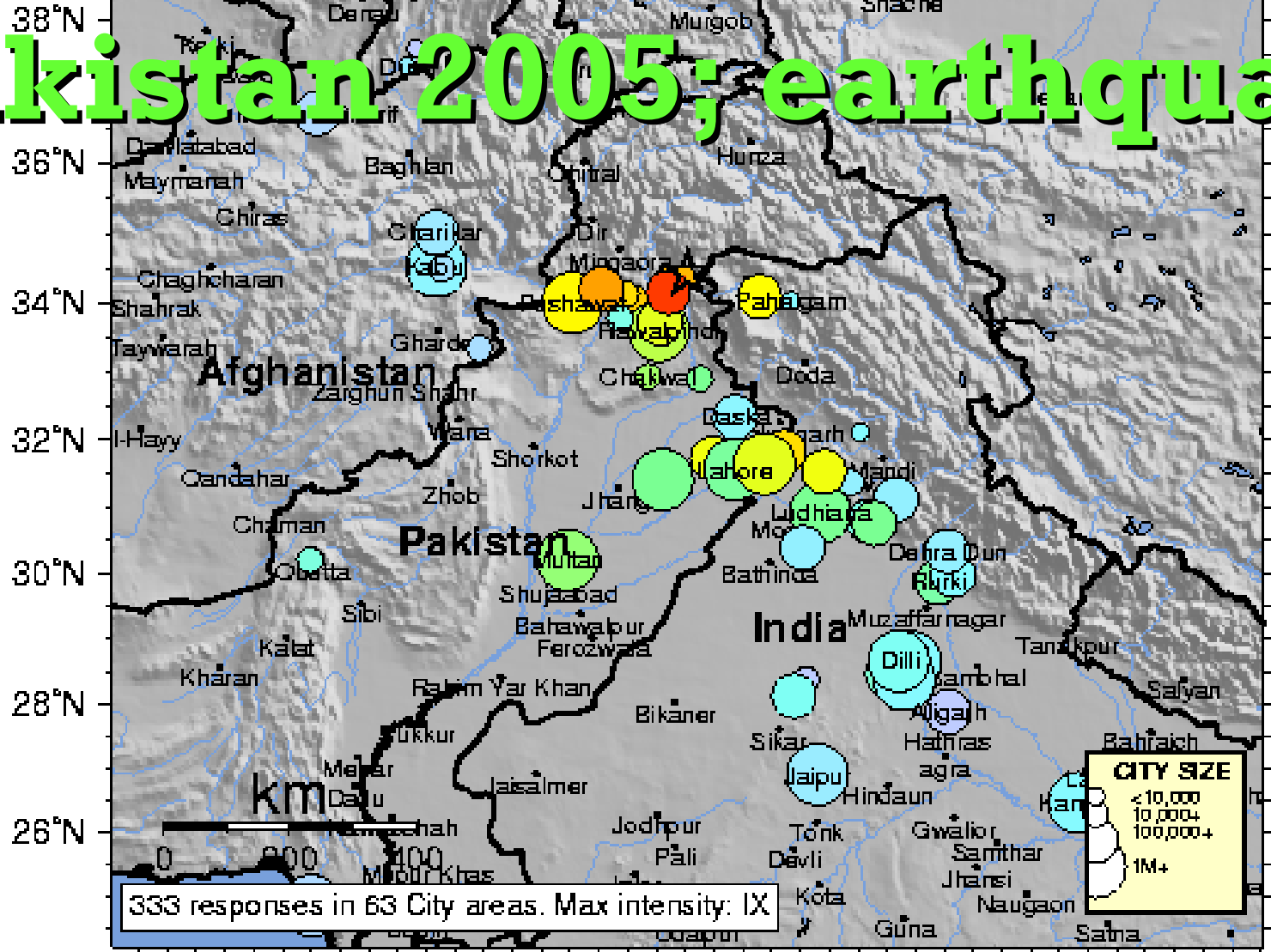
Source: Government of Pakistan - as of Nov 3, 2005



PI Hotspot Map - Forecasting Future m > 7 Earthquake Locations: April 2006 - 2046

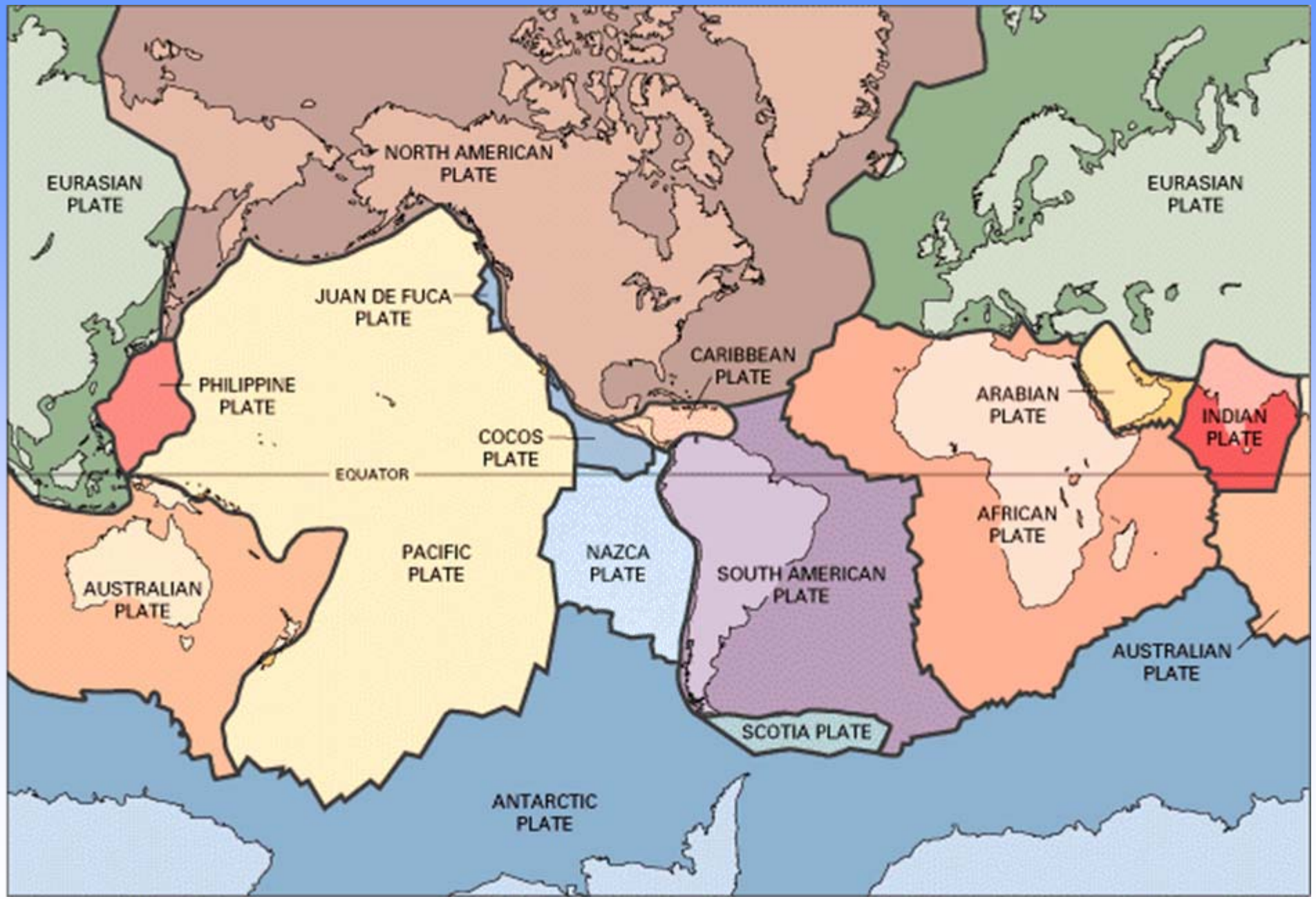

200km
100km
50km
20km
CHINA
Xinjiang
Badakhshan
Nurestan
AFGHANISTAN
Indus
Northern Areas
PAKISTAN
North West Frontier
Asadabad
Konar
Nangarhar
Peshawar
Srinagar
Azad Kashmir
Rawalpindi
Islamabad Capital Territory
Jammu & Kashmir
INDIA
Punjab
Himachal Pradesh

