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Preliminary damage survey report on 2015 Nepal Gorkha Earthquake

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Advance Party of Japanese Investigation Team for the 2015 Nepal Earthquake Disaster

JSCE: Japanese Society of Civil Engineers

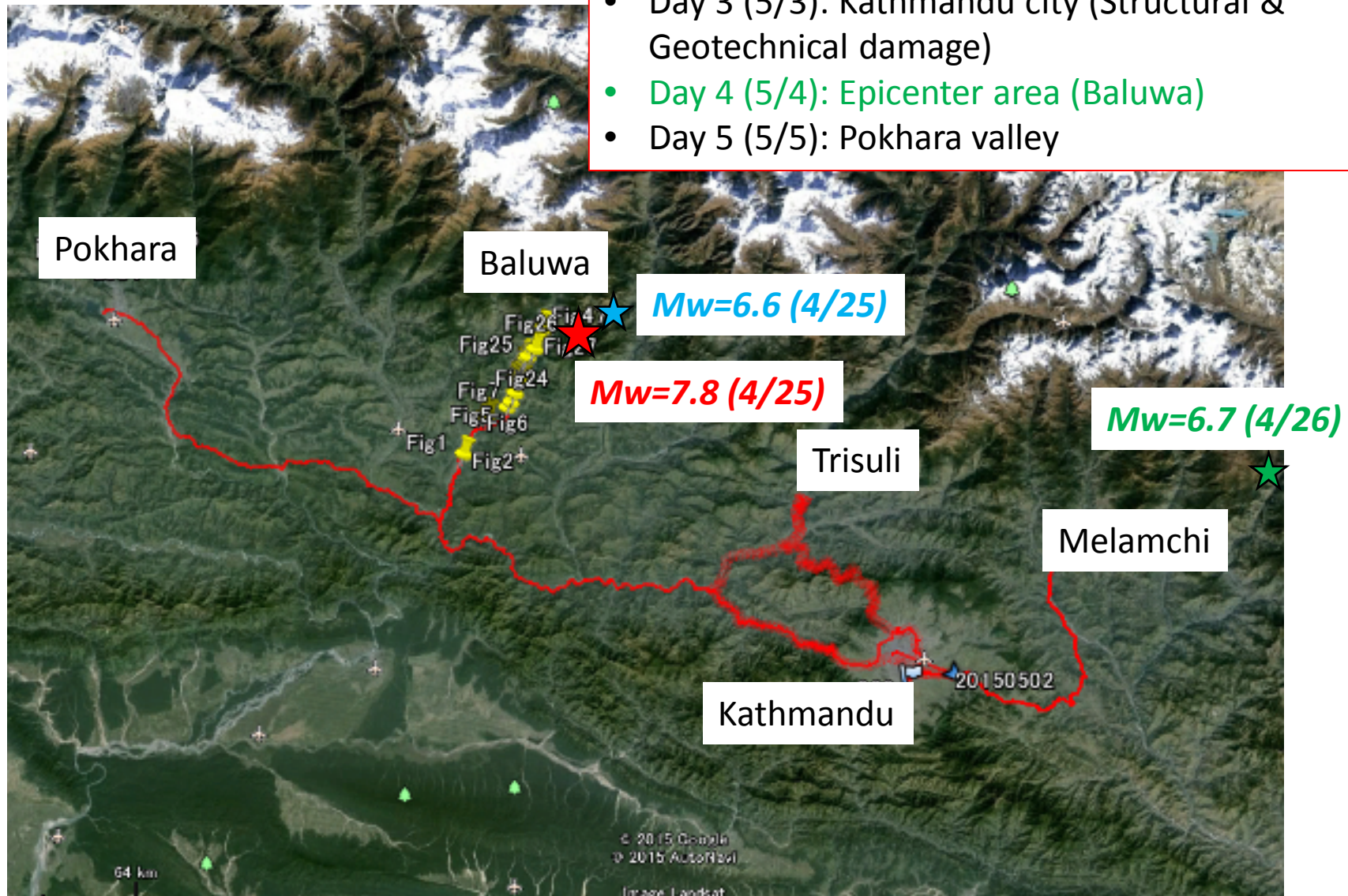
JGS: Japanese Geotechnical Society

ATC3, ISSMGE: Asian Technical Committee, Int. Society of Soil Mech. & Geotech. Eng.



Damage survey

- Day 1 (5/1): Kathmandu city (Heritage area)
- Day 2 (5/2): Trishuli & Melamchi
- Day 3 (5/3): Kathmandu city (Structural & Geotechnical damage)
- Day 4 (5/4): Epicenter area (Baluwa)
- Day 5 (5/5): Pokhara valley



