

Nepal Engineer's Association Talk Program

“Nepal Prepared for Imminent Earthquakes: A hope for the future”

Narayan Prasad Marasini, PhD

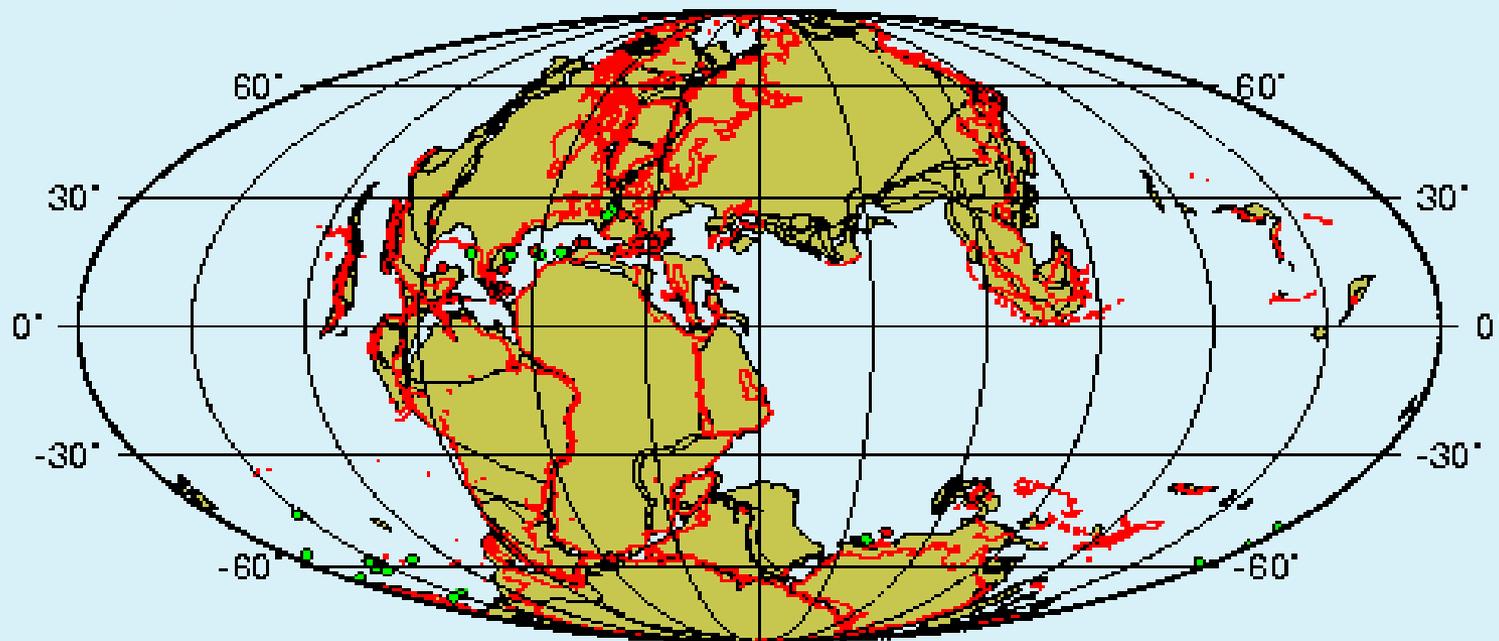
Division Director, School Earthquake Safety Program (SESP)
National Society for Earthquake Technology- Nepal (NSET)

May 17, 2019





How/why do Earthquakes Occur ?

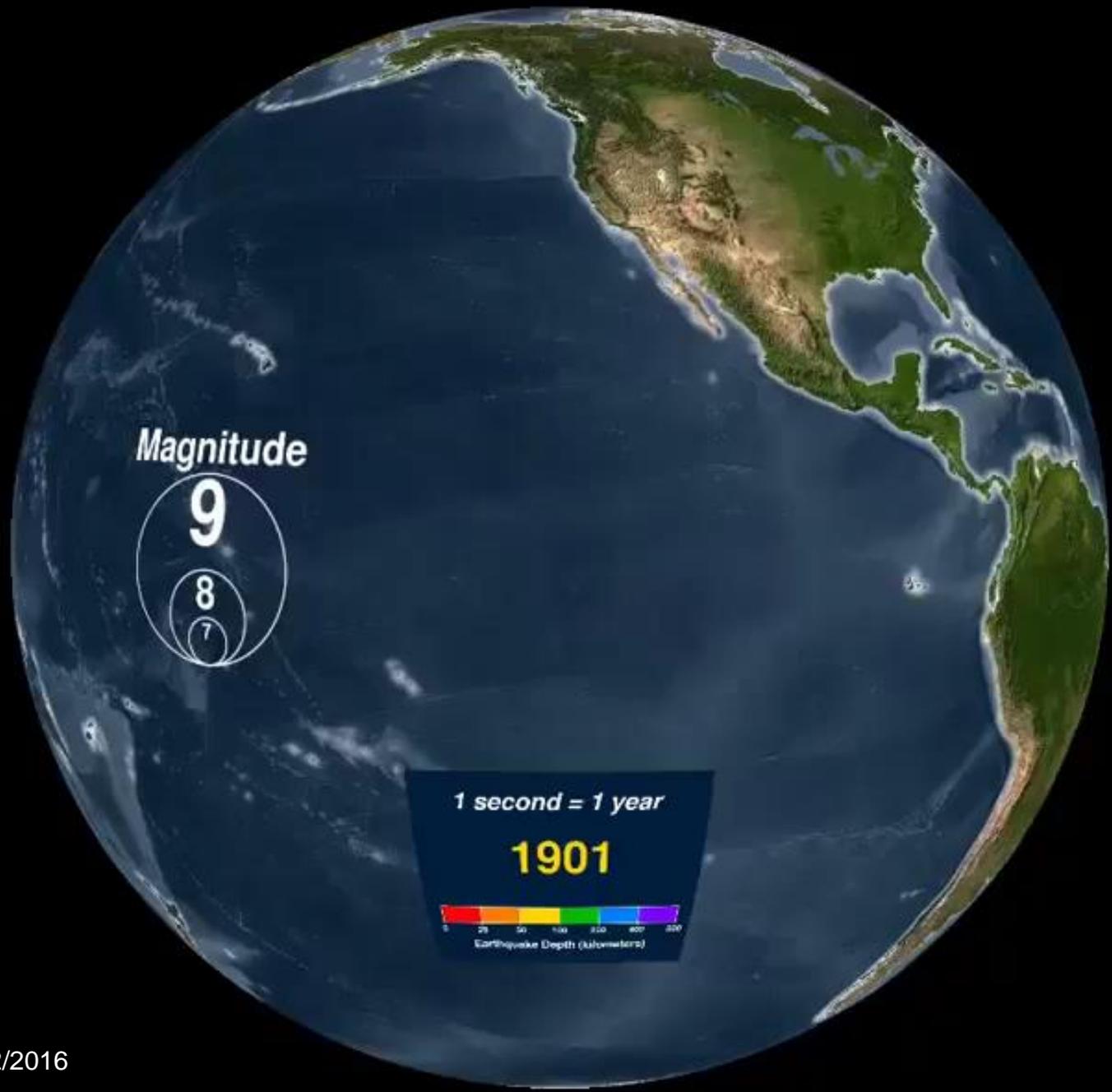


150 My Reconstruction





Earth



7/22/2016

Earthqua



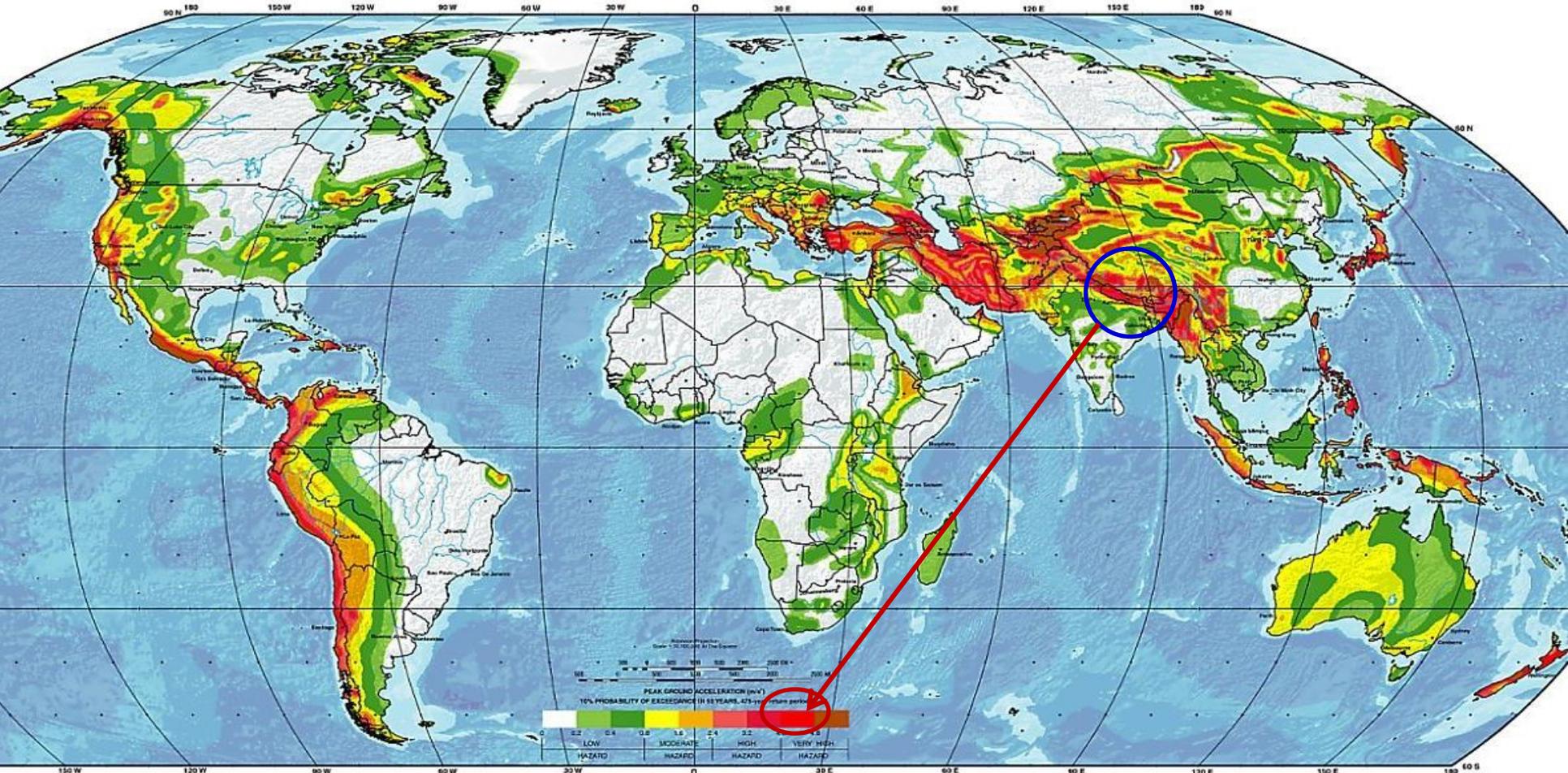


Where are we?