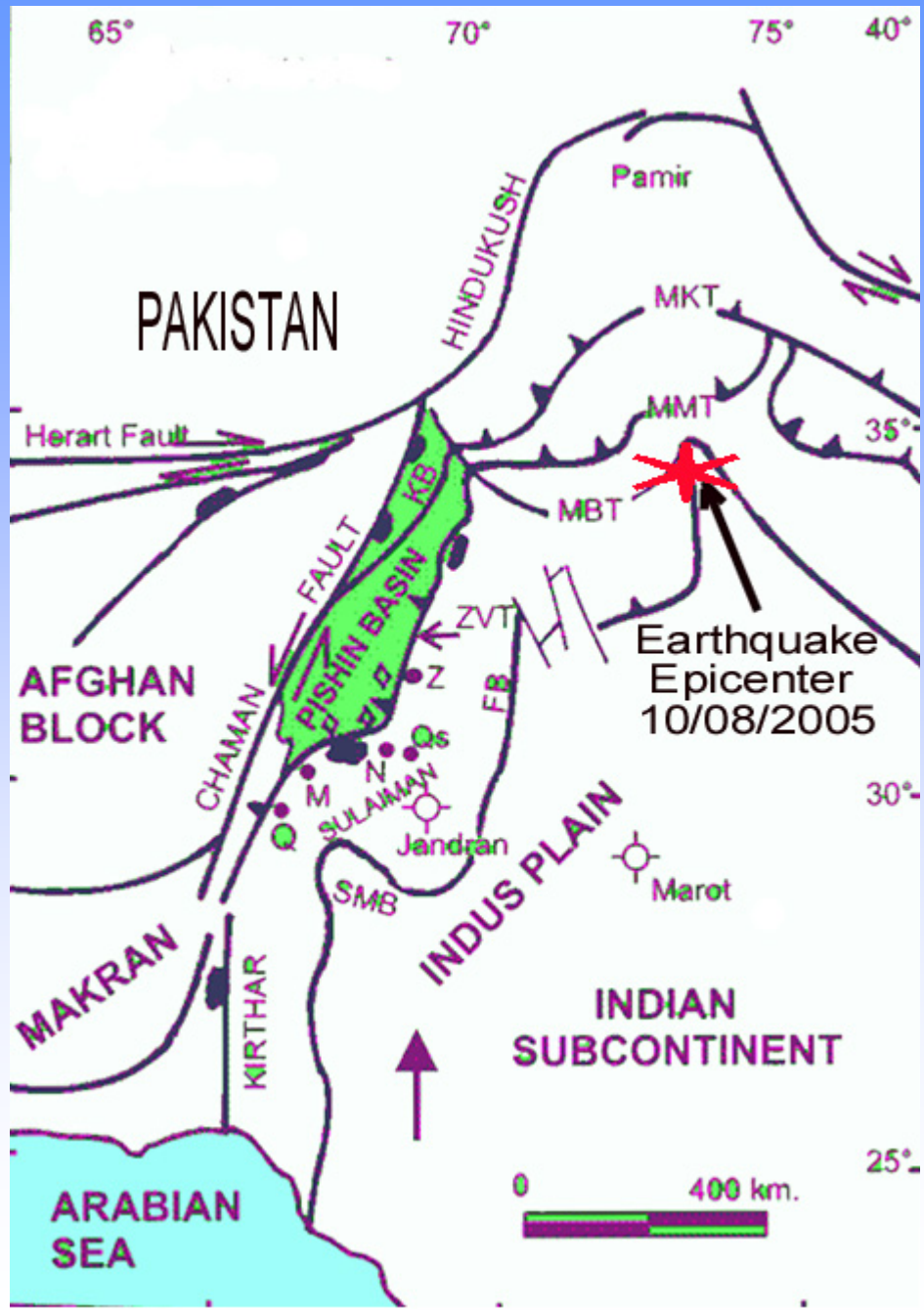
Pakistan 2005; earthquake

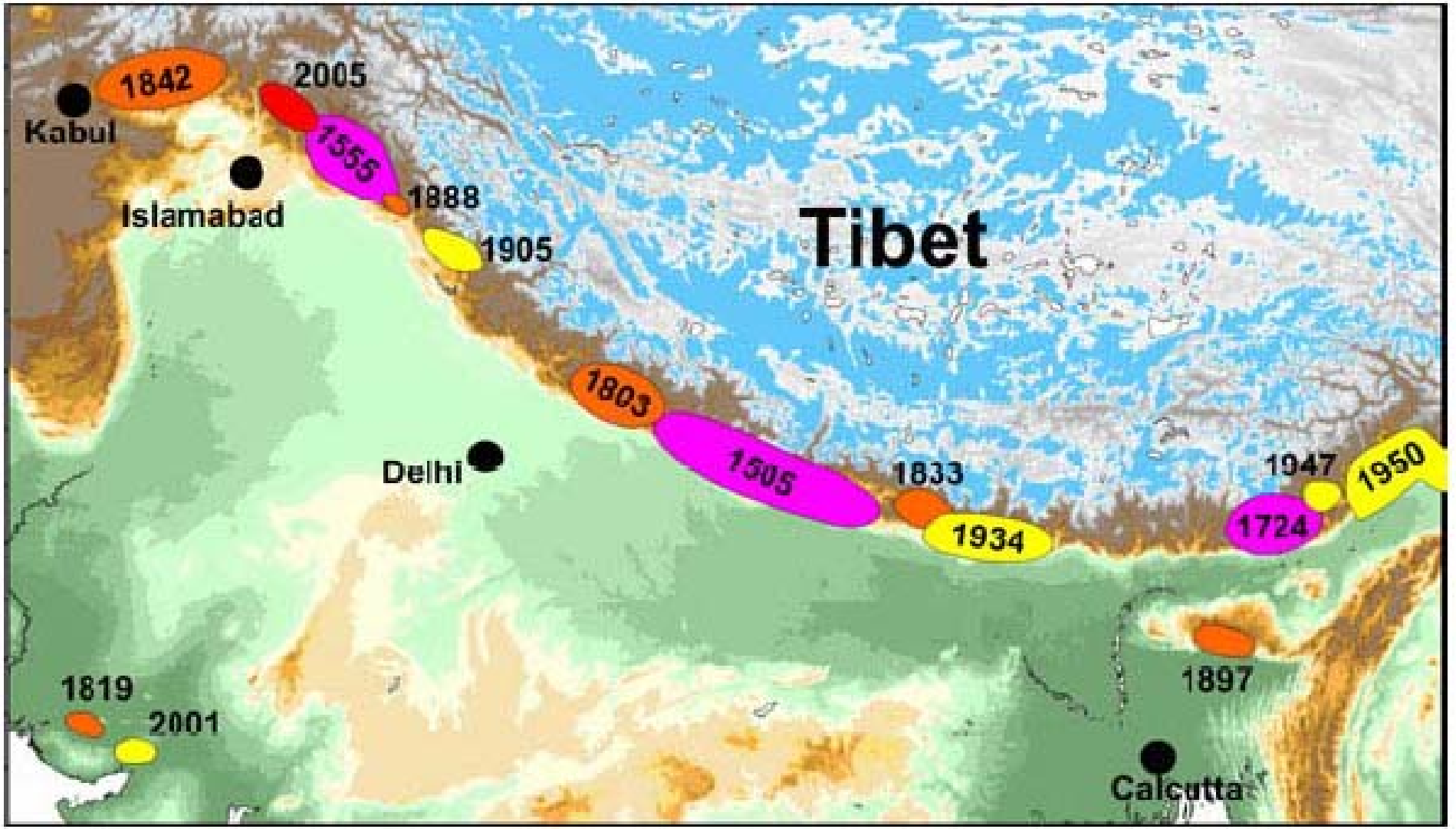


Oct. 8th, 2005

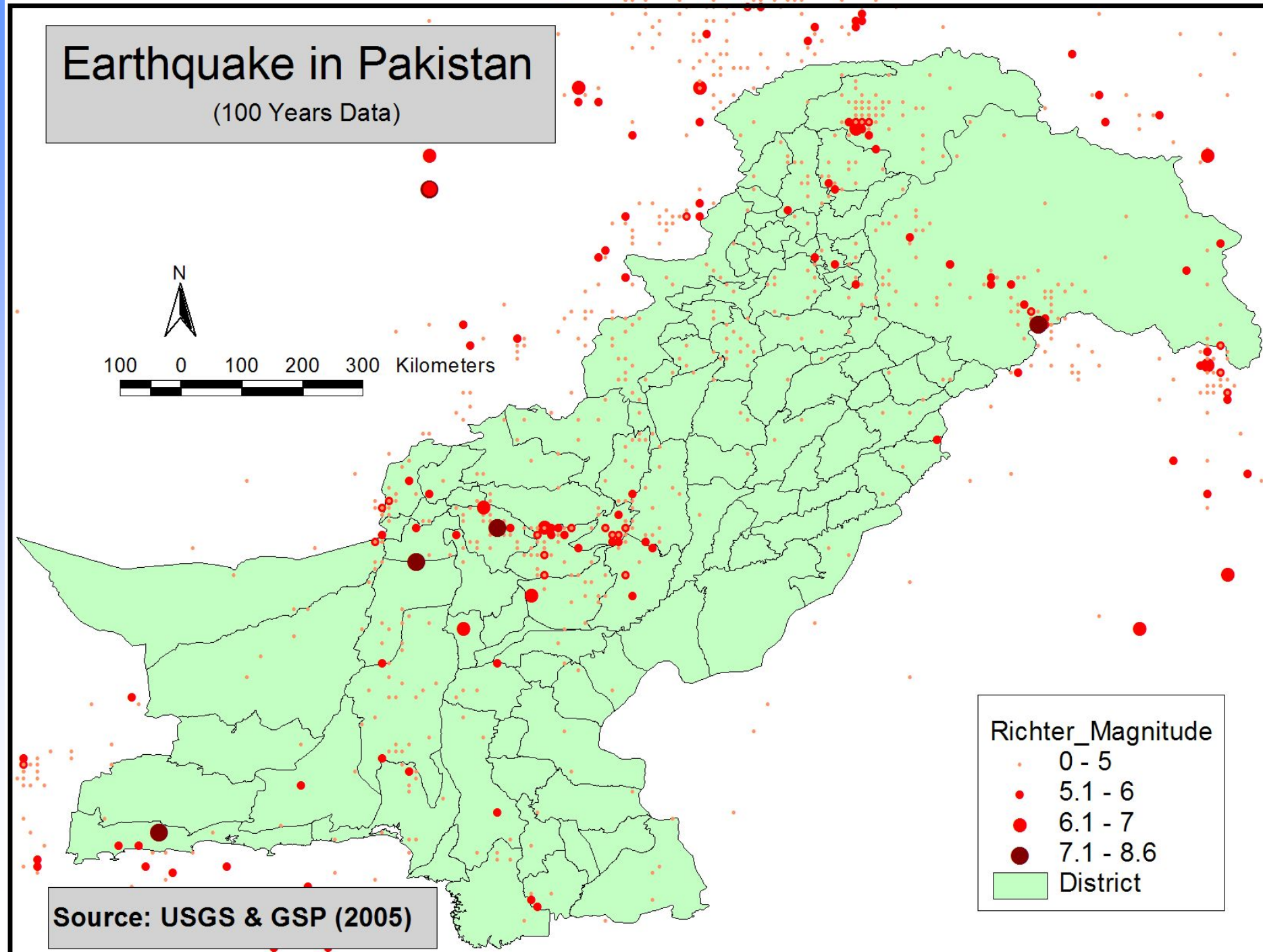
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

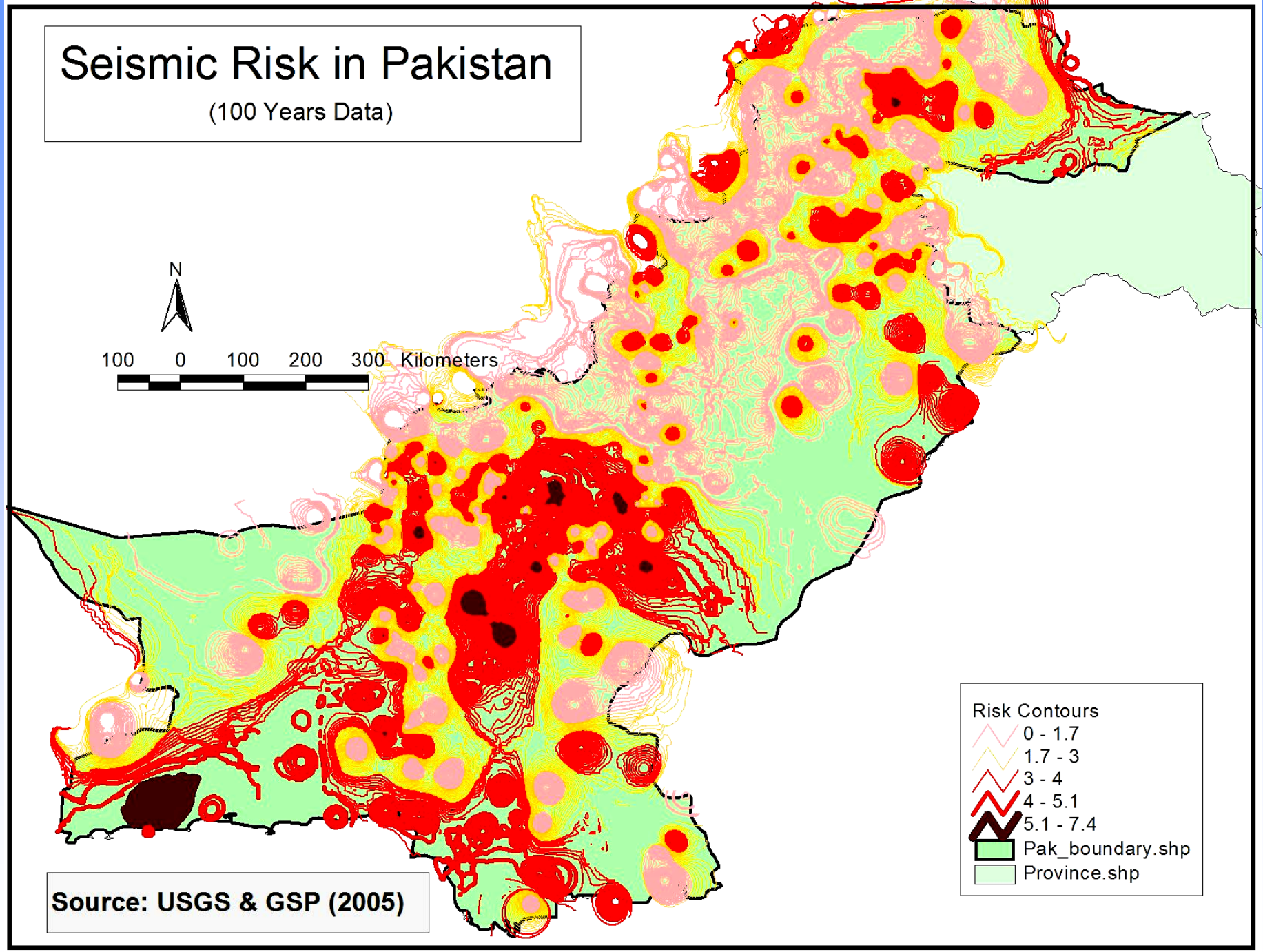

EURASIAN PLATE
NORTH AMERICAN PLATE
EURASIAN PLATE
JUAN DE FUCA PLATE
CARIBBEAN PLATE
PHILIPPINE PLATE
ARABIAN PLATE
INDIAN PLATE
COCOS PLATE
EQUATOR
AFRICAN PLATE
PACIFIC PLATE
NAZCA PLATE
SOUTH AMERICAN PLATE
AUSTRALIAN PLATE
AUSTRALIAN PLATE
SCOTIA PLATE
ANTARCTIC PLATE