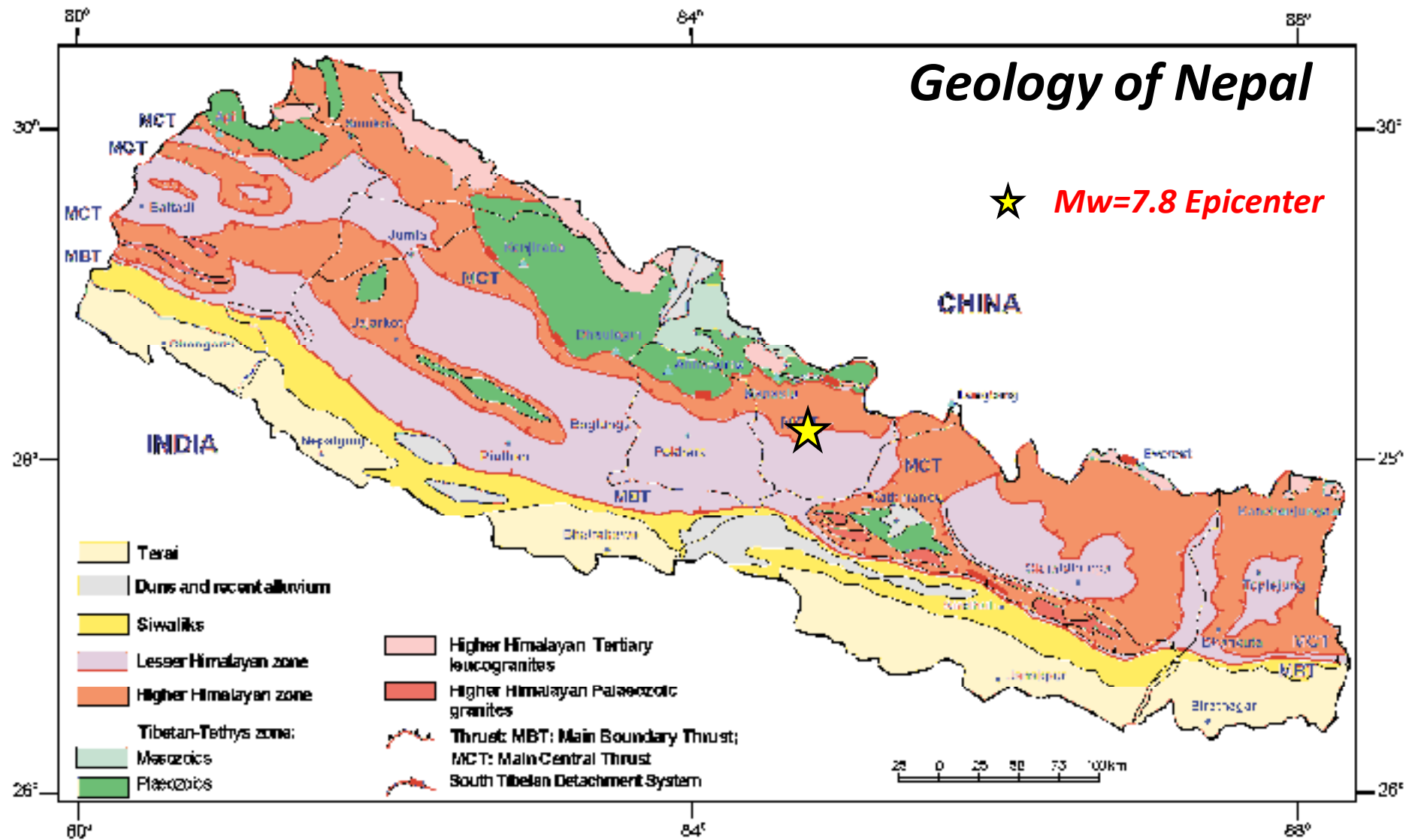
PART I

Damage survey in Kathmandu City

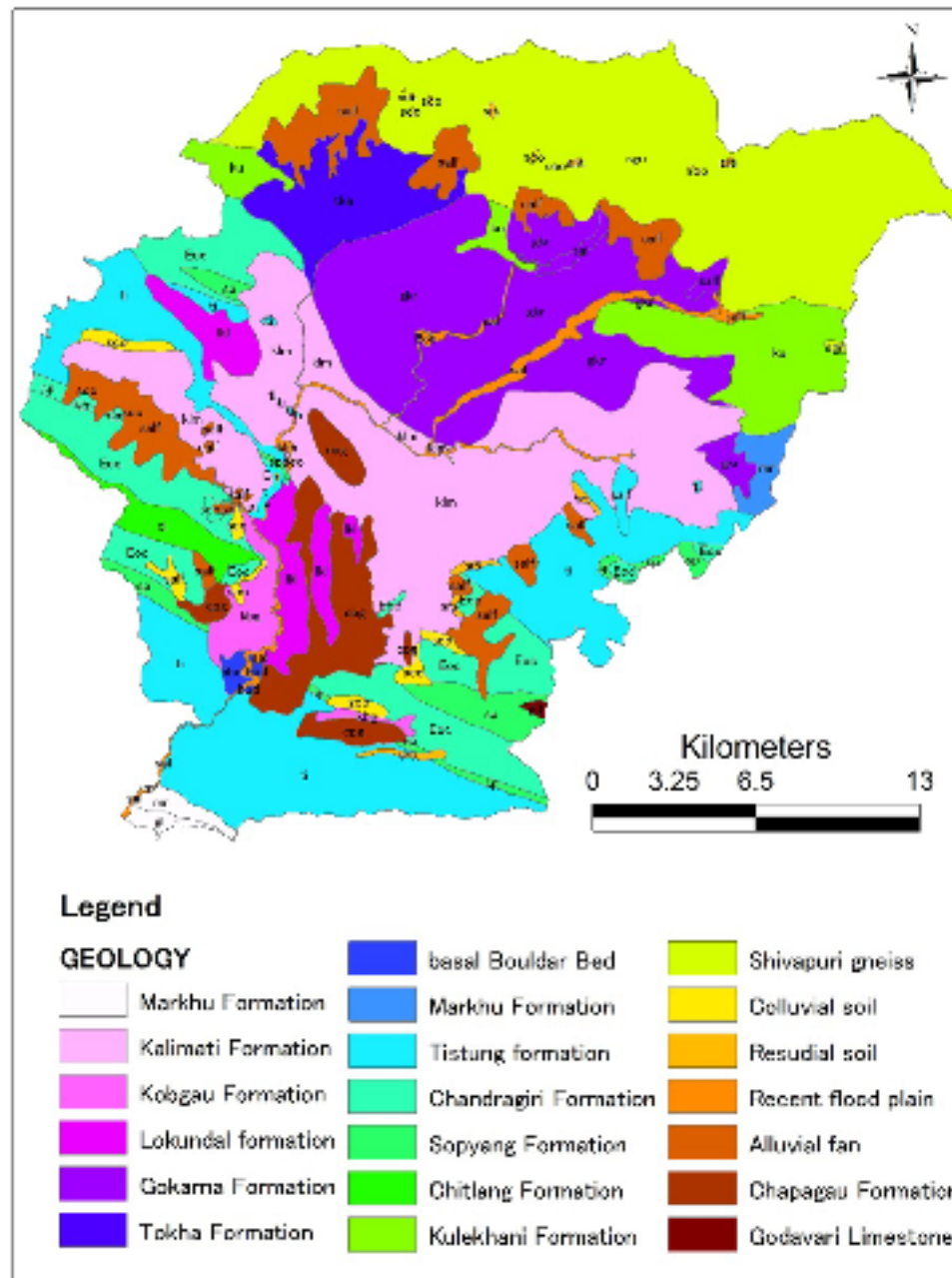
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1. Introduction

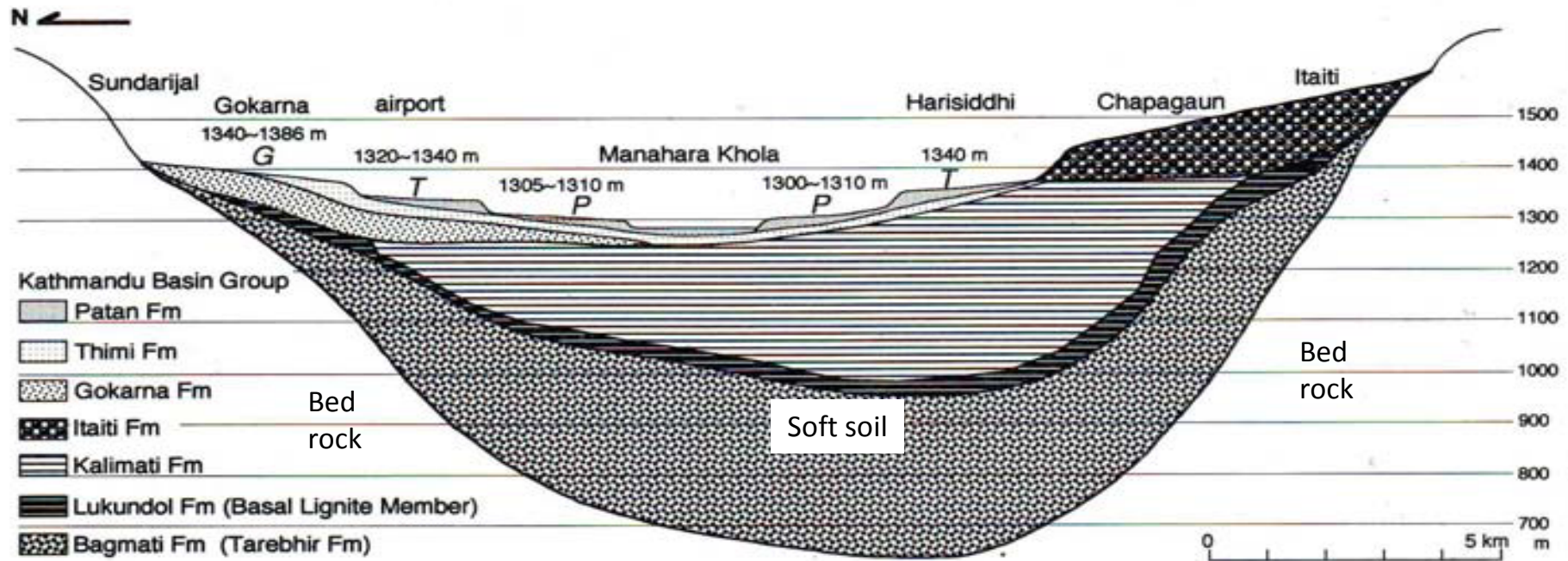


1.1. Geology of Kathmandu valley and surroundings



(Source:
Department
of Mines and
Geology
(DMG, 1998)