GLOBAL SEISMIC HAZARD MAP

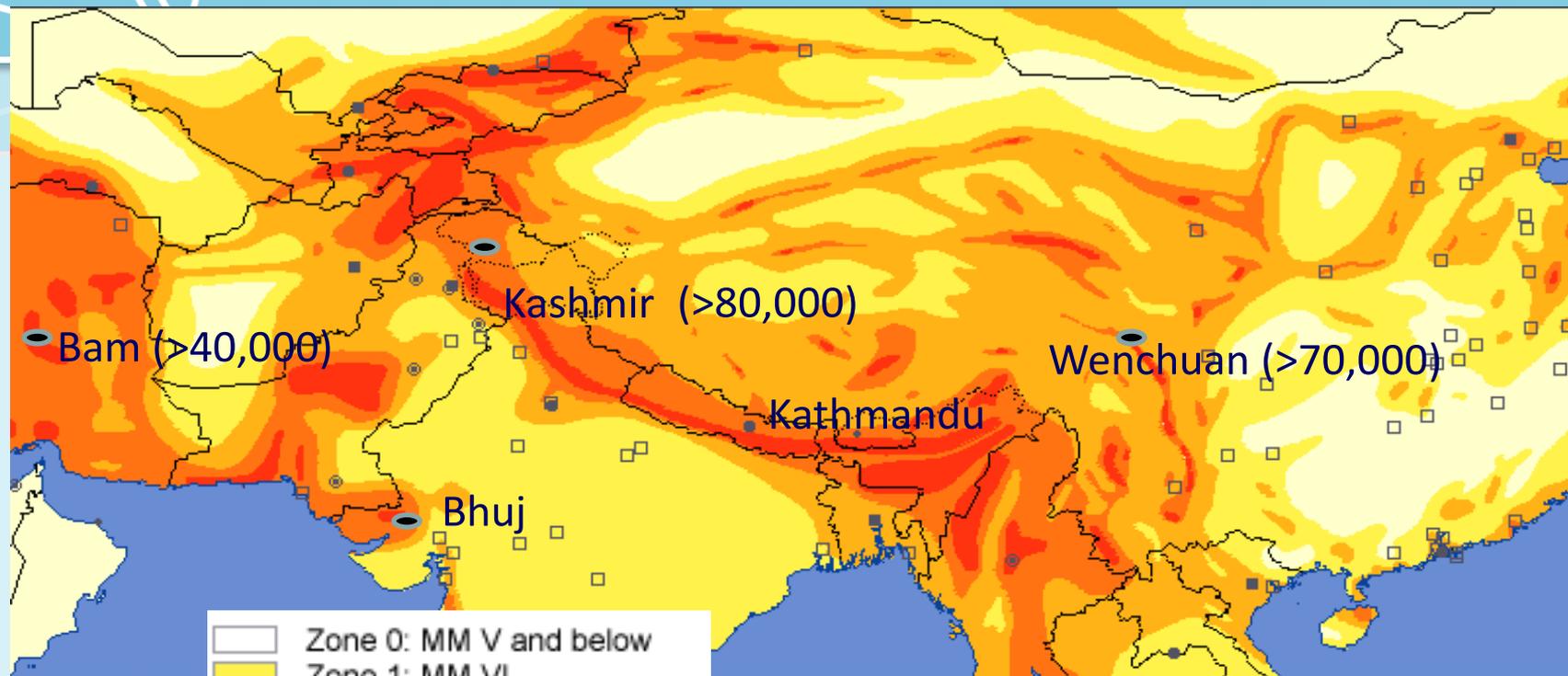
Produced by the Global Seismic Hazard Assessment Program (GSHAP),
a demonstration project of the UN/International Decade of Natural Disaster Reduction, conducted by the International Lithosphere Program.

Global map assembled by D. Giardini, G. Grÿnthal, K. Shedlock, and P. Zhang
1999





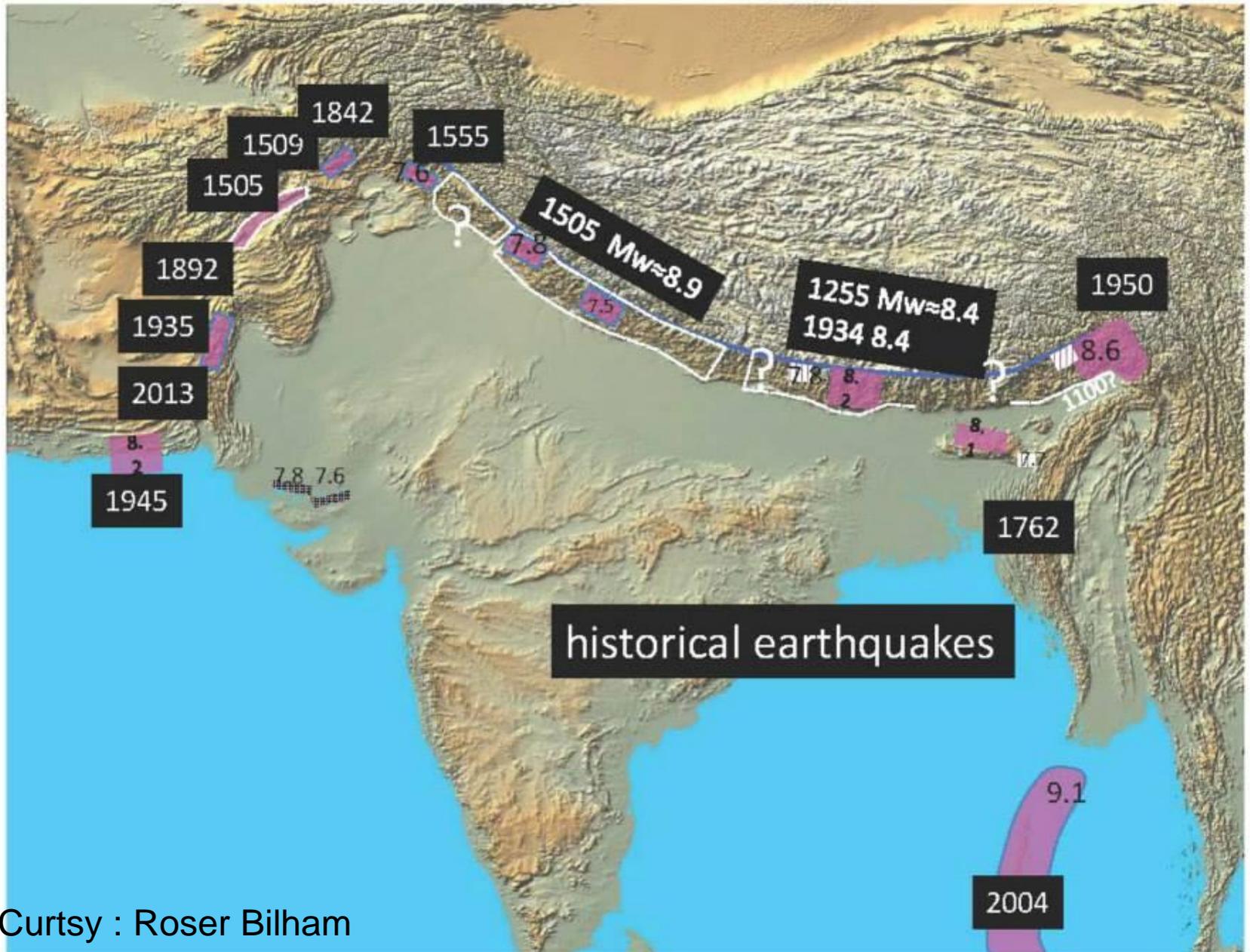
Nepal and Seismic Hazard



	Zone 0: MM V and below
	Zone 1: MM VI
	Zone 2: MM VII
	Zone 3: MM VIII
	Zone 4: MM IX and above

Probable maximum intensity (MM: modified Mercalli scale) with an exceedance probability of 10% in 50 years (equivalent to 'return period' of 475 years) for medium subsoil conditions



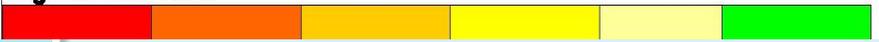


Curtsy : Roser Bilham

Disaster Risk Calendar Prepared by Analyzing DesInventar Database (1971-2014)

Months / Events	Poush + Magh (January)	Magh+ Fagun (February)	Fagun + Chaitra (March)	Chaitra+Baisakh (April)	Baisakh+ Jyestha (May)	Jyestha + Asadh (June)	Asadh + Shrawan (July)	Shrawan + Bhadra (August)	Bhadra + Aswin (September)	Aswin + Kartik (October)	Kartik + Mangsheer (November)	Mangsheer + Poush (December)
Fire	Green	Green	Orange	Red	Yellow	Green	Green	Green	Green	Green	Yellow	Yellow
Flood	Green	Green	Green	Green	Green	Yellow	Red	Orange	Yellow	Yellow	Green	Green
Epidemic	Green	Green	Green	Green	Green	Yellow	Orange	Red	Yellow	Yellow	Green	Green
Landslide	Green	Green	Green	Green	Green	Yellow	Orange	Orange	Yellow	Yellow	Green	Green
Thunder storm	Green	Green	Green	Red	Orange	Yellow	Orange	Yellow	Green	Green	Green	Green
Hailstorm	Green	Green	Red	Orange	Yellow	Green	Green	Green	Green	Yellow	Yellow	Green
Storm	Green	Green	Yellow	Orange	Red	Yellow	Green	Green	Green	Green	Yellow	Green
Drought	Green	Green	Green	Green	Yellow	Yellow	Yellow	Red	Orange	Green	Green	Green
Cold Wave	Red	Orange	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Orange
Heat Wave	Green	Green	Green	Yellow	Red	Orange	Yellow	Green	Green	Green	Green	Green
Avalanche	Green	Green	Green	Yellow	Green	Green	Green	Yellow	Red	Orange	Green	Green
Snow Storm	Red	Orange	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Yellow	Orange
Earthquake	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red

LEGEND
High to Low Risk



Note: Earthquake can occur at any time, and hence it has no seasonal variation





Why Disasters in Nepal?



Fragile Geology

Diverse Physiography

Lack of Awareness

8,848 m.

90,000 m.

5/17/2019





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Earthquake Safe Communities In Nepal

Why we are at Risk?



5/17/2019

Earthquake Risk Reduction and Preparedness



Major Earthquakes in Nepal History

Year	Description
1255 AD (June 7)	This is the oldest known event to severely damage Kathmandu, with an estimated MMI intensity of X (Rana et al. 2007) with magnitude of M7.6. Historical records indicate that many houses and temples in Nepal collapsed, and one third of population was killed.
1960 AD	Only five years following the 1255 AD earthquake, this earthquake resulted in collapse of many buildings and temples, and then caused subsequent widespread epidemic and famine.
1408, 1681, 1767, 1810, 1823 AD	Although limited information is available, these earthquake caused heavy loss of lives and collapse and damage of many buildings including temples were noted in Nepal and the Kathmandu Valley
1833 AD (August 26), epicenter to east of	Kathmandu valley was hit by two main shocks in the late summer, one in the the afternoon at 6 pm and the other in the night at 11 pm. Most of buildings, houses, public shelters, and temples collapsed. The Tower of Dharahara was severely damaged. Thimi and Bakhtapur were completely destroyed. Records indicate

Year

Description

1934 AD
(January 15),
Great Nepal-
Bihar
Earthquake

The strongest earthquake of the 20th century to impact Nepal, this event caused the highest number of casualties ever recorded in Nepal. The earthquake is estimated to have caused around 10,600 fatalities (USGS, 2015a) (with approximately 8,500 fatalities occurring within the borders of Nepal). More than 126000 houses severely damaged, and more than 80,000 buildings completely collapsed

1980 AD

The largest impacts occurred in the far western portion of Nepal from this M6.5 earthquake 125 people lost their lives; 248 were seriously injured. 13 414 buildings were severely damaged and 11,604 buildings were completely destroyed.