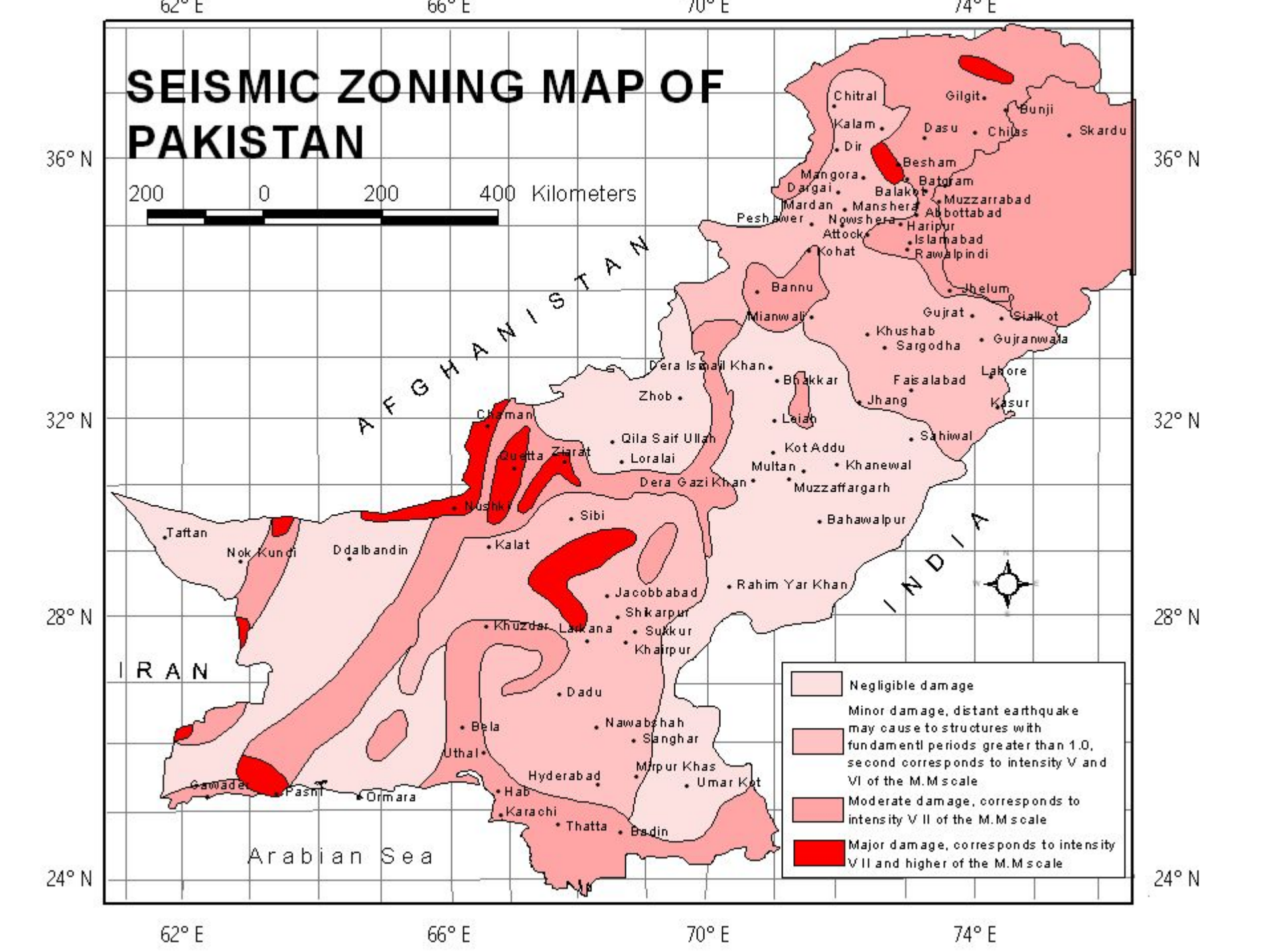

65°
70°
75°
40°
PAKISTAN
HINDUKUSH
Pamir
MKT
MMT
35°
Herart Fault
MBT
KB
FAULT
PISHIN BASIN
ZVT
Earthquake
Epicenter
10/08/2005
AFGHAN
BLOCK
CHAMAN
Z
FB
Qs
N
M
Q
SULAIMAN
30°
Jandran
Marot
INDUS PLAIN
SMB
MAKRAN
KIRTHAR
INDIAN
SUBCONTINENT
ARABIAN
SEA
25°
0
400 km.



Large historical earthquake events in Northern Pakistan and India. The colored areas show the approximate rupture zones and the October 8, 2005 event is shown in red. (Source: Bilham 2005 and Center for the Observation and Modelling of Earthquakes and Tectonics, COMET, 2005)


Earthquake in Pakistan
(100 Years Data)
N
100 0 100 200 300 Kilometers
Richter_Magnitude
0 - 5
5.1 - 6
6.1 - 7
7.1 - 8.6
District
Source: USGS & GSP (2005)


Seismic Risk in Pakistan
(100 Years Data)
N
100 0 100 200 300 Kilometers
Risk Contours
0 - 1.7
1.7 - 3
3 - 4
4 - 5.1
5.1 - 7.4
Pak_boundary.shp
Province.shp
Source: USGS & GSP (2005)


SEISMIC ZONING MAP OF PAKISTAN
200 0 200 400 Kilometers
62° E
66° E
70° E
74° E
36° N
32° N
28° N
24° N
AFGHANISTAN
IRAN
INDIA
Arabian Sea
Chitral
Gilgit
Bunji
Kalam
Dasu
Chilas
Skardu
Dir
Besham
Mangora
Batgram
Dargai
Balakot
Mardan
Manshera
Muzzarrabad
Abbottabad
Peshawer
Nowshera
Haripur
Attock
Islamabad
Kohat
Rawalpindi
Bannu
Jhelum
Mianwali
Gujrat
Sialkot
Khushab
Sargodha
Gujranwala
Dera Ismail Khan
Bhakkar
Faisalabad
Lahore
Zhob
Jhang
Kasur
Chaman
Leiah
Qila Saif Ullah
Sahiwal
Kot Addu
Quetta
Ziarat
Loralai
Multan
Khanewal
Dera Gazi Khan
Muzzaffargarh
Nushki
Sibi
Bahawalpur
Taftan
Nok Kundi
Dalbandin
Kalat
Jacobbabad
Rahim Yar Khan
Shikarpur
Khuzdar
Larkana
Sukkur
Khairpur
Dadu
Bela
Nawabshah
Sanghar
Uthal
Mirpur Khas
Hyderabad
Umar Kot
Gawadar
Pasni
Ormara
Hab
Karachi
Thatta
Badin
Negligible damage
Minor damage, distant earthquake may cause to structures with fundamentl periods greater than 1.0, second corresponds to intensity V and VI of the M.M scale
Moderate damage, corresponds to intensity V II of the M.M scale
Major damage, corresponds to intensity V II and higher of the M.M scale

0 8

O C T O B E R


October 8, 2005 Kashmir Earthquake
Photo By: A. Nisar (MMI Engineering/EERI)
November 14-17, 2005

08 OCTOBER

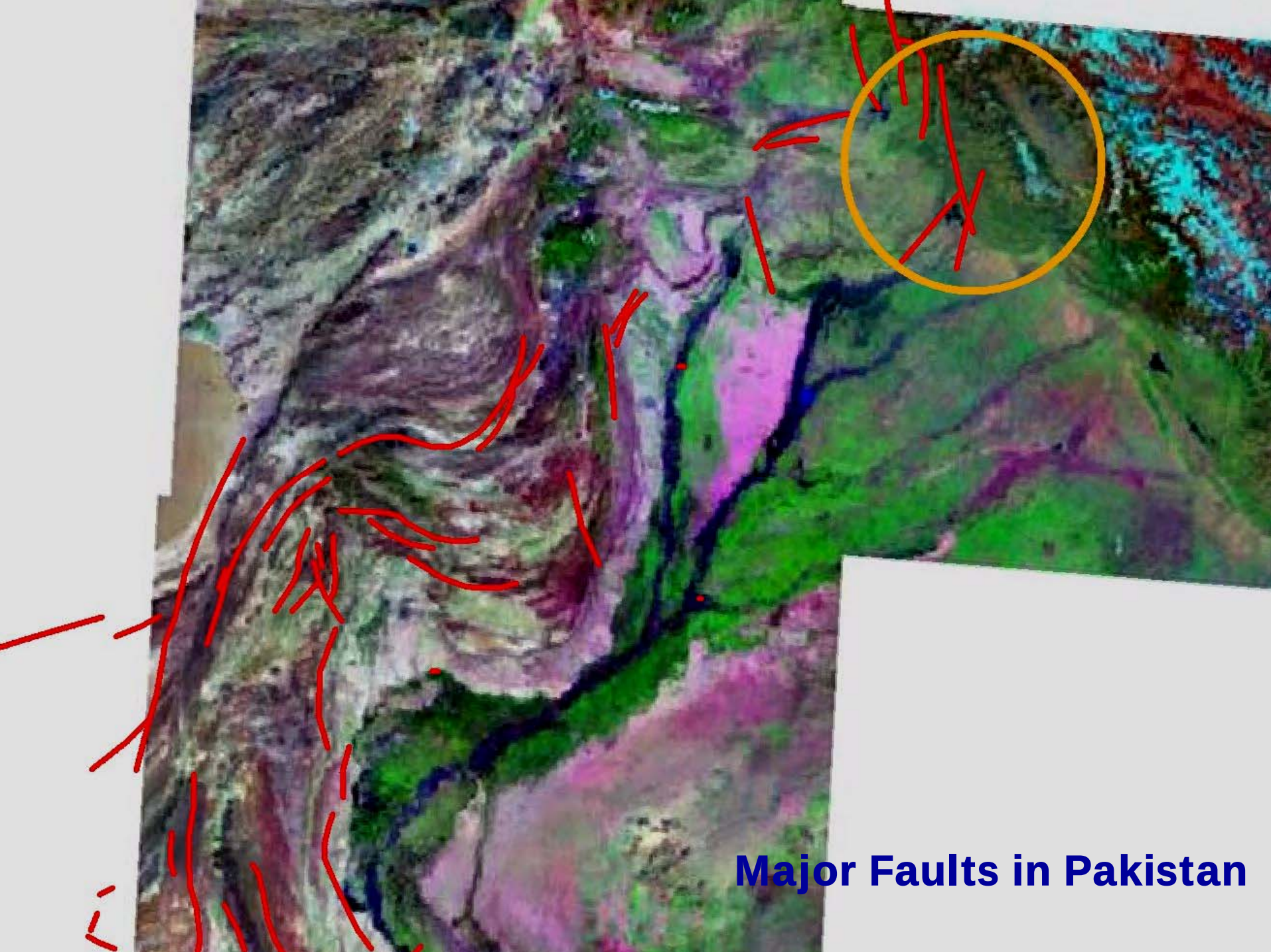
08 OCTOBER

0 8 OCTOBER

0 8 O C T O B E R

Why did the earthquake in Pakistan cause so much damage?