1.2. Geology of Kathmandu Valley

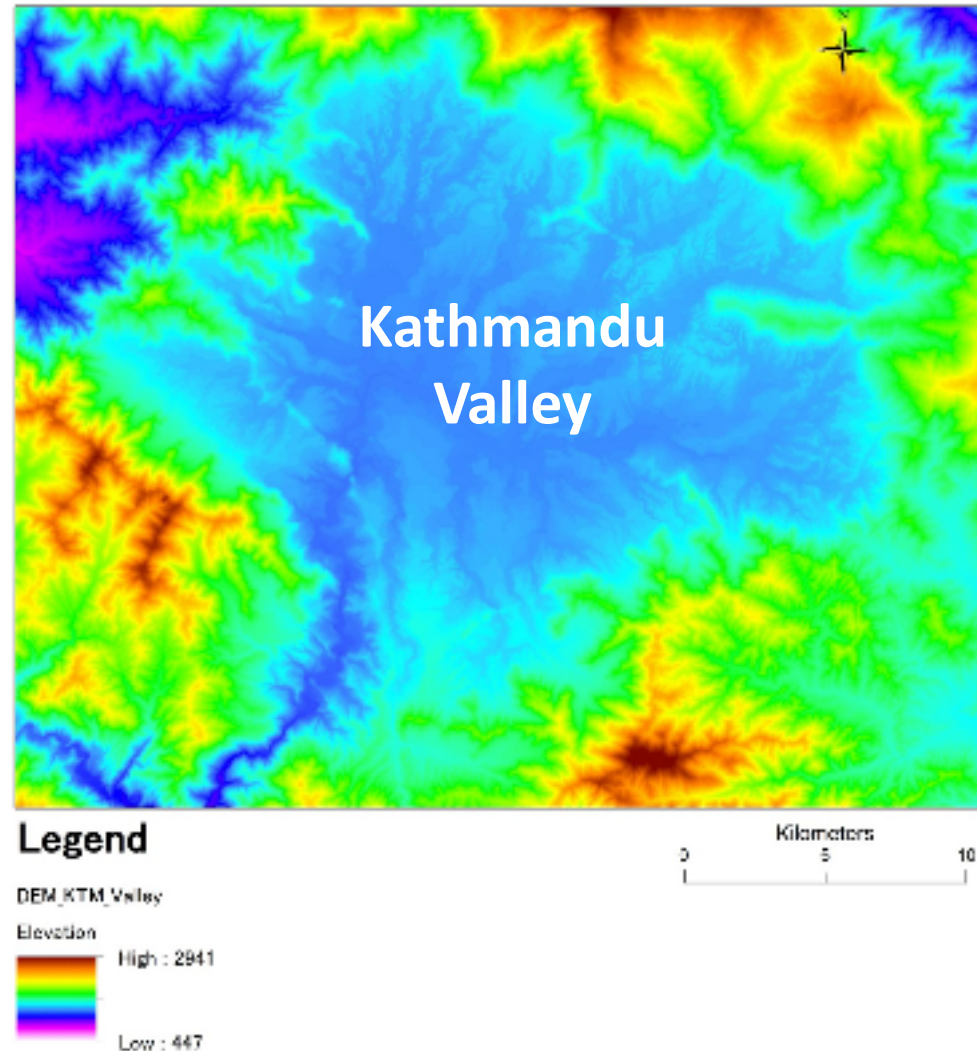


Schematic geologic cross-section of the Kathmandu basin sediments during the late Pleistocene (Sakai et al., 2002)