1988 AD (August
21), Udaypur
Earthquake

The M6.6 earthquake affected mostly the eastern region of Nepal. It resulted 721 deaths, 6553 seriously injuries, and damages to more than 65,000 buildings. Total direct loss was reported to be 5 billion rupees.

2011 AD
(September 18)

The M6.9 earthquake had an epicenter 272km east of Kathmandu and caused widespread damage in the Nepal. The earthquake caused 3 fatalities, 164 injuries, collapse of more than 14,000 houses (CUEE Report 2011-1)

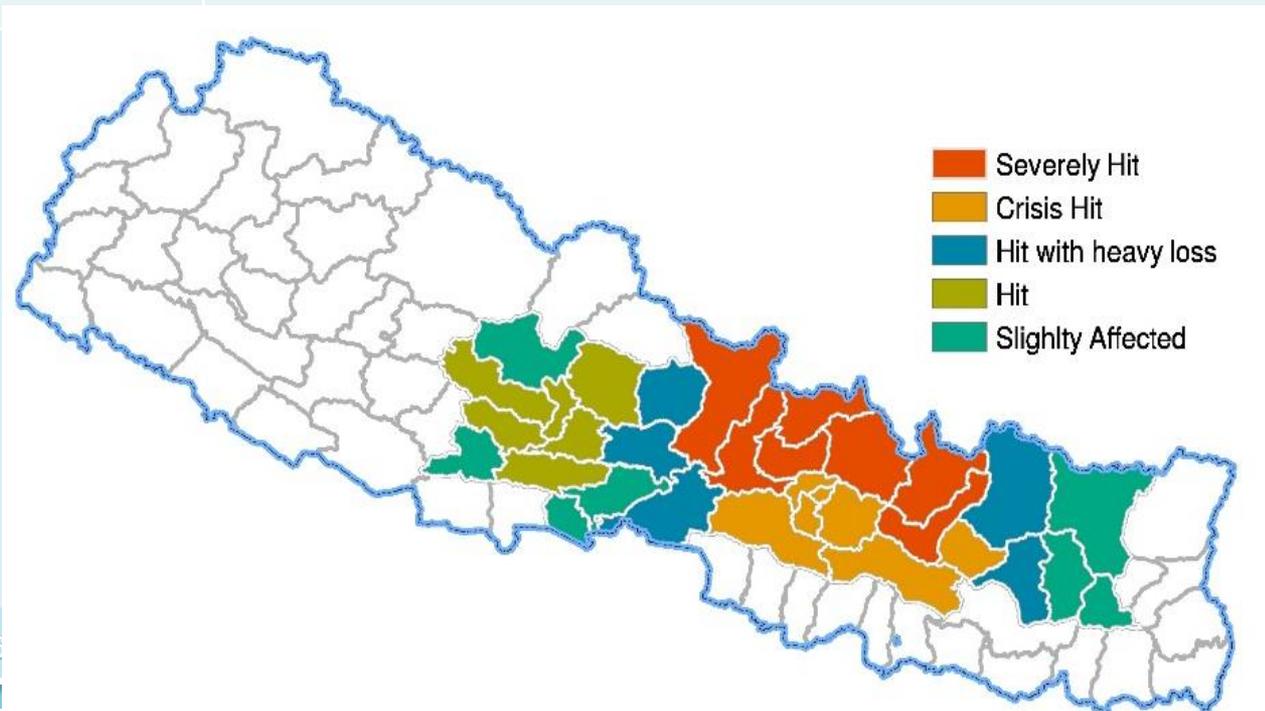
7/22/2016

Year

Description

2015 AD (April 25) Gorkha Earthquake and major aftershocks on May 12, 2015

The 25 April 2015 Gorkha Earthquake, and the hundreds of aftershocks that followed, including a M6.8 on 12 May 2015, caused loss of 8,790 lives and more than 22,300 people were injured along with widespread damage to houses and infrastructure across 32 districts of Nepal. The Post Disaster Needs Assessment (PDNA), identified housing as the most affected sector with an additional 2.5% to 3.5% of the population, at least 700,000 people, would be pushed into poverty in the year following the quake as a result of the disaster



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1934 Earthquake: 8.4 Mw





1988 Earthquake: 6.6 Mw





2011 Earthquake: 6.9 Mw





2015 Earthquake: 7.8 Mw



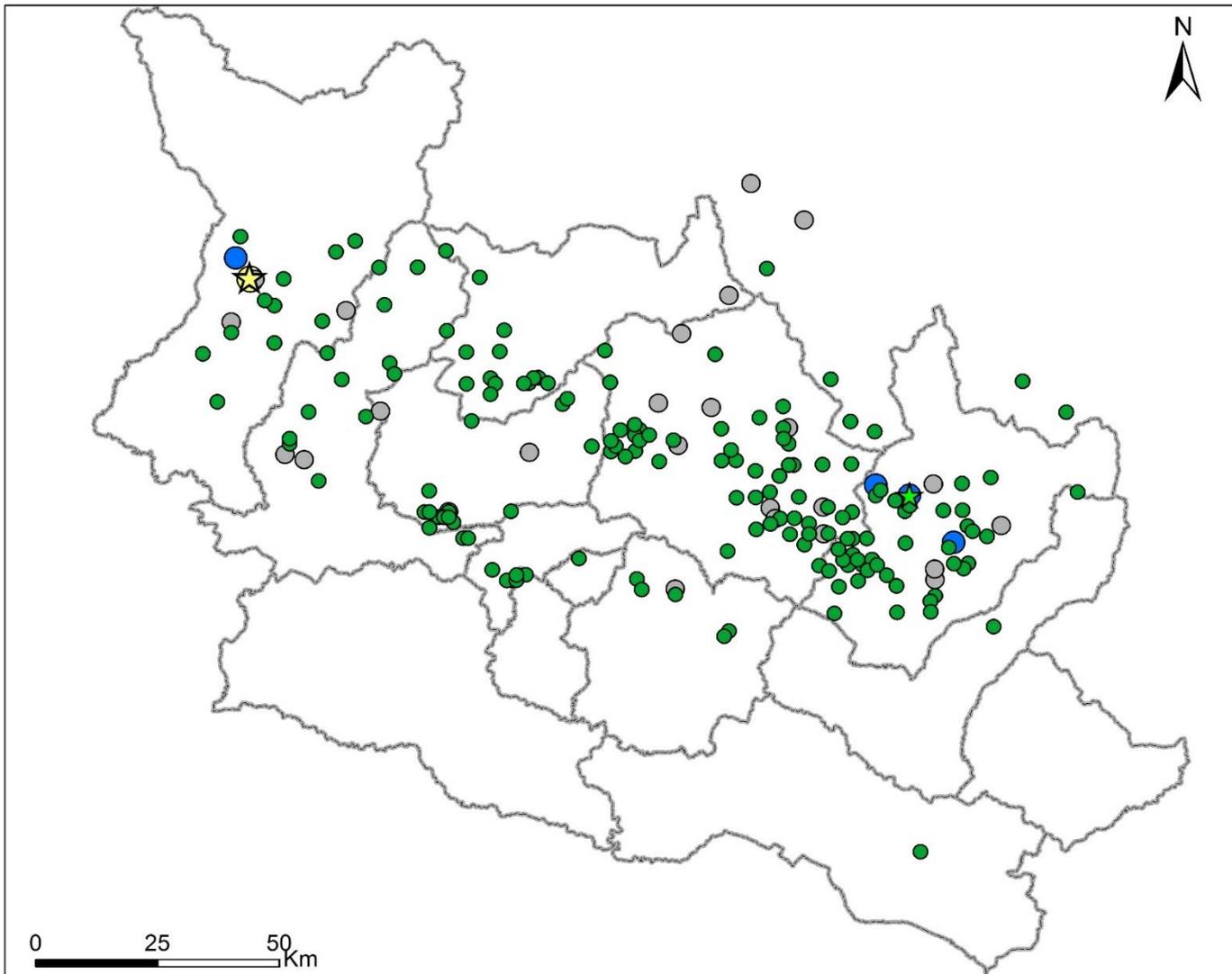
3/11/2015



EPA



GORKHA EARTHQUAKE 2015
Epicenter Map
Location of Aftershocks



Legend

-  Chilankha 12 May
-  Barpak 25 April
- Local Magnitude**
-  4 - 5
-  5 - 6
-  6 - 7
-  7 - 7.6
-  District Boundary

GLIDE number: EQ-2015-000048-NPL



Disclaimer: This product is based on data gathered till the time and source mentioned herein and subject to change as per time and data.

Prepared by: National Society for Earthquake Technology - Nepal (NSET), with the support from: USAID/OFDA
 Data Source: USGS-PAGER, NSET, KVDA, CBS, DoS/GoN, NSC/DMG