* The majority of the damage was man-made
* Buildings were built in the wrong places using the wrong materials and the wrong design.
* Most deaths were caused by building collapses
* Government buildings were amongst those most heavy damaged
* Neither the people nor the government was prepared to deal with the disaster
* The affected communities were scattered over a very large area of mountainous terrain, which was difficult to access.
* Pakistan did not have rescue and relief teams with appropriate knowledge/skills –people died waiting to be rescued.



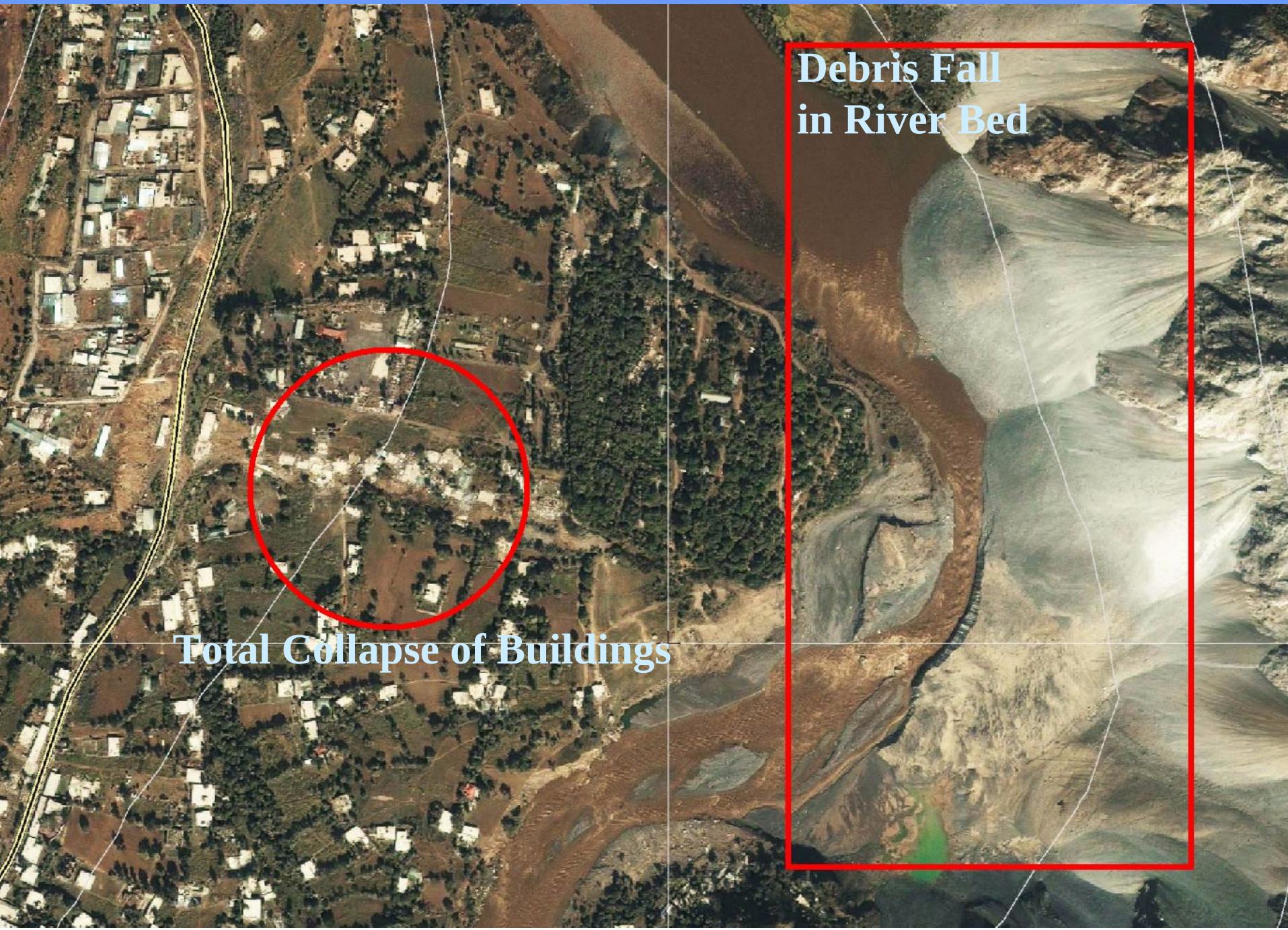
Major Faults in Pakistan


— Plate Boundary
Pakistan
Initial Quake

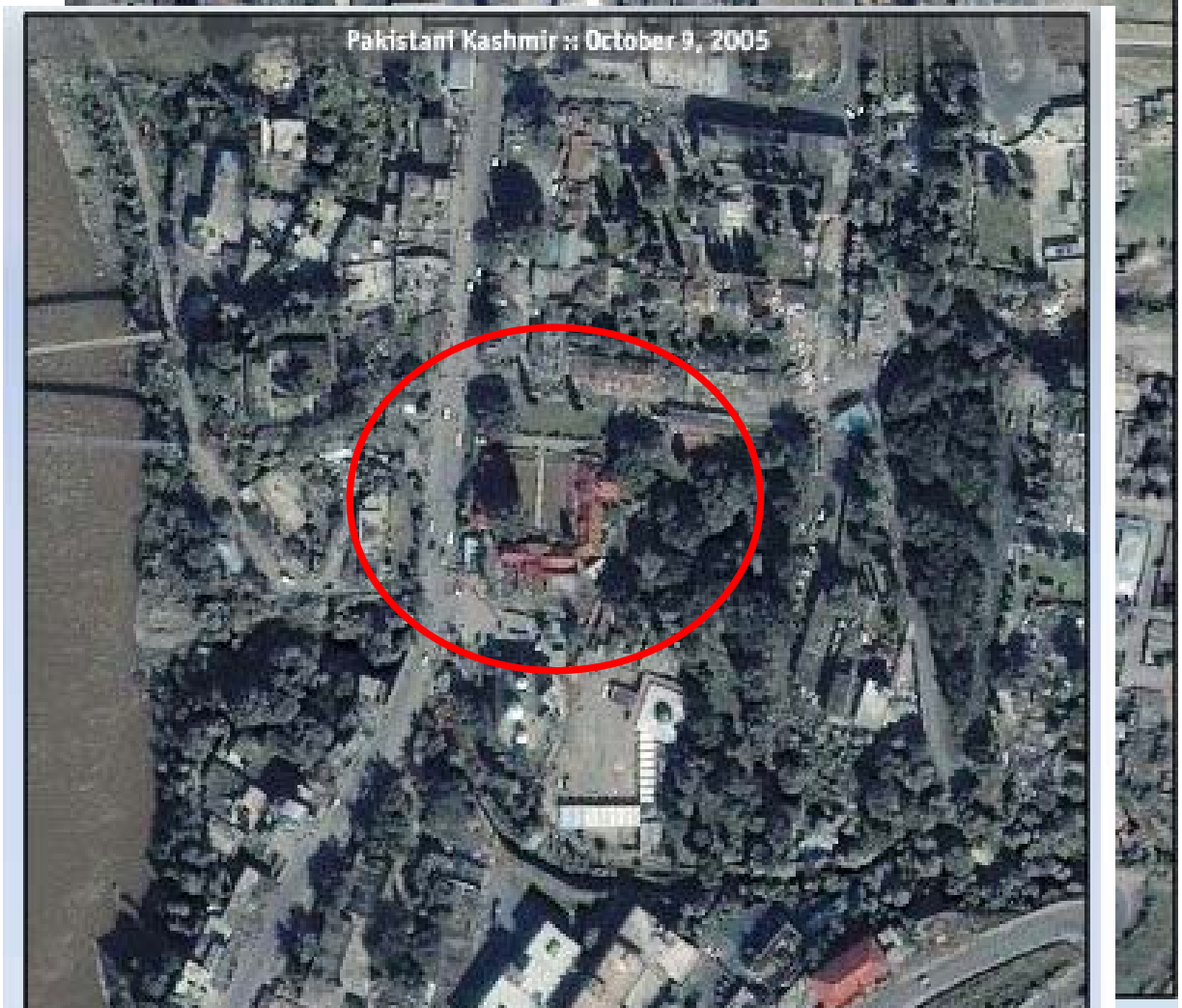
October 27, 2005


October 8, 2005 Kashmir Earthquake
Photo By: Bijan Khatiwal (Columbia University, Earth Institute/IERI)
November 14-21, 2005


October 8, 2005 Kashmir Earthquake
Photo By: Bijan Khatiwal (Columbia University, Earth Institute/IERI)
November 14-21, 2005


Debris Fall
in River Bed
Total Collapse of Buildings


Pakistani Kashmir :: September 22, 2002


Pakistani Kashmir :: October 9, 2005


Pre-Disaster
Post Disaster

Garhi Habibullah's Visit

April 1, 2006

(after 174 days)


ظلم کے خلاف
پاسبان


PSO

Significant Causes of Infrastructure Damage

Engineered (Institutional Buildings)