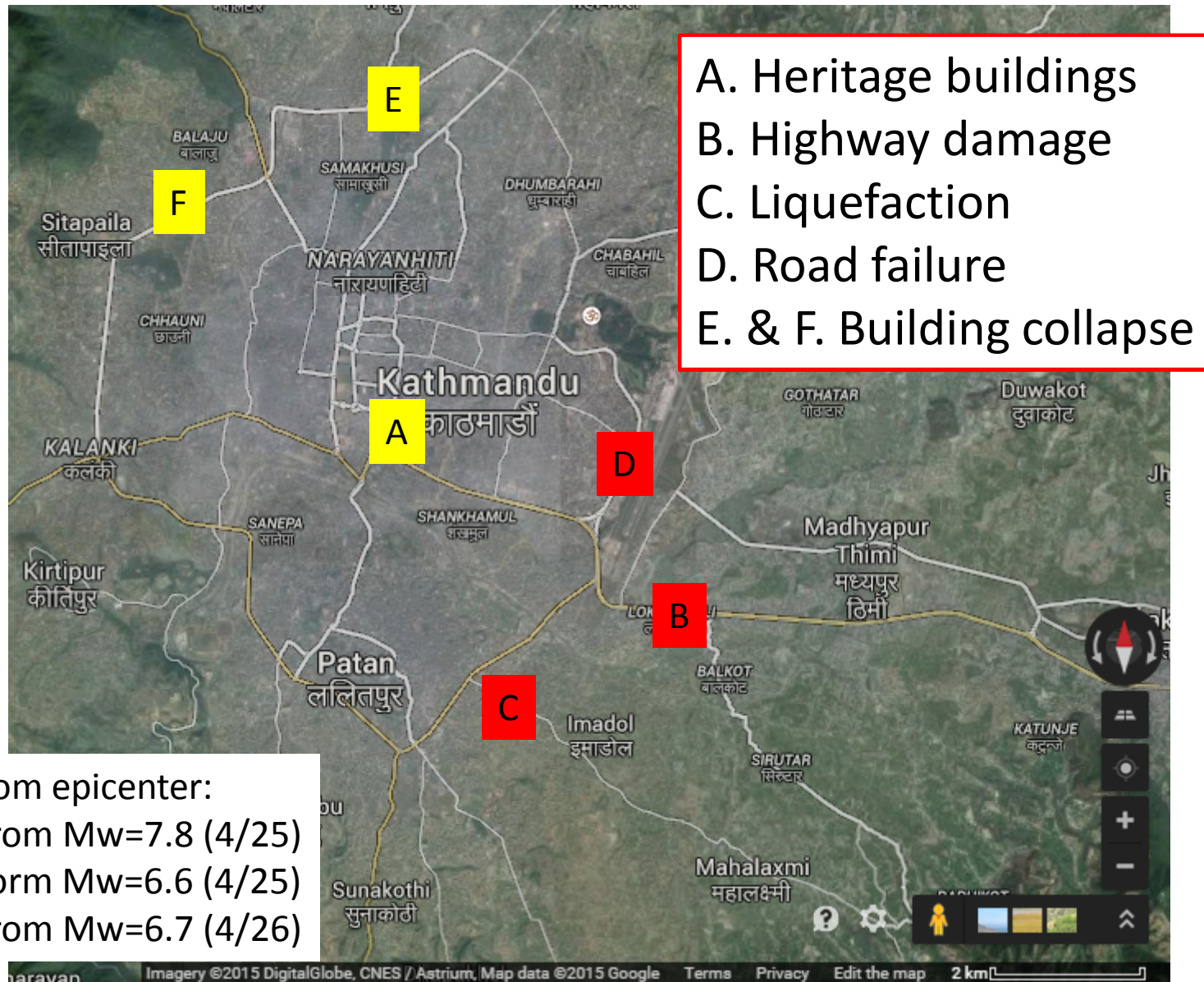
1.3. Morphology of Kathmandu Valley

Kathmandu valley is an intermountain basin (600 sq km) filled by lacustrine deposits derived from the surrounding mountains