Situation Map
 Date: 2015/05/13
 Time: 15:38







LESSON FROM PAST EARTHQUAKES

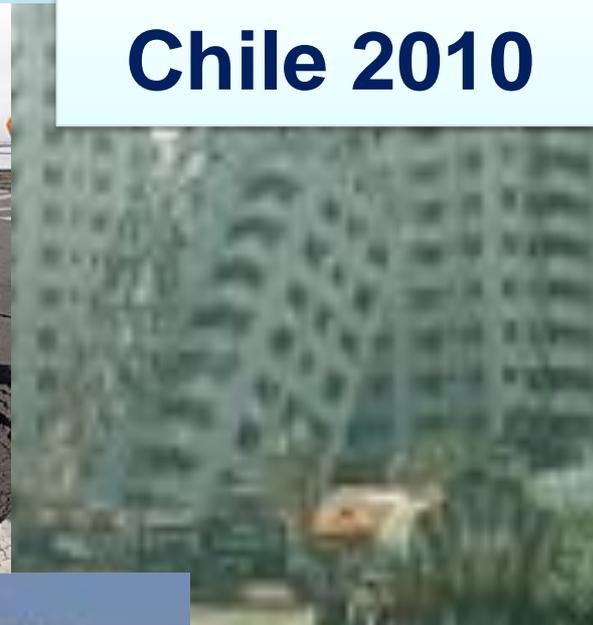
Haiti 2010



- 12 January, 2010
- 7.0 Mg.
- 222,770 deaths

300,000 Injured

Chile 2010

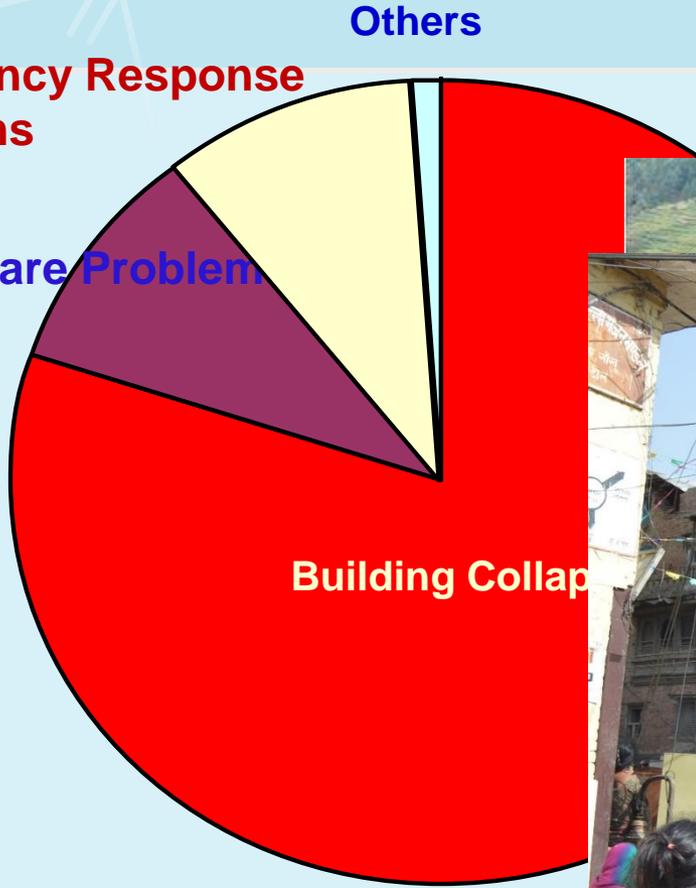


- 27 February, 2010
- 8.8 Mg.
- <1000 deaths





Earthquakes DO NOT Kill People



Others

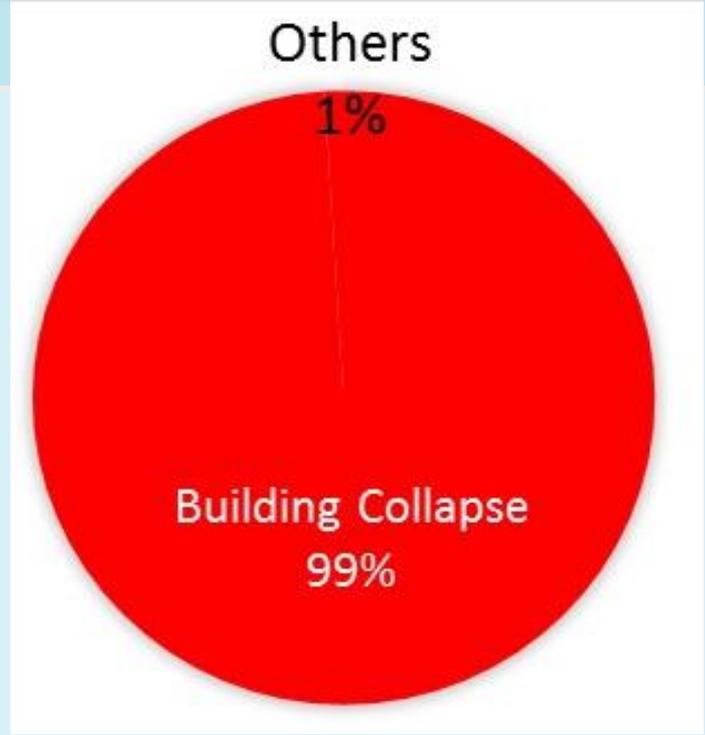
Emergency Response Problems

Medical Care Problem

Building Collapse



Sources of Earthquake Risk



(April 25, 2016 Gorkha Earthquake)

➡ Only way of Reducing Casualty: Safe Buildings

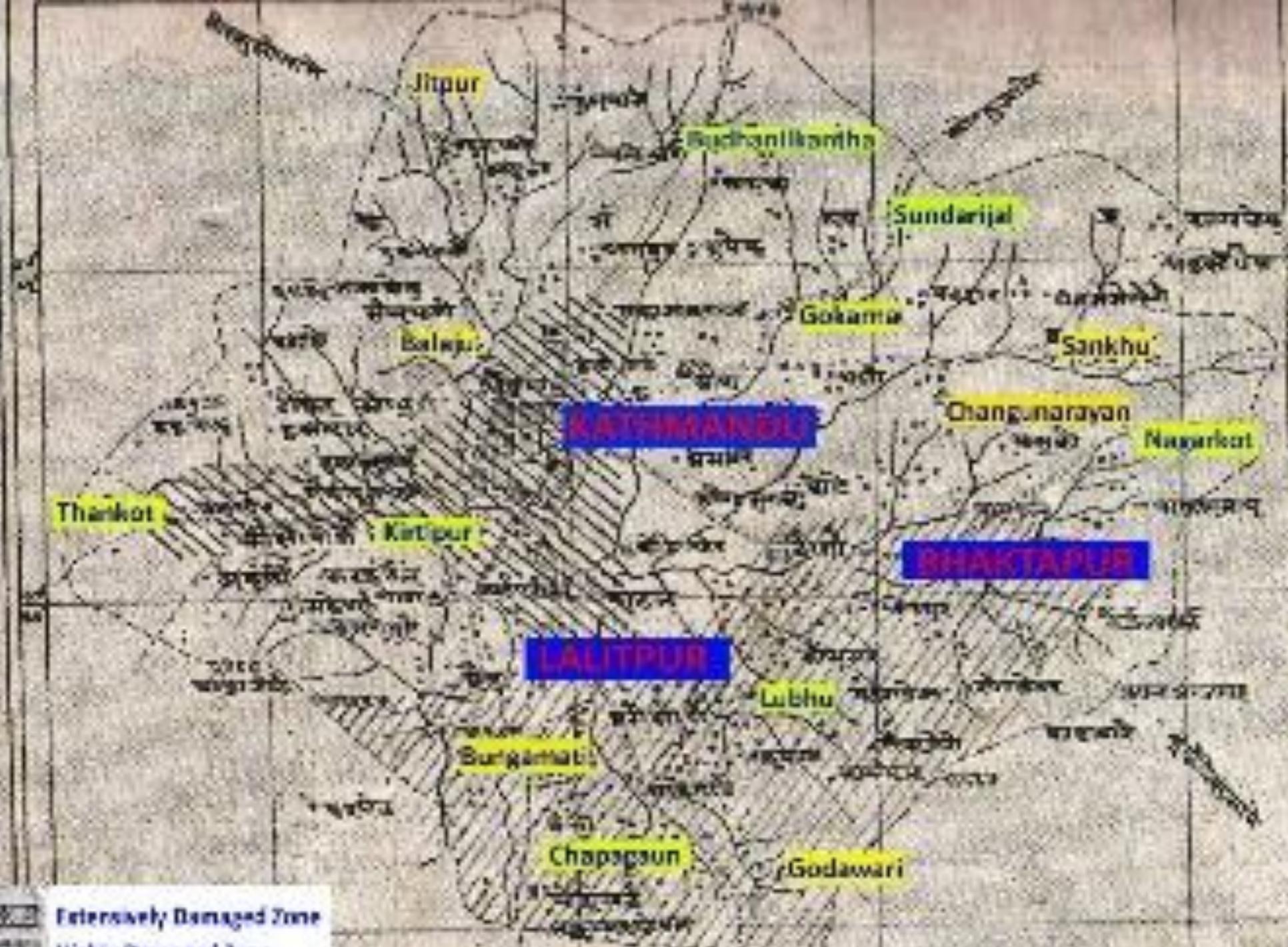
➡ Building Code Implementation



Damage during 1833 Earthquake

- **Epicenter to North-east of Kathmandu**
- **Thimi and Bakhtapur were completely destroyed.**

(Bilham, 1995)



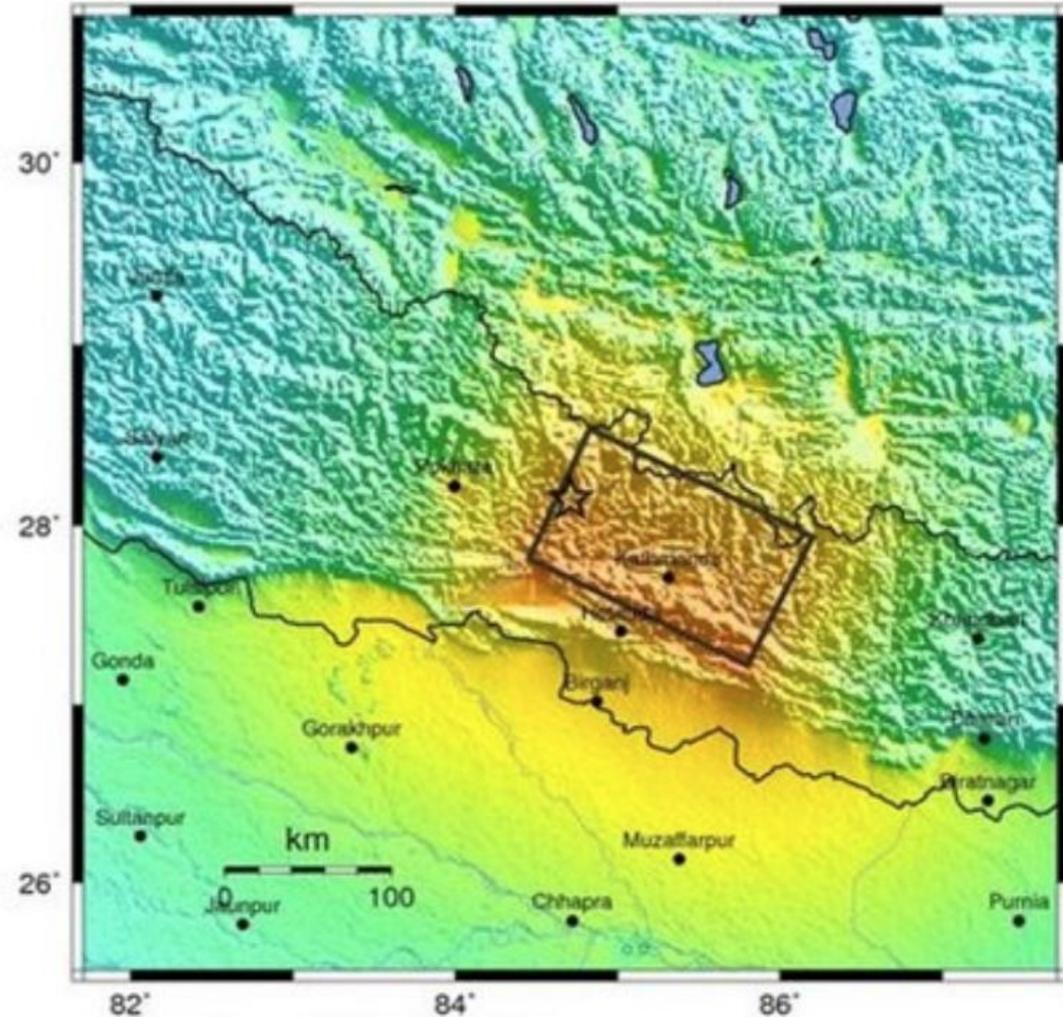
Shaking Intensity

The Modified Mercalli Intensity (MMI) scale depicts shaking severity. The area nearest Katmandu experienced very strong to severe shaking.