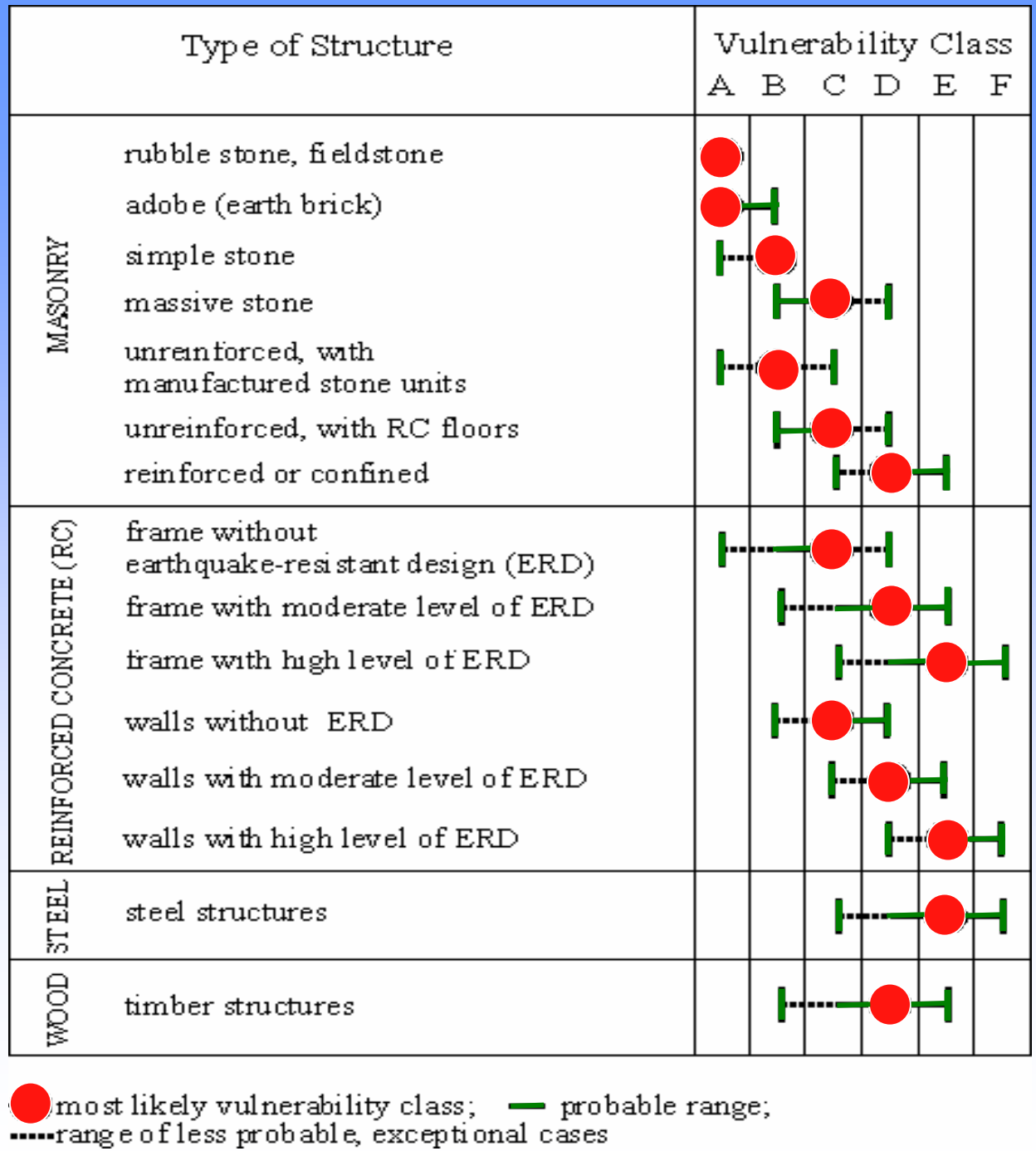
- Quality of construction and construction materials
- Lack of seismic Awareness
- Lack of monitoring
- Building codes (dichotomy) ??
- Governance weakness

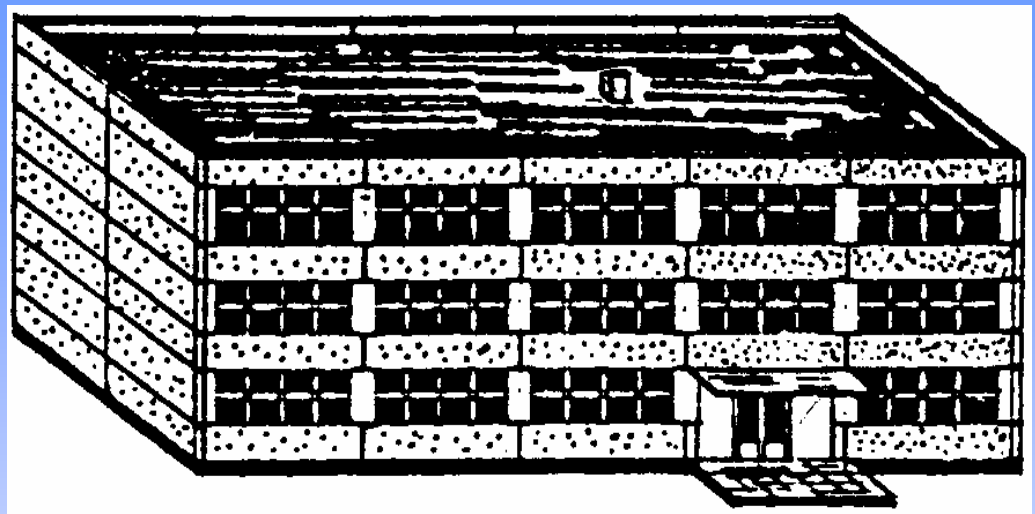
Non-Engineered (Private Buildings/Homes)

- Lack of awareness about seismically resistant design
- Siting of structures
- Aspiration to modernize with insufficient knowledge of safe construction
- Cost