The elevation of the Kathmandu valley varies from 1270m to 1400m



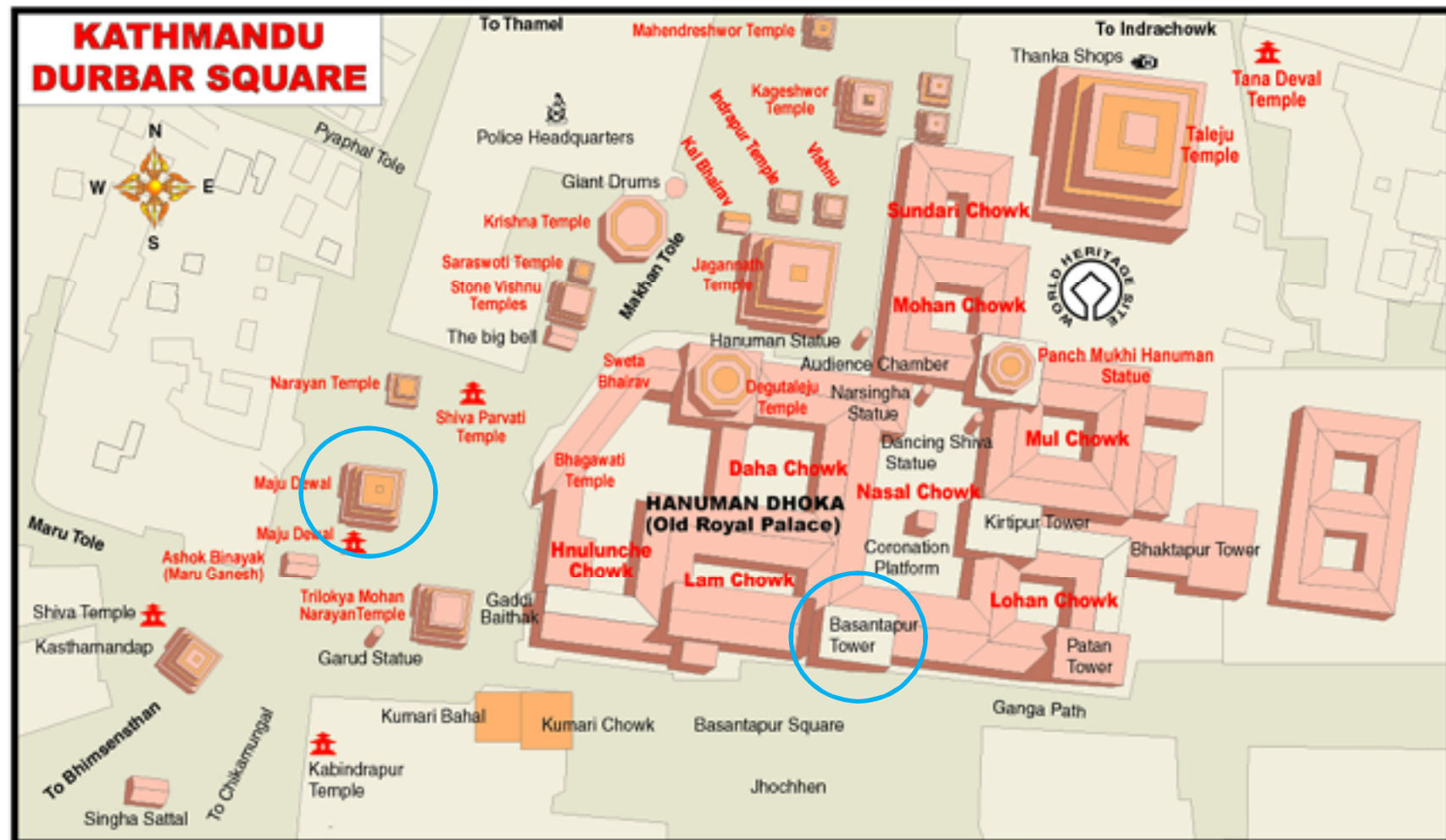
2. Kathmandu city



Structural issues

Geotechnical issues

2.1. Heritage buildings collapse (location A)



Basantapur Tower



Maju Dewal



Most of the temples are more than 500 years old

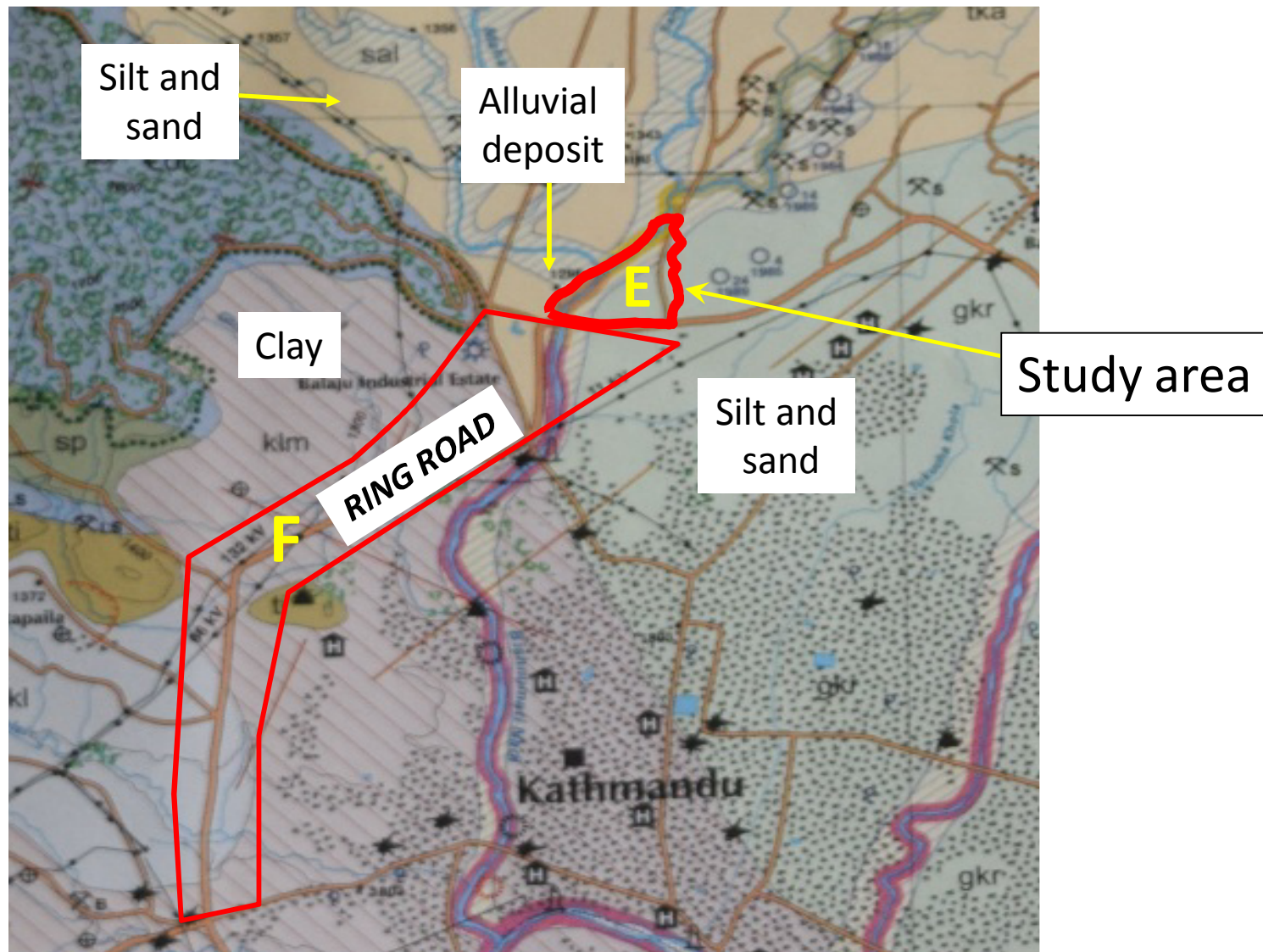
Heritage building collapsed but no damage to nearby RC building



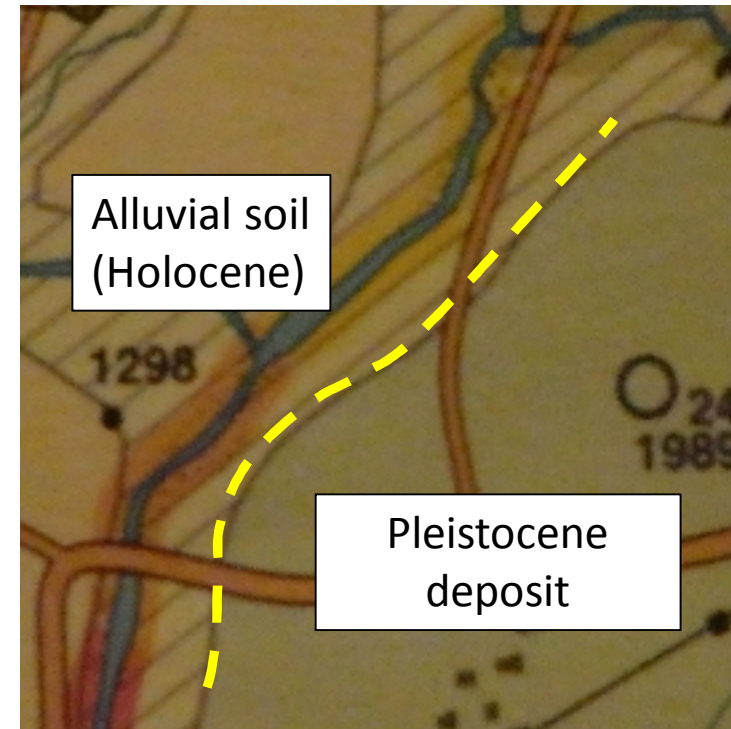
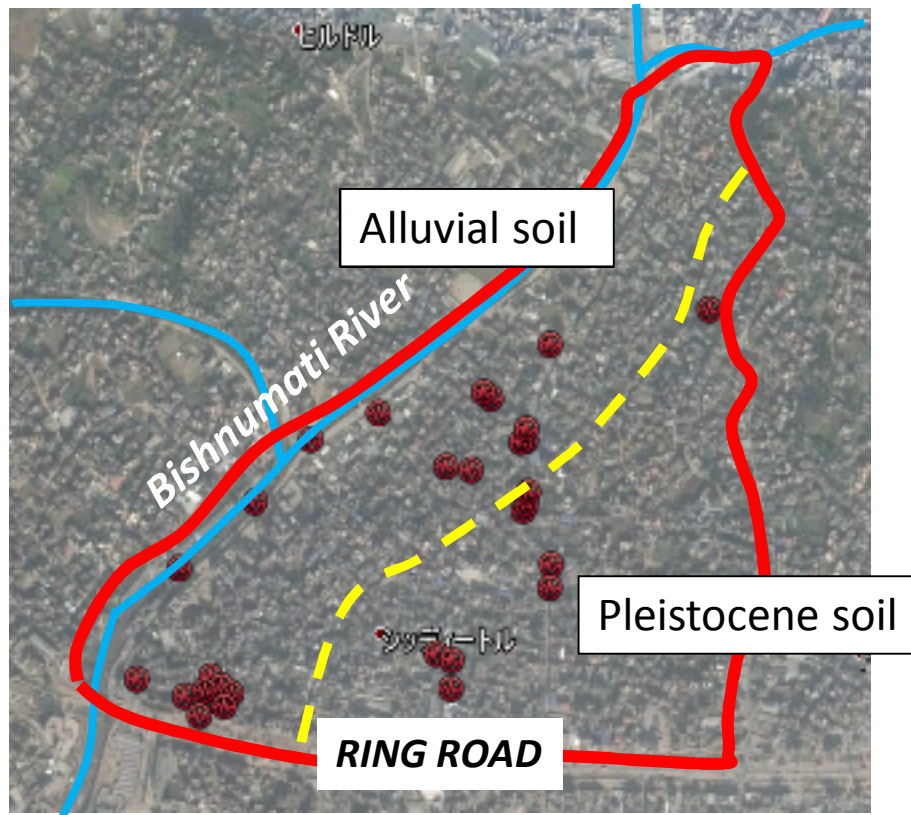
2.2 City center



2.3. Building collapse (North-west of Kathmandu)



Study area (location E)