Modified Mercalli Intensity

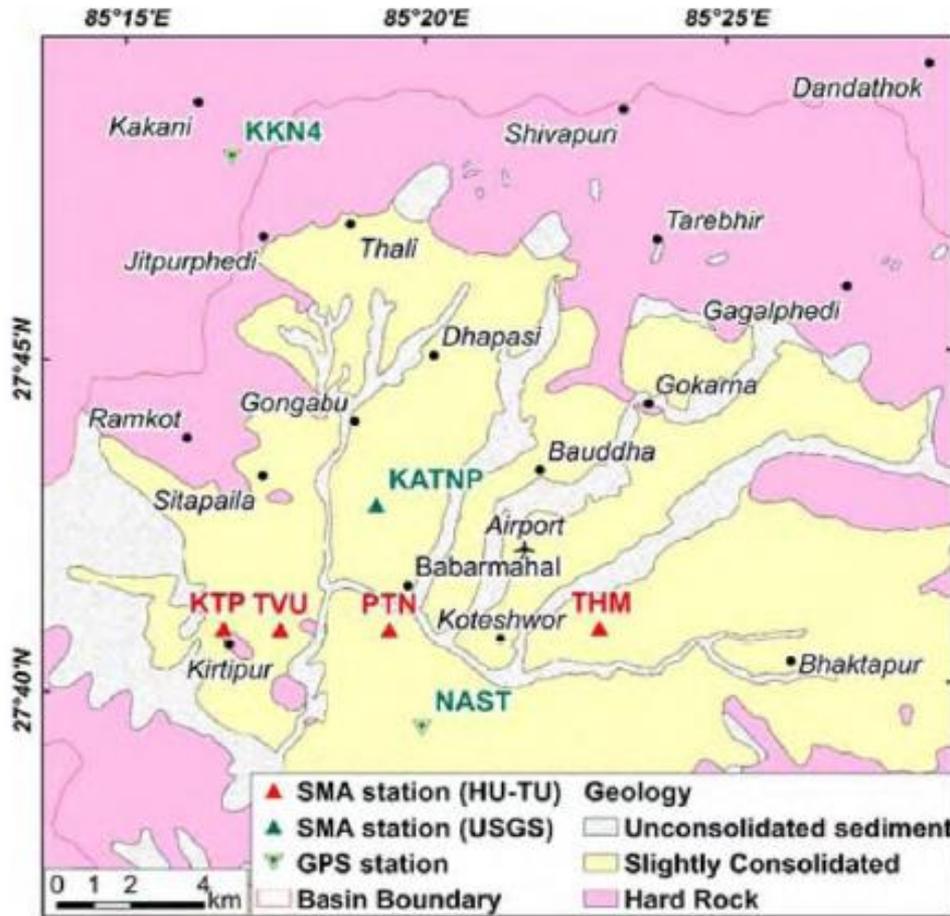


Perceived Shaking
Extreme
Violent
Severe
Very Strong
Strong
 Moderate
 Light
 Weak
 Not Felt



USGS Estimated shaking Intensity from M 7.8 Earthquake

Image courtesy of the US Geological Survey



Shaking Recorded at KTM Valley

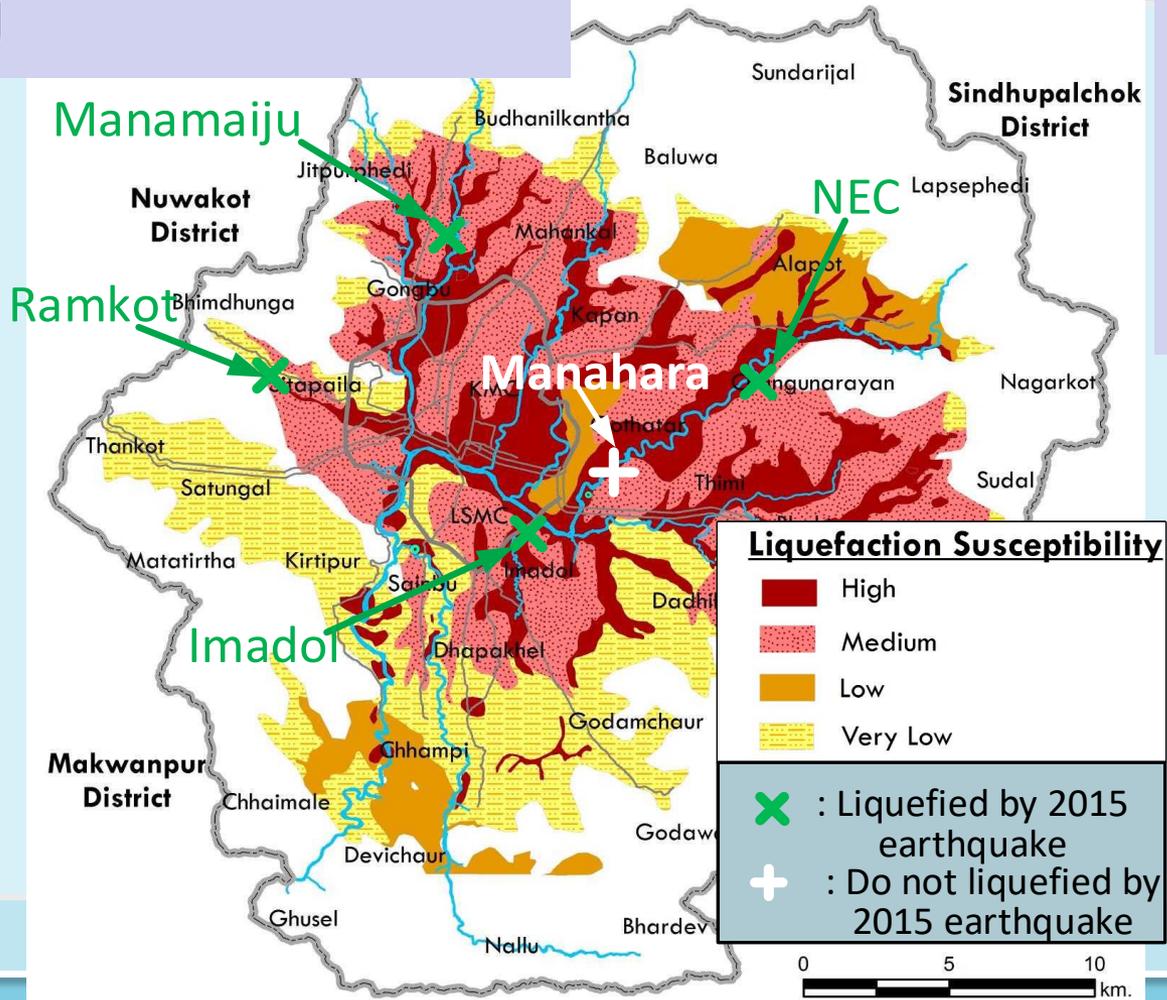
Station Name (location)	Geographic Location (latitude, longitude)	Site Category	Peak Ground Acceleration in g
KATNP (US Embassy, Kathmandu)	27.71235, 83.31561	Soil	0.16 (N-S)
DMG (Lainchor)	27.7193, 85.3166	Soil	0.15 (N-S)
KTP (at Kirtipur Municipality Office)	27.68182, 85.27261	Rock	0.24 (E-W)
TVU (Central Dept of Geology, Tribhuvan Uni.)	27.68072, 85.3772	Soil	0.24 (E-W)
THM (Univ. Grants Commission, Sanothimi, Bhaktapur)	27.68082, 85.31897	Soil	0.15 (N-S)
PTN (Pulchowk Campus, Tribhuvan Uni.)	27.68145, 85.28821	Soil	0.15 (N-S)





- ❖ Standard Penetration test (SPT)
- ❖ Continuous soil sampling
- ❖ PS-logging

- Manamaiju
- Imadol
- NEC
- Ramkot
- Manahara





SPT





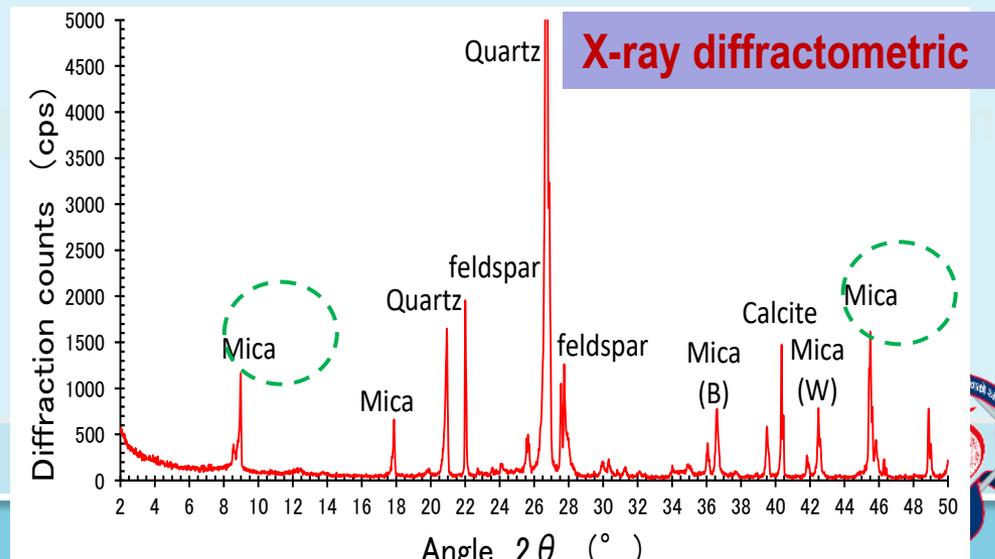
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PS- logging



Mineralogical test

- Kathmandu soil is unique and heterogeneously distributed.
- From the X-ray diffraction analyses Kathmandu soil contain, quartz 60–80%, feldspar 10–20%, mica 10–20% and calcite 5–10%.
- Kathmandu soil contain significant percentage of Mica, Equations established based on the experiences in other parts of the world may not be work for Kathmandu so need to be verified first.
- In order to refine or reestablish the equations, identification of field evidences are necessary.