Differentiation of structures (building) Into Vulnerability classes

European Macroseismic Scale



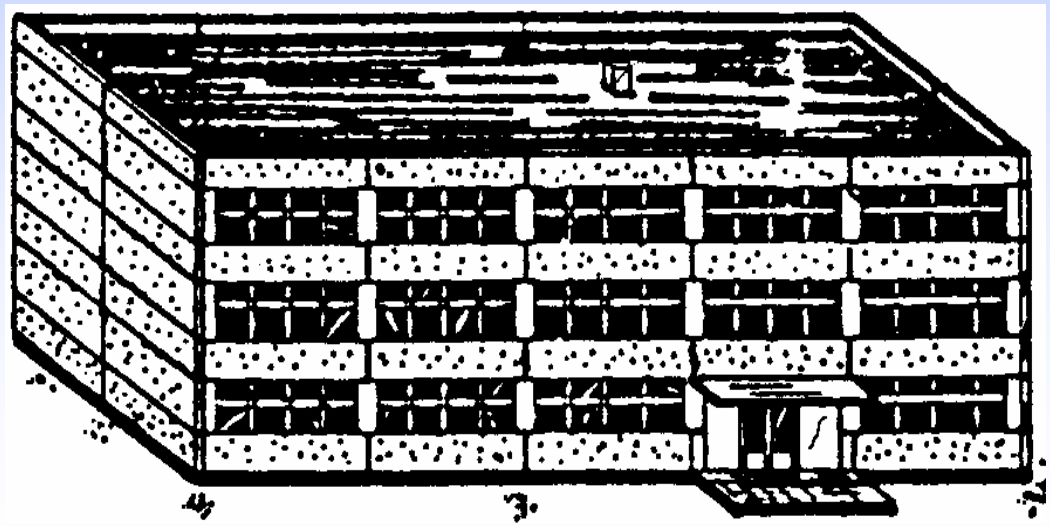


GRADE 1

NEGLIGIBLE
TO
SLIGHT DAMAGE

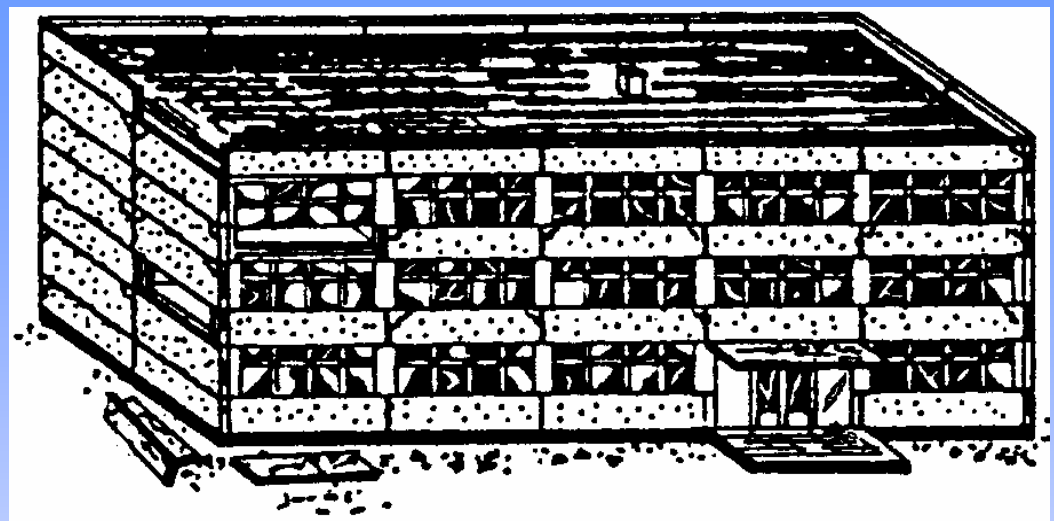
GRADE 2

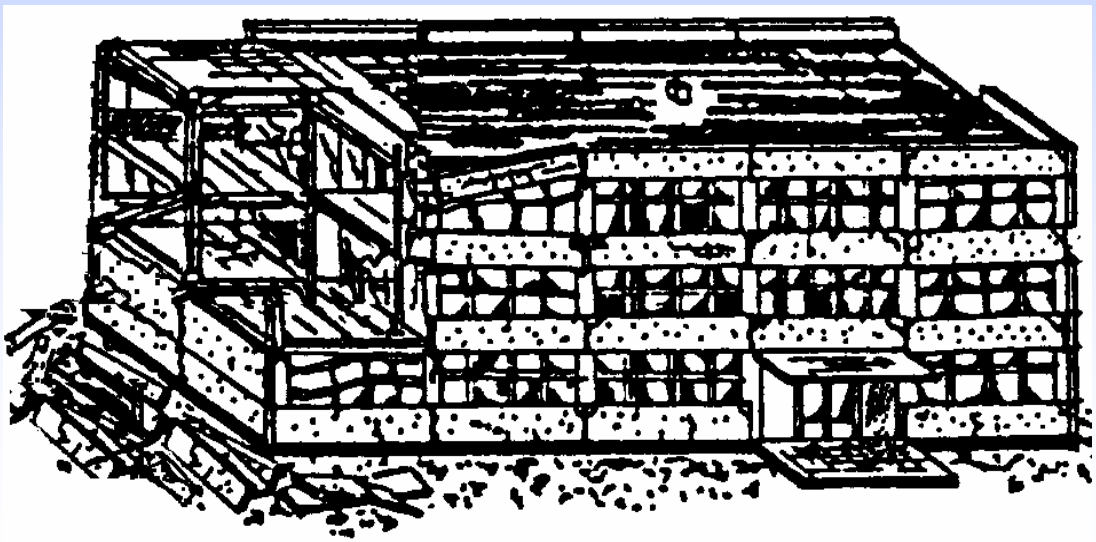
MODERATE DAMAGE



GRADE 3

SUBSTANTIAL TO HEAVY DAMAGE





GRADE 4

VERY HEAVY DAMAGE

GRADE 5

DESTRUCTION

GRADE 2

GRADE 3

GRADE 3

GRADE 4

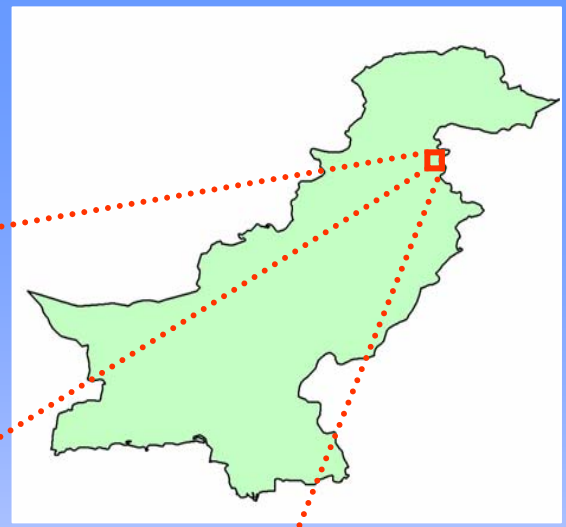
GRADE 5

GRADE 5

GRADE 5

GRADE 5

Location of Garhi Habibullah

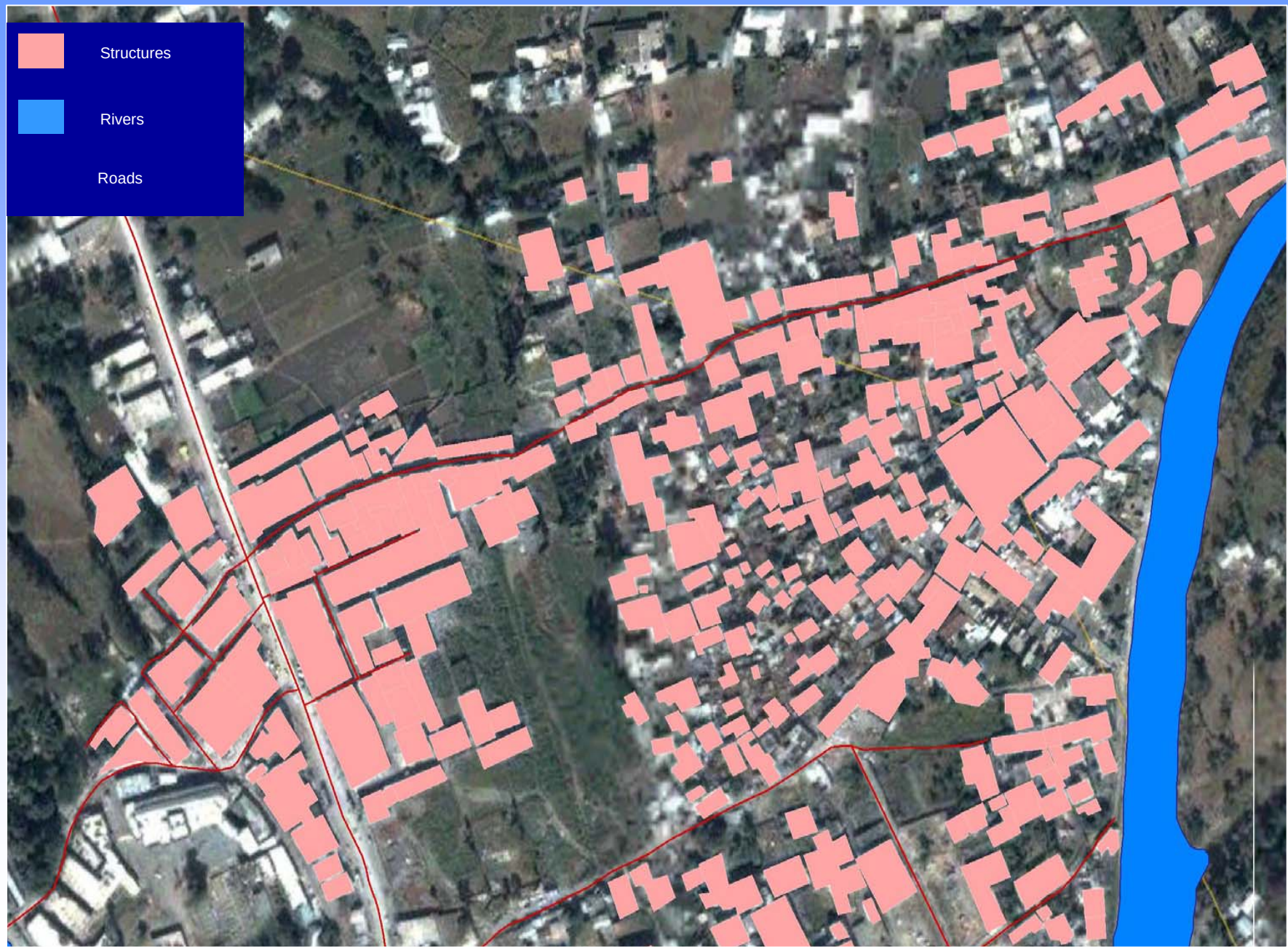


Quick Bird Imagery – 2006 of Grahi Habibullah

(Downloaded from Google Earth)