At least 28 buildings totally collapsed or should be demolished

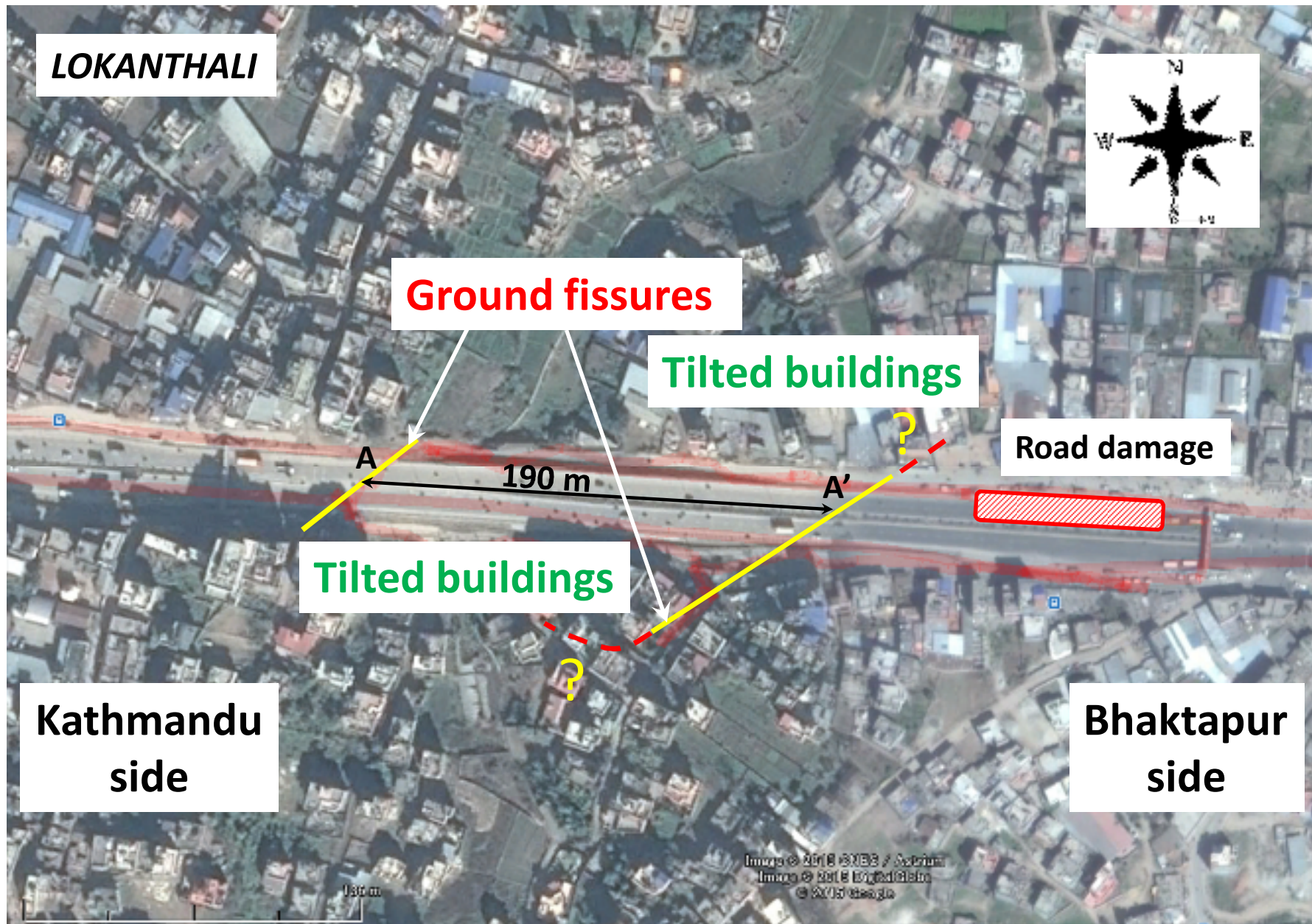
Most heavily damaged buildings are located on the ***alluvial soil deposit***

Along the Ring Road (location F)

Local ground motion amplification and/or loss of bearing capacity,
poor quality of non-engineered RC buildings