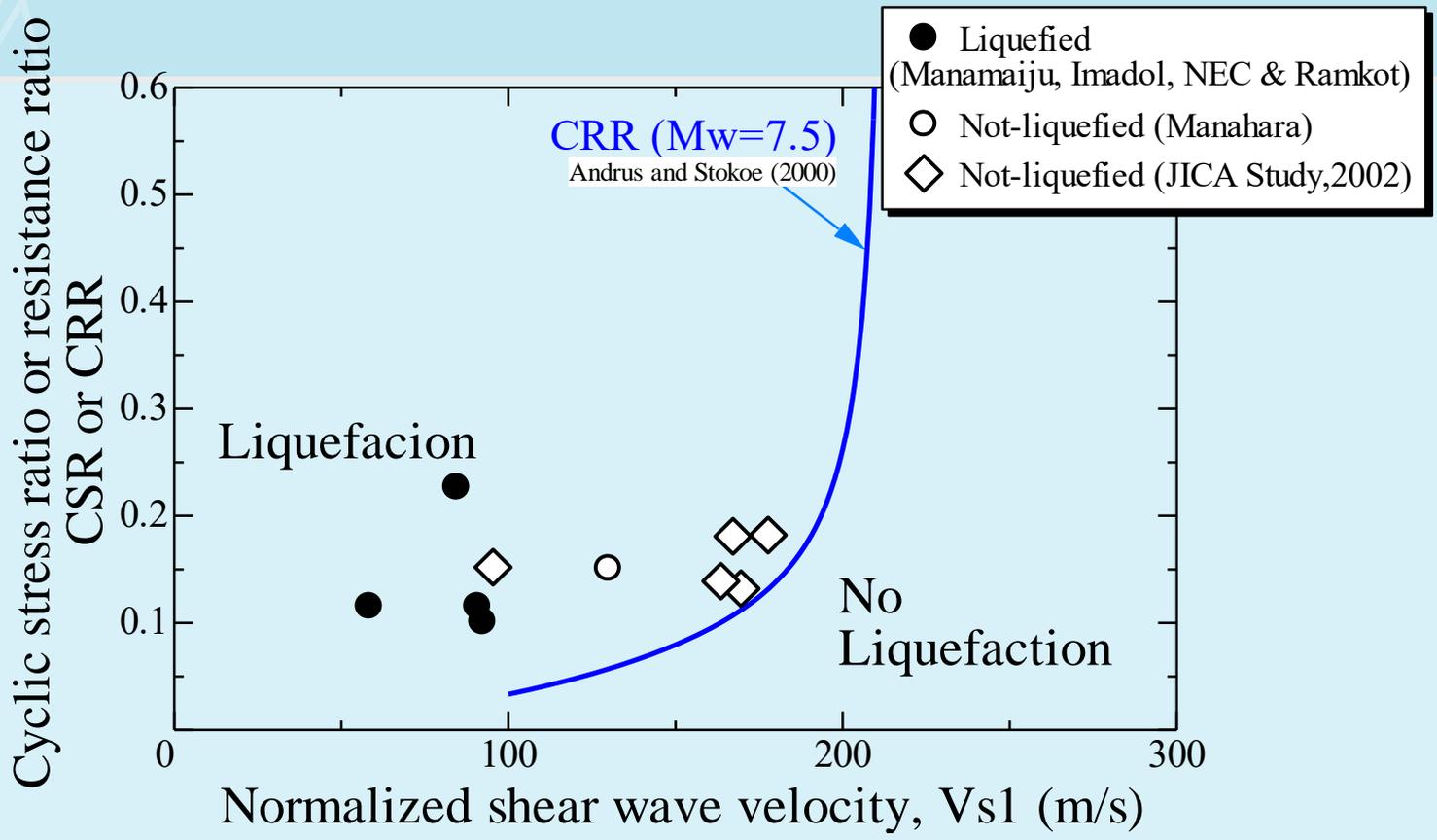


Laboratory test for Dynamic Analysis



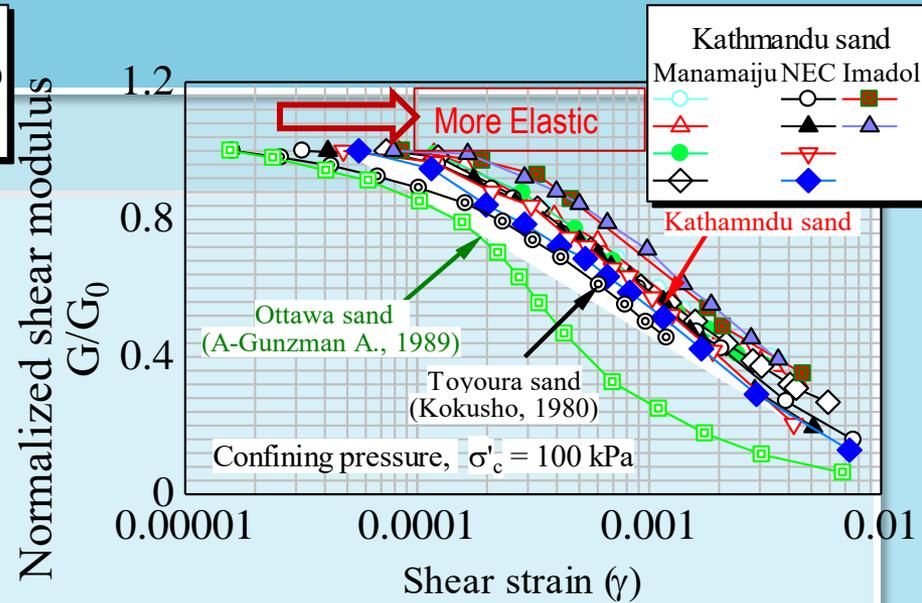
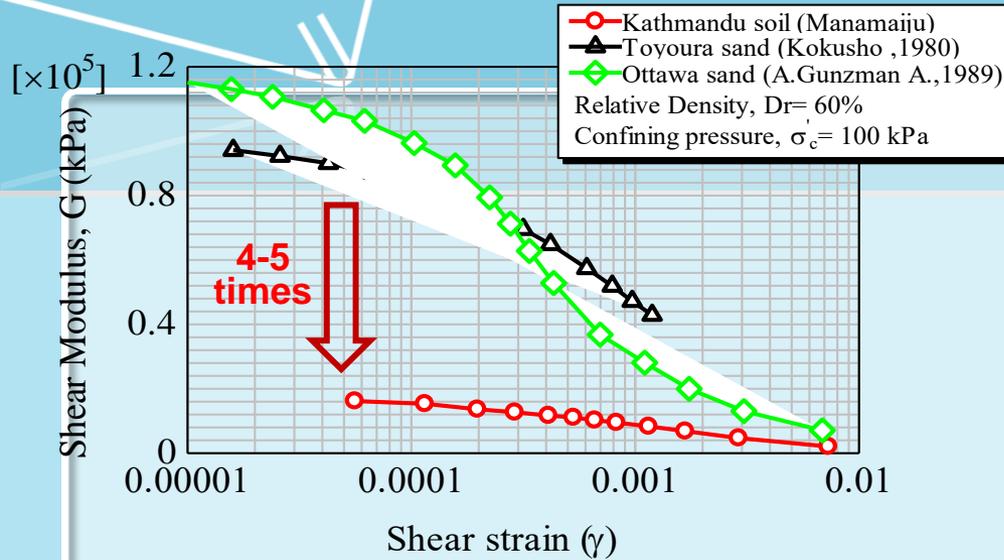
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S-wave (V_s) based Liq. Assessment

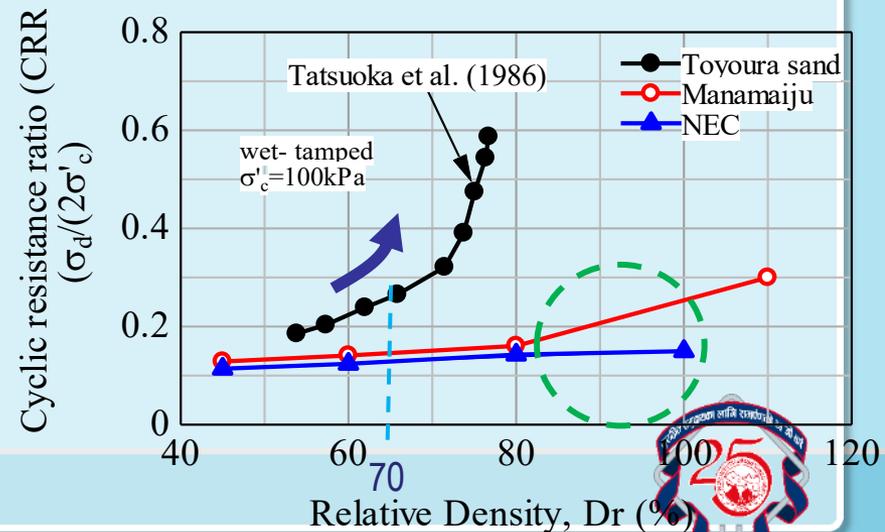


This curve Over estimate the Liquefaction Potential in Kathmandu soil

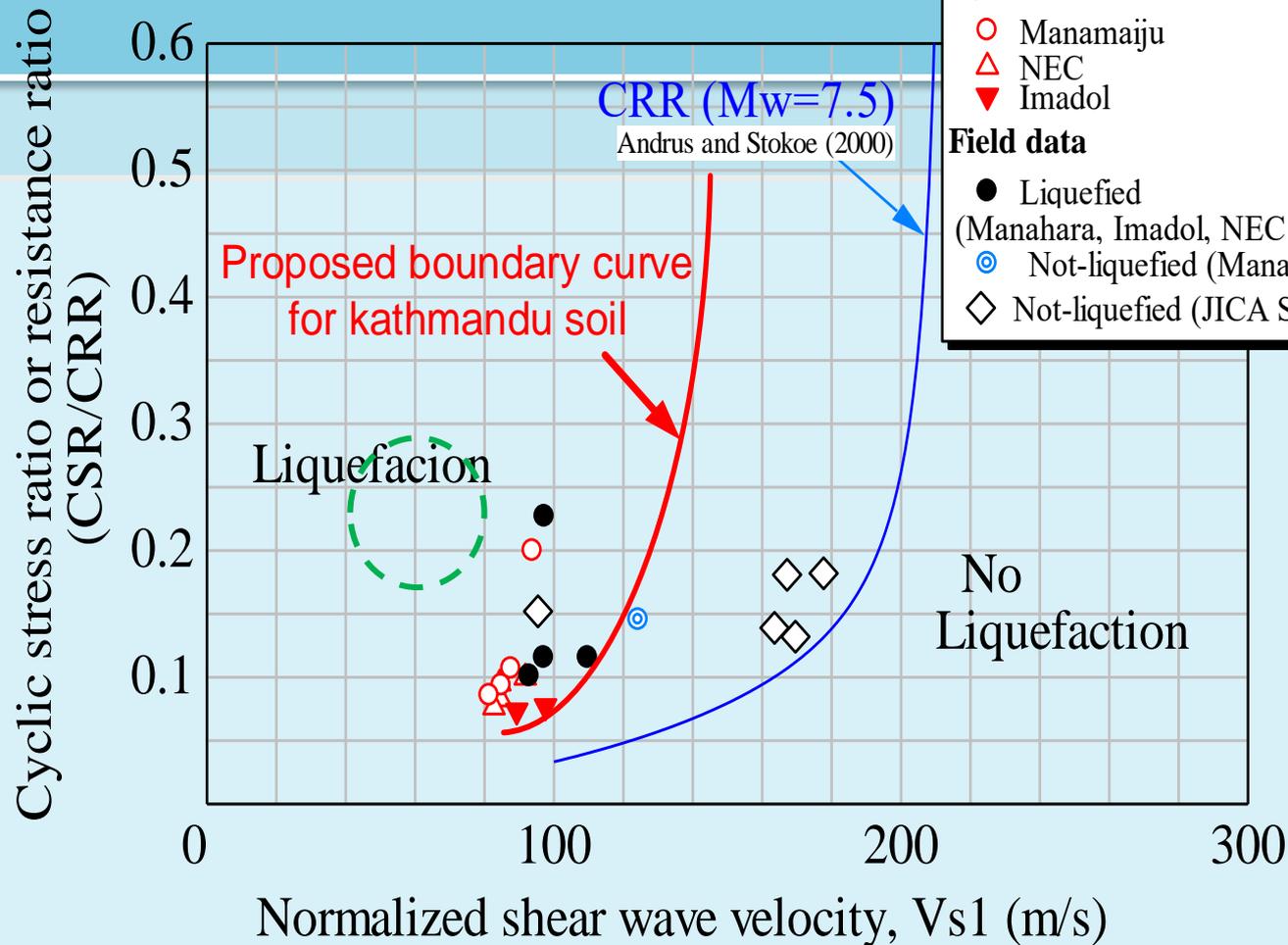
Deformation test results



- Kathmandu soil is soft & more compressible
- More elastic than Toyoura and Ottawa sand
- Stiffness is 4-5 times less than Toyoura and Ottawa sand
- Deformation characteristic is similar with the Toyoura sand
- Damping ratio shows Kathmandu soil is more elastic & consume less energy