QuikBbird Satellite Image of Garhi Habibullah

Vector Layer of settlements of Garhi Habibullah



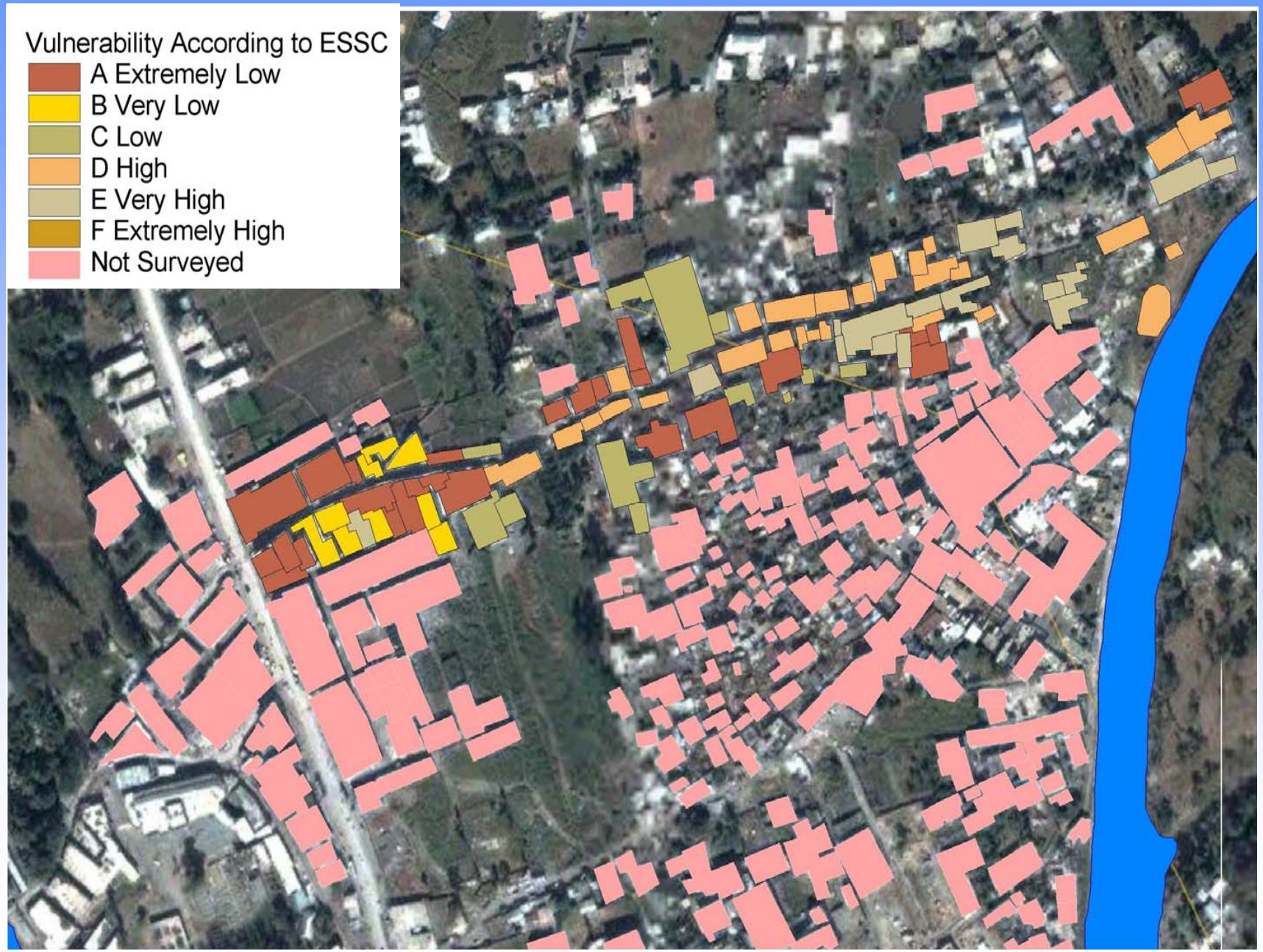
EMS Grade Applications in the Field

EMS Grade Applications in the Field

EMS Grade Applications in the Field

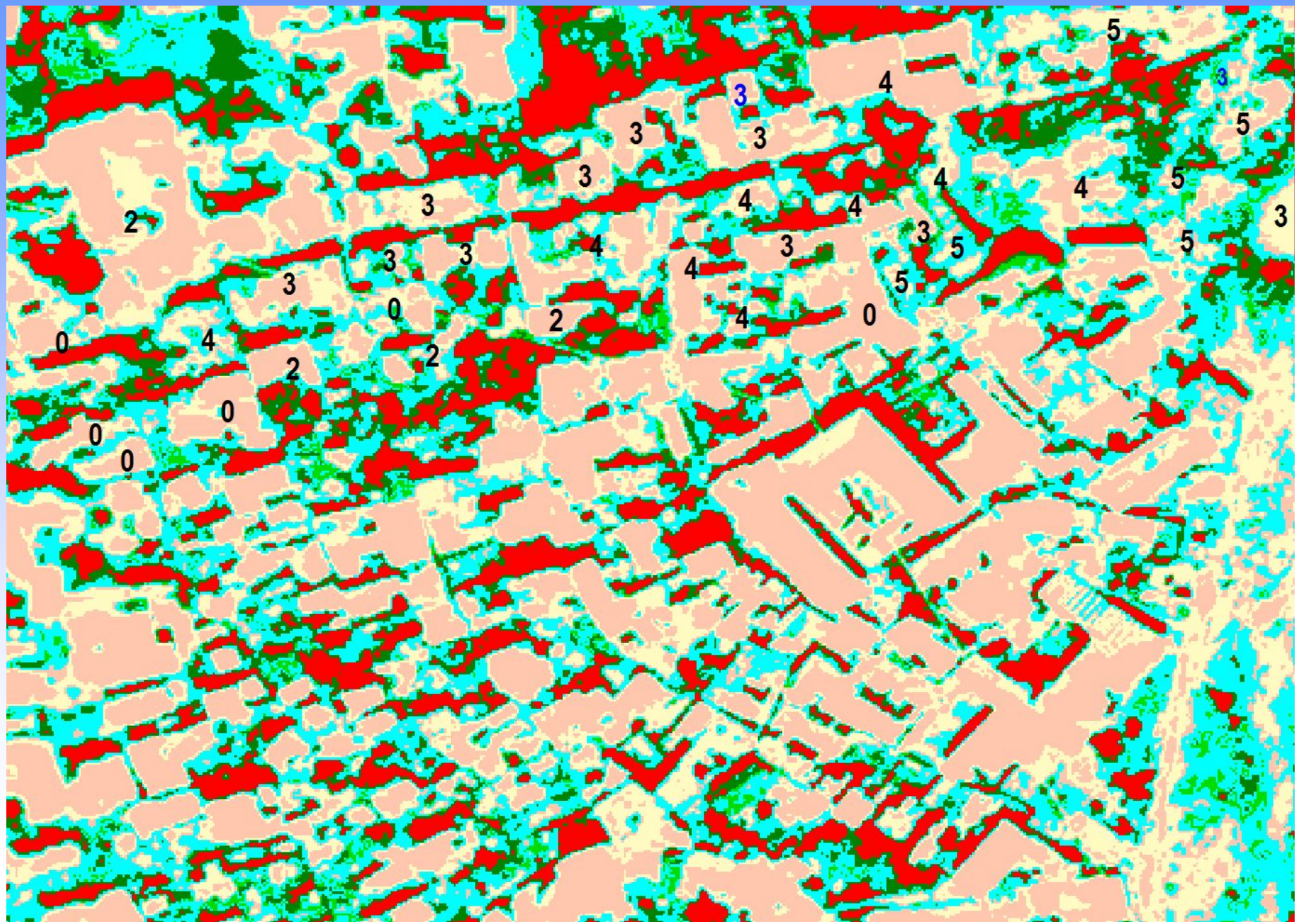
Along with the allocated Grade

Structures Classified According to European Seismic Scale



Classified Thematic Layer of Study Area

Shadow Extraction through Classification Technique



Conclusion

1. There was total ignorance both by the Public and Government about the seismic Hazards and the potential of the risk is underestimated

2. Use of RS and GIS techniques could be effective to study the post damage Assessment

3. Country level risk map could be completed efficiently with the help of GIS Tools

4. For the preliminary analysis google-earth images are good but not recommended for detailed analysis

5. Filed investigations are recommended for the Risk Zones Analysis

6. EMS is equally applicable in Pakistan for the damage assessment

Sources

NEWS PAPERS:

Sunday Express,4/ December /2005

Daily Express,16/ December/ 2005

Jang Midweek Magazine, 19/ October/ 2005

Dawn, Young world, 25/ February/ 2006

Jang Midweek Magazine, 2/ November/ 2005

BOOKS:

Christopher, R. W. Geosystems, An Introduction to Physical Geography

.

Sources

WEBSITES:

www.Google.com

www.earthqauke.usgs.gov/learning/kids/facts.php

www. charateristicsWikipedia, the free encyclopedia. tm

www.GEsource Natural Disasters and Hazards -2 Earthquakes. tm

www.Answer.com

www.Encarta.com

www.wikipedia.com

www.Webcrawler.com

www.howstuffworks.com

Acknowledgement (Research Team):

Mr. Razaaq Ahmed

Ms. Yasmeen Anis

Ms. Saima Shaikh

Mr. Suhaib Bin Farhan

Mr. Salman Qureshi

Dr. M. H. Arsalan

Dr. Raza Mehdi

Mr. Syed Ali Naqi

Mr. Nadeem Khan

Higher Education Commission (HEC), Islamabad, Pakistan

Q / A