2.4. Damage along Araniko Highway (location B)



Embankment settlement

Before earthquake

Photo source: Google map
May 2013



Extension completed
in 2011

During survey

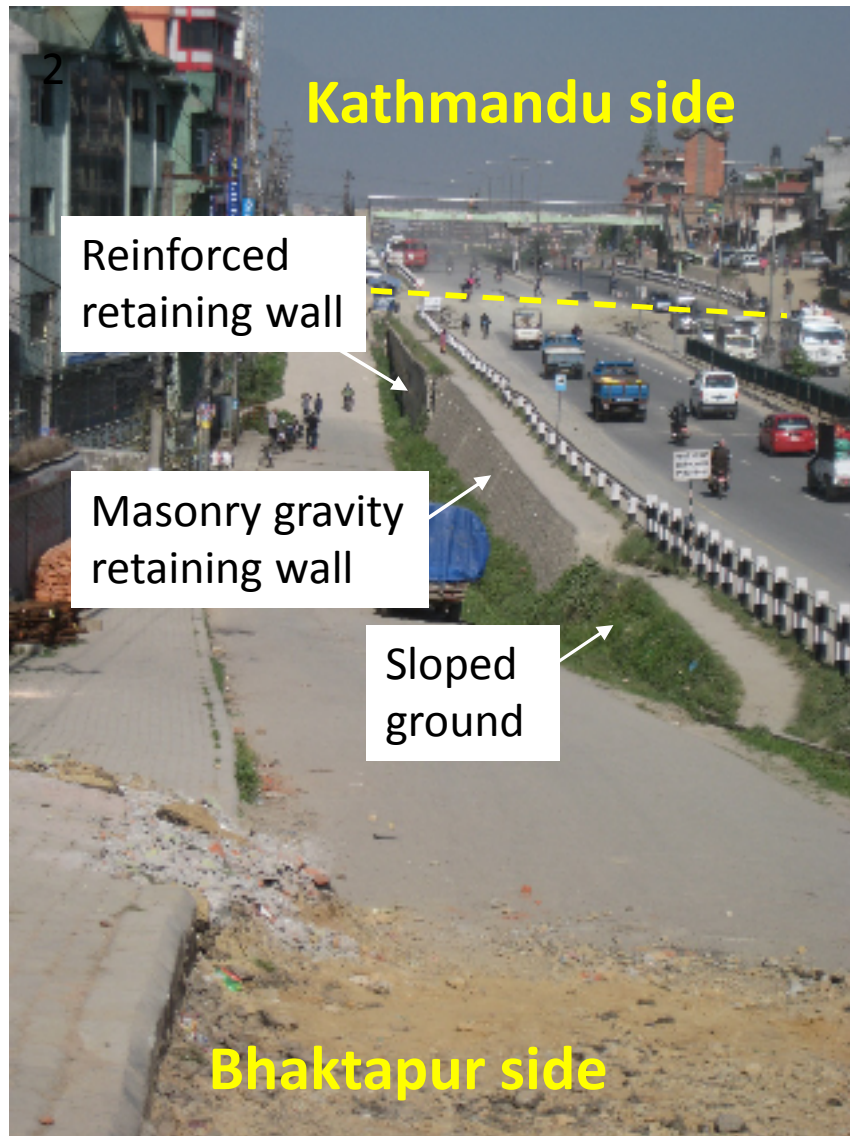


Just after earthquake

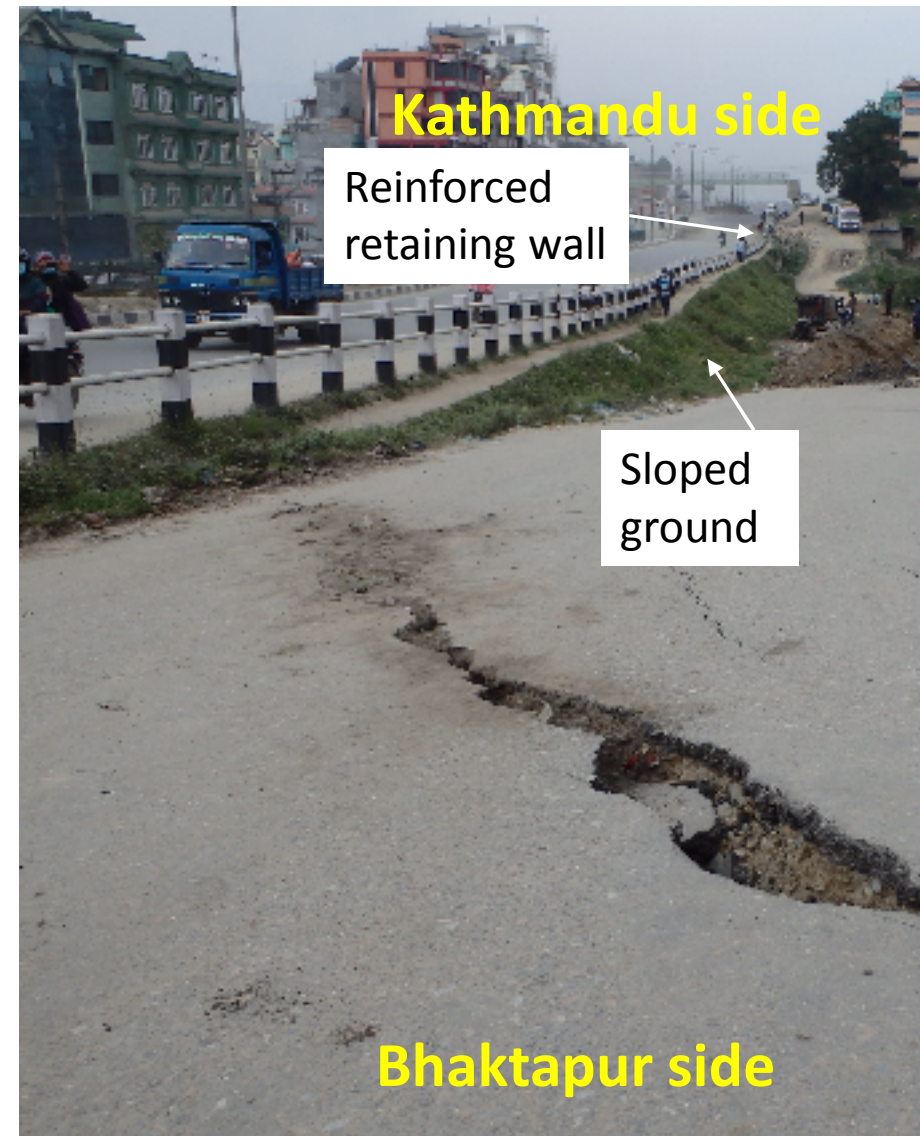


Photo source: wordpress.com

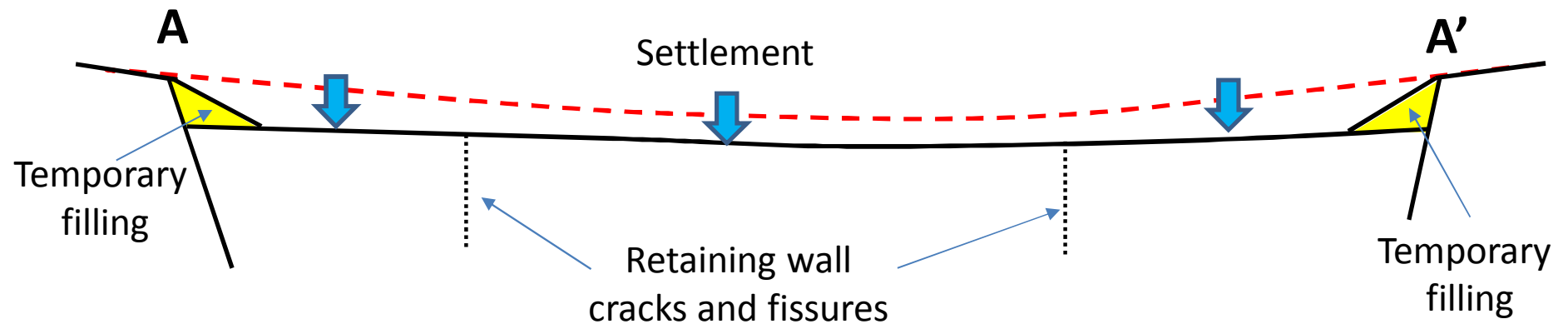
Southern side



Northern side



Section A-A'



Retaining walls cracks



Road pavement failure



- Damage due to poor compaction of the filling soil

Ground failure nearby embankment



Ground-failure-induced tilting and subsidence of buildings



2.5. Soil liquefaction (location C)



Sand boiling



- No damage induced to surrounding buildings
- Water table very low during dry season