Boundary curve for Kathmandu soil is Different

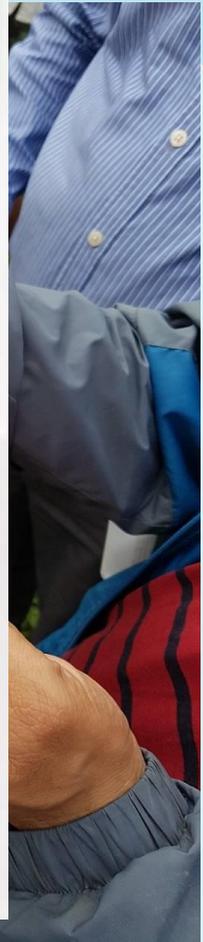
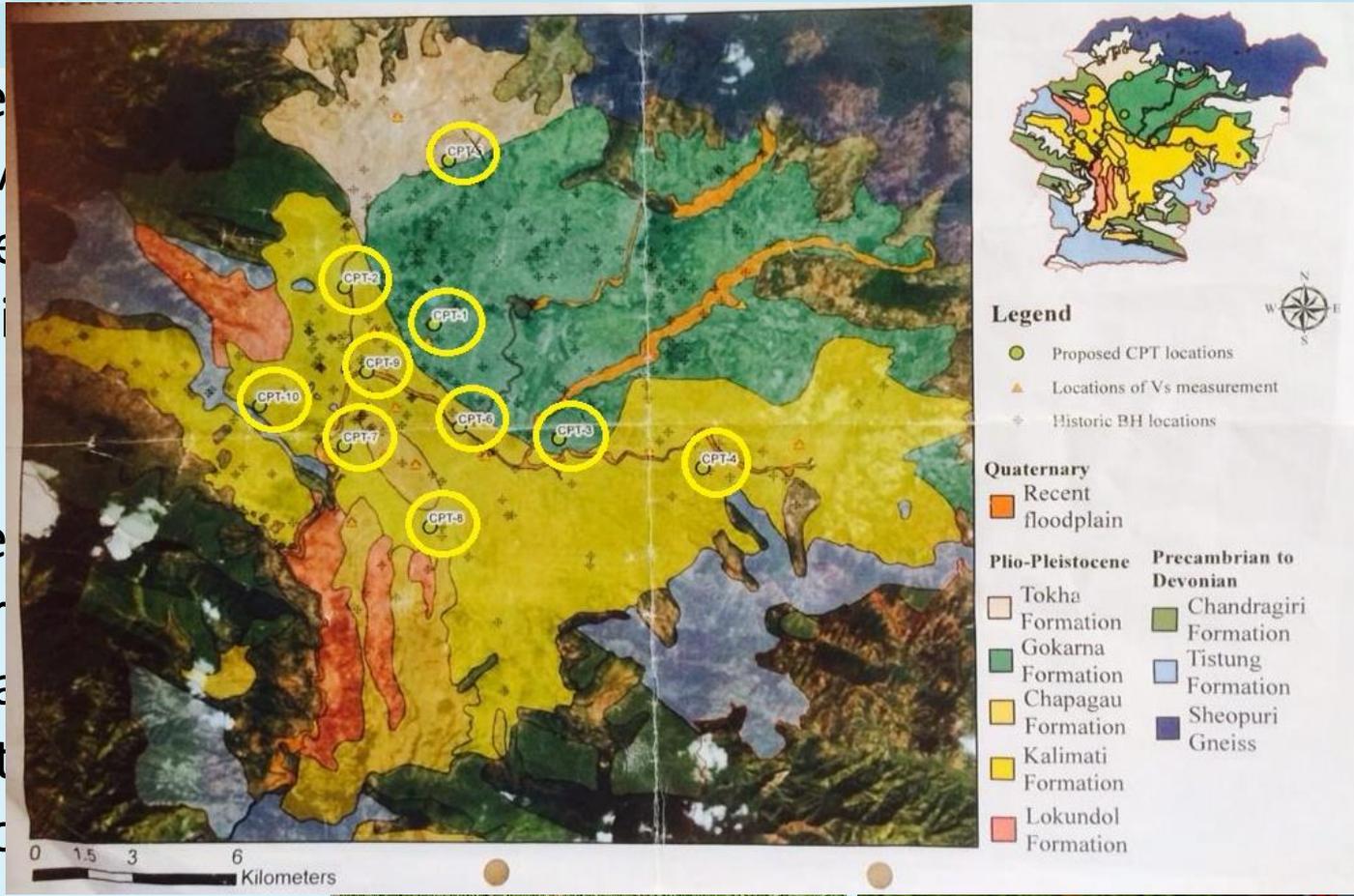


• Field in-situ & laboratory test results are combined and proposed the new boundary curve based on S-wave velocity



SAFER – Geotechnical Investigation of Kathmandu Soil

- Geotechnical Investigation of the Soil
- To Geotechnical Strain Rate After



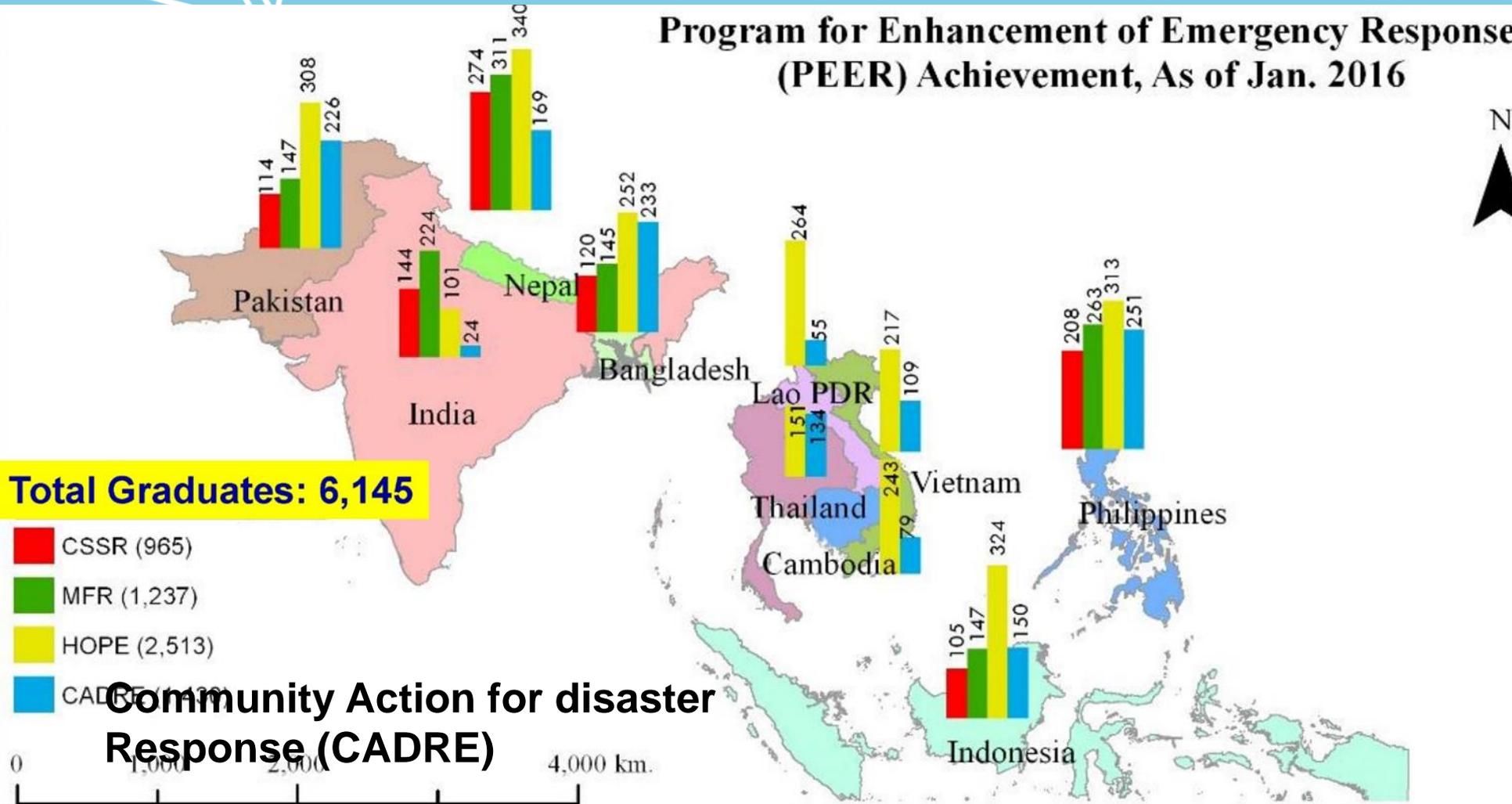
What worked during 2015 Gorkha Earthquake?

7/22/2016



PEER Program (1997-2016)

Program for Enhancement of Emergency Response (PEER) Achievement, As of Jan. 2016





Impact of PEER Program in 2015 Gorkha Earthquake

- **Graduates Lead for Search and Rescue team**
- **All major hospitals asked PEER graduate for Assessment immediately**
- **Functioned inside hospital buildings as per recommendations**





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Search & Rescue was quite systematic and effective from Security forces and Volunteer organizations



NA jointly conducting rescue operations with other security agencies



NA soldier rescuing a girl from an unstable collapsed structure in Gongabu

precious life saved in Duttatreya in Bhaktapur





***‘Miracle Baby’ boy
rescued after 22 hrs
under rubble in
Bhaktapur***

Photo: Amul Thapa

***The baby boy with his
delighted mother a few
weeks later***



Photo: Sunil Sharma



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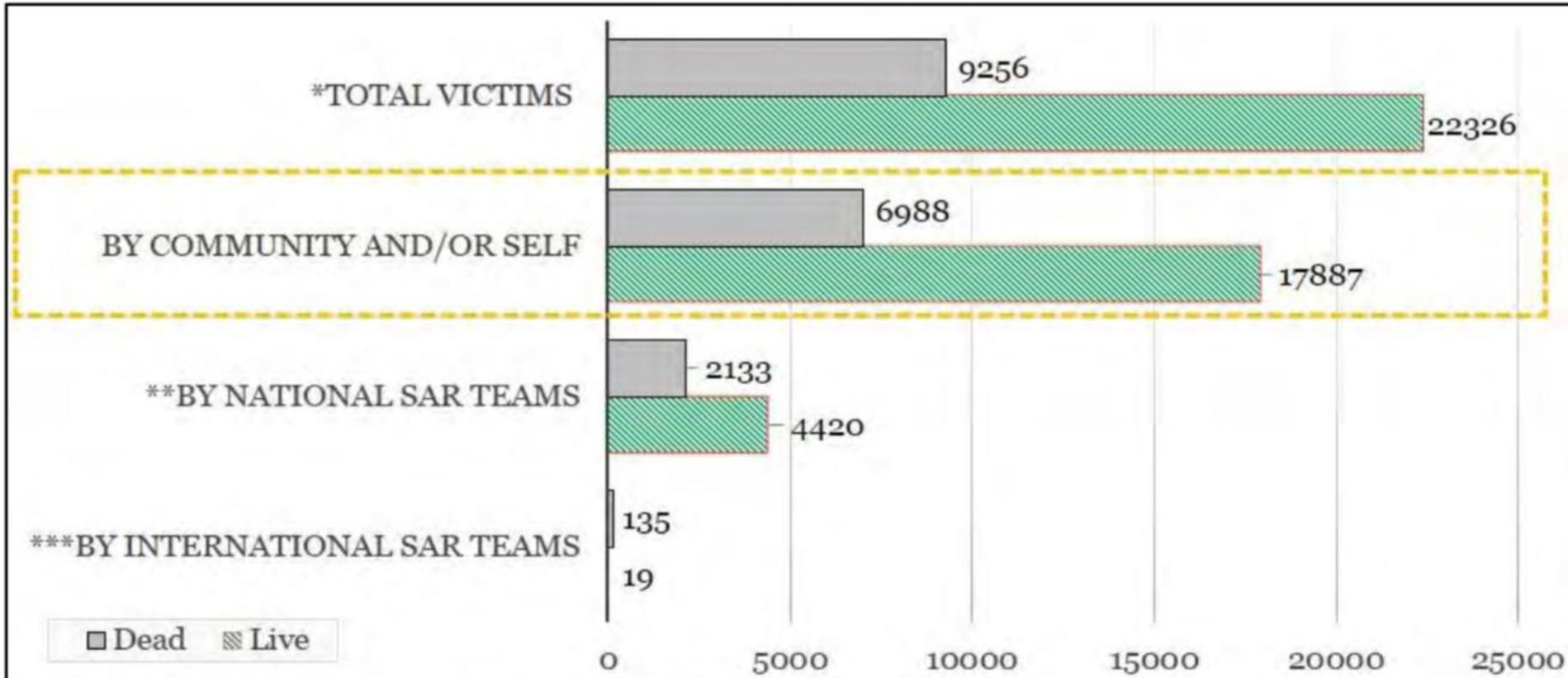
BACK OUTSIDE: patients evacuated from a hospital: KATHMANDU (Credit: AP)



NEPAL MEDICAL RESPONSE: KATHMANDU (Credit: AP)



Achievements of Multinational Team



Source: *Nepal Police, 2 July 2015, **Reports by Nepalese Army, Nepal Police and Armed Police Force June 2015 *** report by Nepalese Army, June 16, 2015

Extricated Victims and Recovered Dead Bodies by Different SAR Teams (source: MNMCC, 2015).



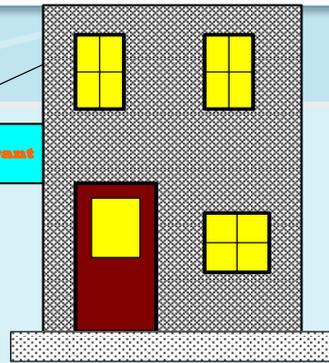
New building constructed compliance with NBC & Vulnerable 300 Schools Retrofitted: **All Performed Good**



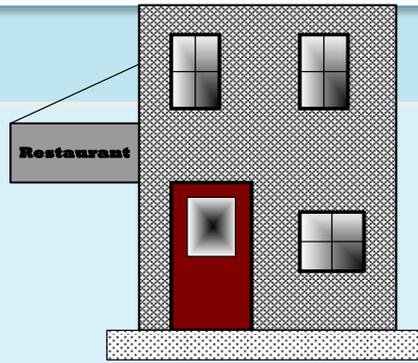
- **Schools are Retrofitted for much Higher Intensity!**
- **Retrofitted Schools were used by Communities as Emergency Shelters from the First Day**



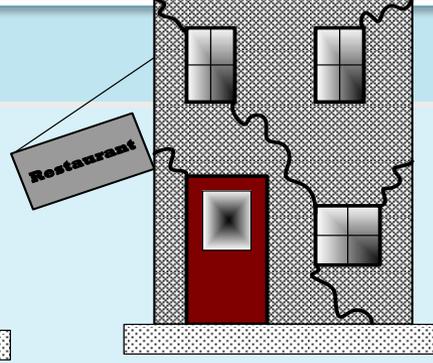
Strategy to Reduce the Earthquake Risk



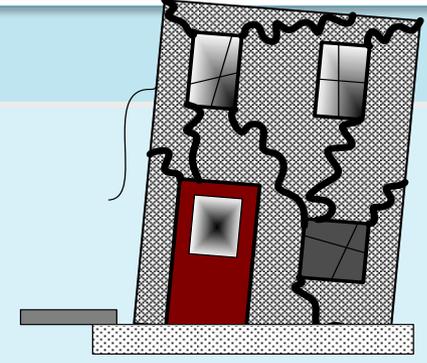
Operational



**Immediate
Occupancy**



Life Safety



**Collapse
Prevention**

0 %

Damage or Loss

99 %

Ref: FEMA 451 B

Lowest

Rehab Cost to Restore after event

Highest

Highest

Retrofit Cost to achieve objective before event

Lowest



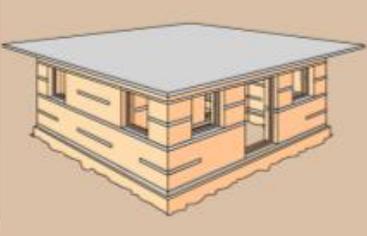
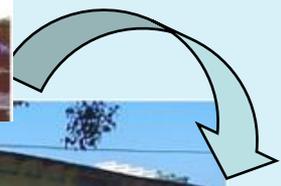
Strategy to Reduce the Earthquake Risk

Earthquake Safety

Stop Increasing Risk

Decrease Existing Risk

Be Prepared



पुनर्निर्माणभित्रको सकस



डा. नारायण मरासिनी

पिन भनेर पुनर्निर्माणभित्रको सकस, भन्दा कसरी गर्दछिन्। कुनै अनुभव हो भने बढेकाको घर नयाँ बनाउनु हुन्छ।

कुनै घरको भवनको पुनर्निर्माणको आवश्यकता पर्दा कसरी गर्नुपर्छ भन्ने कुरा धेरै मान्छेहरूलाई थाहा हुँदैन। त्यसैले यहाँ यो कुराको बारेमा थोडा कुरा लेखेका छौं।

कुनै घरको पुनर्निर्माण गर्दा धेरै कुराहरूको ध्यान गर्नुपर्छ। त्यसैले यहाँ यो कुराको बारेमा थोडा कुरा लेखेका छौं।

पुनर्निर्माण भन्नाले कुनै घरको भवनको पुनर्निर्माण गर्ने कुरा हो। यसको लागि धेरै कुराहरूको ध्यान गर्नुपर्छ। त्यसैले यहाँ यो कुराको बारेमा थोडा कुरा लेखेका छौं।

फेरि ठूलो भूकम्प जाला ?

फेरि ठूलो भूकम्प जाला ?

भूकम्पको जोखिमको बारेमा धेरै कुराहरूको ध्यान गर्नुपर्छ। त्यसैले यहाँ यो कुराको बारेमा थोडा कुरा लेखेका छौं।

भूकम्पीय कम्पन र काठमाडौँ

भूकम्पीय कम्पन र काठमाडौँ

काठमाडौँको भूकम्पीय कम्पनको बारेमा धेरै कुराहरूको ध्यान गर्नुपर्छ। त्यसैले यहाँ यो कुराको बारेमा थोडा कुरा लेखेका छौं।

भूकम्पबाट कसरी जोगाउने स्कूल ?

भूकम्पबाट कसरी जोगाउने स्कूल ?

स्कूलहरूमा भूकम्पबाट जोगाउने तरिकाको बारेमा धेरै कुराहरूको ध्यान गर्नुपर्छ। त्यसैले यहाँ यो कुराको बारेमा थोडा कुरा लेखेका छौं।



बुधबार, २५ वैशाख २०७६, ०६ : ०९

- राजनीति
- अर्थ
- समाज
- कला
- खेल
- विश्व
- स्वास्थ्य
- नागरिक खोज
- विचार
- अन्तर्वाता
- नागरिक बजार
- भिडियो

फेरि ठूलो भूकम्प जाला ?

सोमबार, ०४ चैत २०७५, ०८ : ३८ | डा. नारायण मरासिनी

7.2K SHARES

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aid has not been disbursed to beneficiaries. These issues have led to the appointment of a new CEO in the NRA in January. However, simply changing the leadership will not ensure quick results. It will take time to establish new structures that can be implemented in a feasible manner. Of course, the former leadership was not totally inefficient. In the past one year, the NRA accomplished the challenging task of establishing administrative management by developing new structures and producing necessary policies for effective reconstruction. Despite such coordination and collaboration among different stakeholders, a lack of commitment

the mandate was well implemented post-earthquake, the absence of agencies to implement recovery programmes proved to be a shortcoming. Mobilising personnel Following the change in NRA leadership, a few important decisions have been made. The new leadership must expedite programmes that, in the past, were either incomplete or delayed. In addition, some new structures and programmes must be devised so that the change in leadership can be justified. Perhaps this is why the government has decided to mobilise technicians from the Nepal Army and the Armed Police Force to assist in reconstruction. The NRA has not formulated

अब पुनर् उद्धार तत्त्वोत्थरण के हो र कस्तो जमानमा बस्नको जोडिमा रहन्छ ? जमिनमा घर्ष पानीको तह सहर भन्दा गरी विश्वको नदी के देखिन्छ भने भूकम्पको दौरान जमिनमा हुने तरलीकरण पनि सञ्चालना हुने भन्दाको एक मुद्दा कारण हो। सन् १९९४ को सपानको निम्तामा गाएको भूकम्प प्रश्नमा सन् २०७० मा मुक्तिवादनको काठमाडौँमा भएको भूकम्प, त्यसैगरी सन् २०१५ मा सपानको सेलावा गाएको भूकम्प, जहाँ जमिन तरलीकरणले गर्दा जोडिमा सरचनामा ठूलो क्षति भएको पाइन्छ। त्यसैगरी नेपालमा पनि बिस १९९० को महाभूकम्प, २०४२ सालको भूकम्प र

जमानमा तरलीकरणको जोडिमाका पाहचान र बस्नको जोडिमा रहन्छ ? जमिनमा घर्ष पानीको तह सहर भन्दा गरी विश्वको नदी के देखिन्छ भने भूकम्पको दौरान जमिनमा हुने तरलीकरण पनि सञ्चालना हुने भन्दाको एक मुद्दा कारण हो। सन् १९९४ को सपानको निम्तामा गाएको भूकम्प प्रश्नमा सन् २०७० मा मुक्तिवादनको काठमाडौँमा भएको भूकम्प, त्यसैगरी सन् २०१५ मा सपानको सेलावा गाएको भूकम्प, जहाँ जमिन तरलीकरणले गर्दा जोडिमा सरचनामा ठूलो क्षति भएको पाइन्छ। त्यसैगरी नेपालमा पनि बिस १९९० को महाभूकम्प, २०४२ सालको भूकम्प र

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