2.6. Road failure (location D)



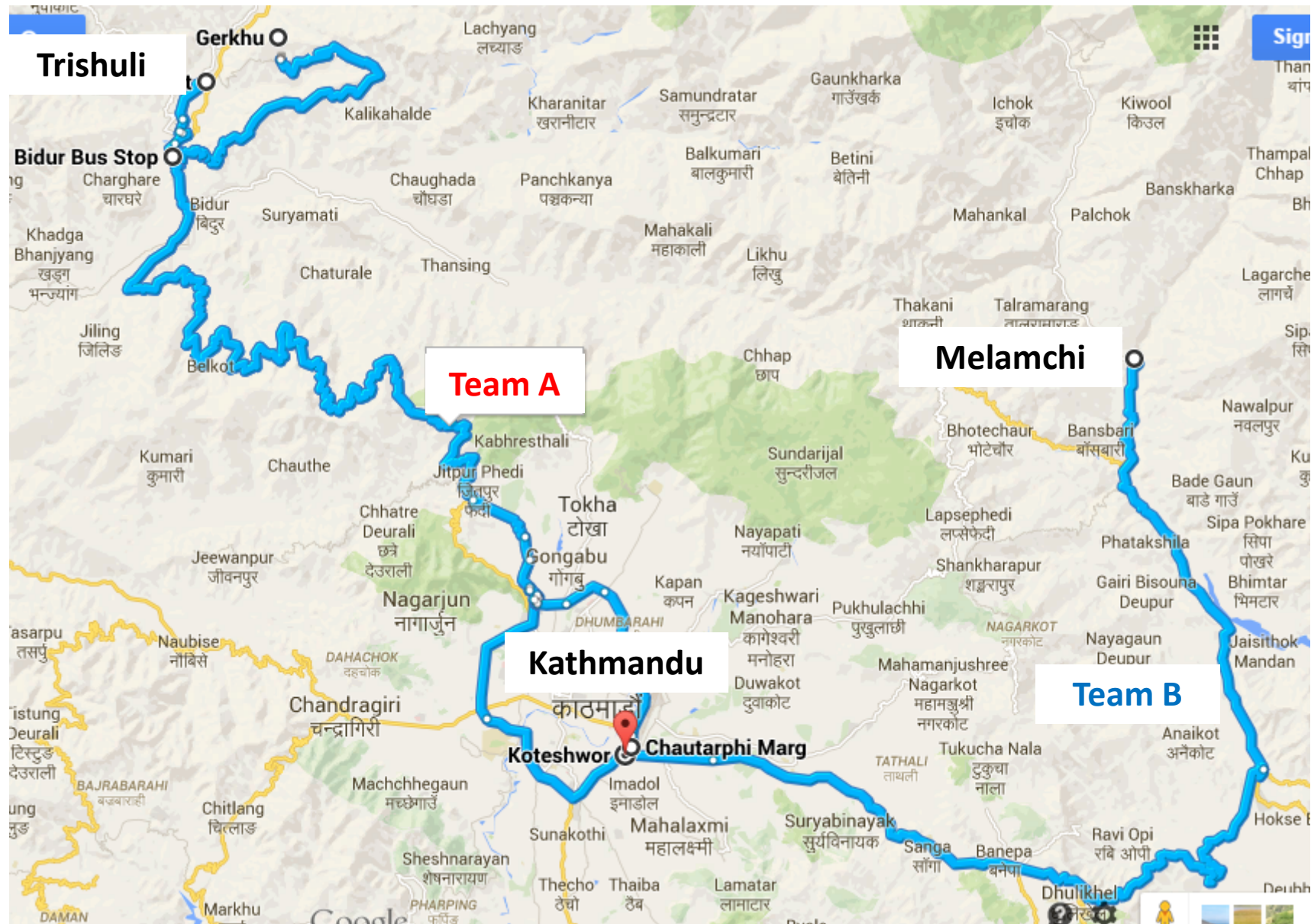
PART II

Damage survey near Epicenter Area and Pokhara

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3. Trishuli & Melamchi



On the way to Trishuli

Shallow landslide



Rock fall



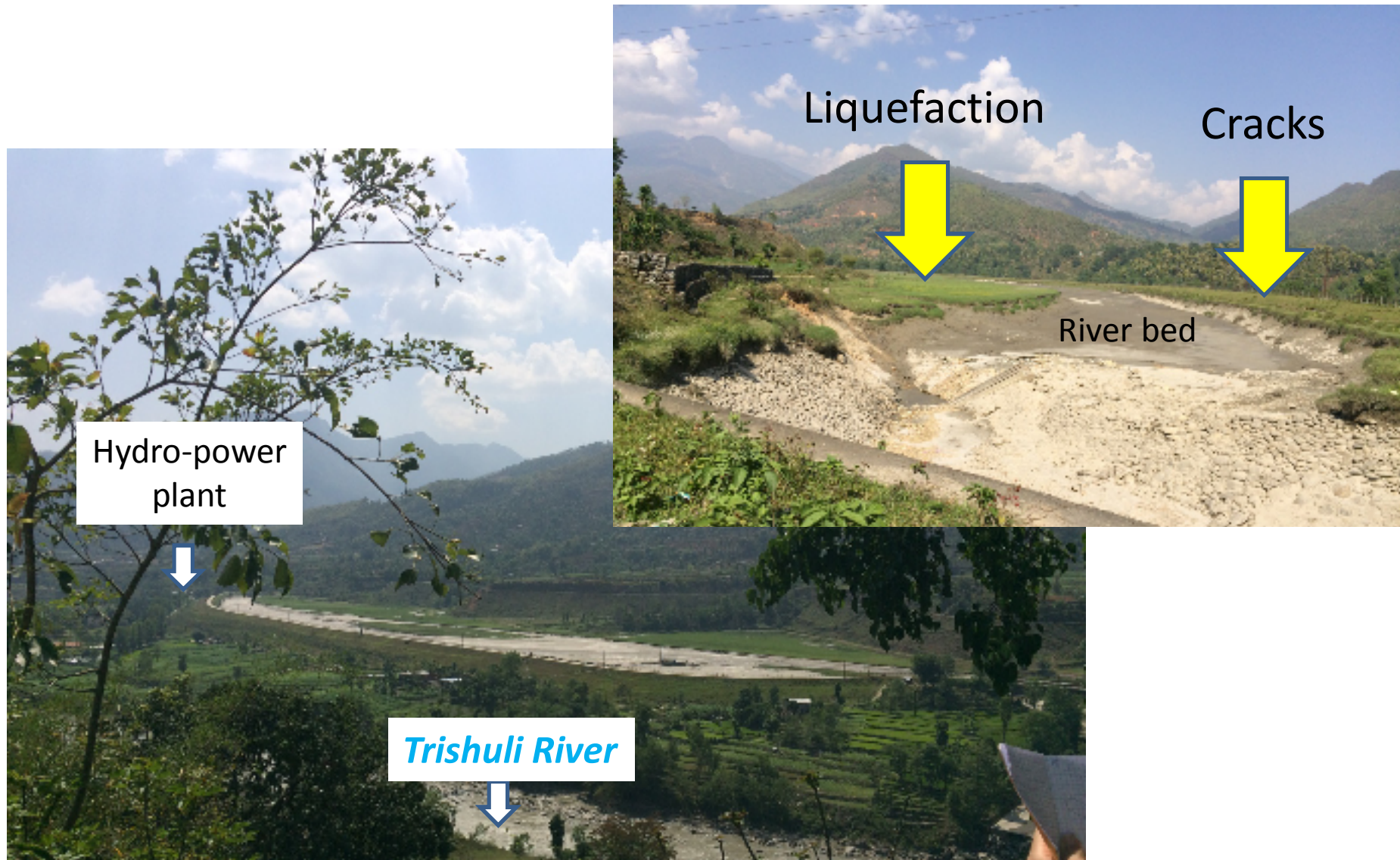
Villages encountered:

- Ranipauwa
- Nipala
- Battar (Bidur)
- Gerkhu

> 80% houses damaged



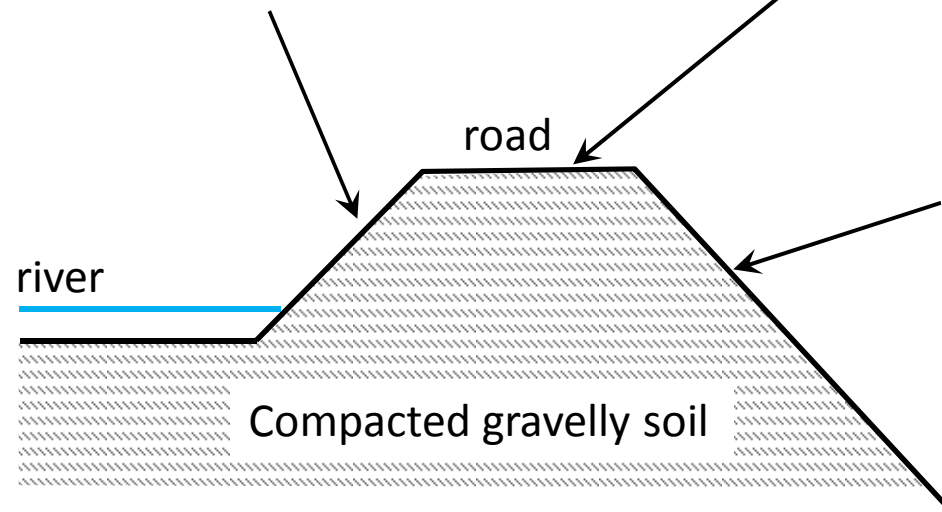
Damage to Trishuli earth dam



Upstream



Embankment



Downstream

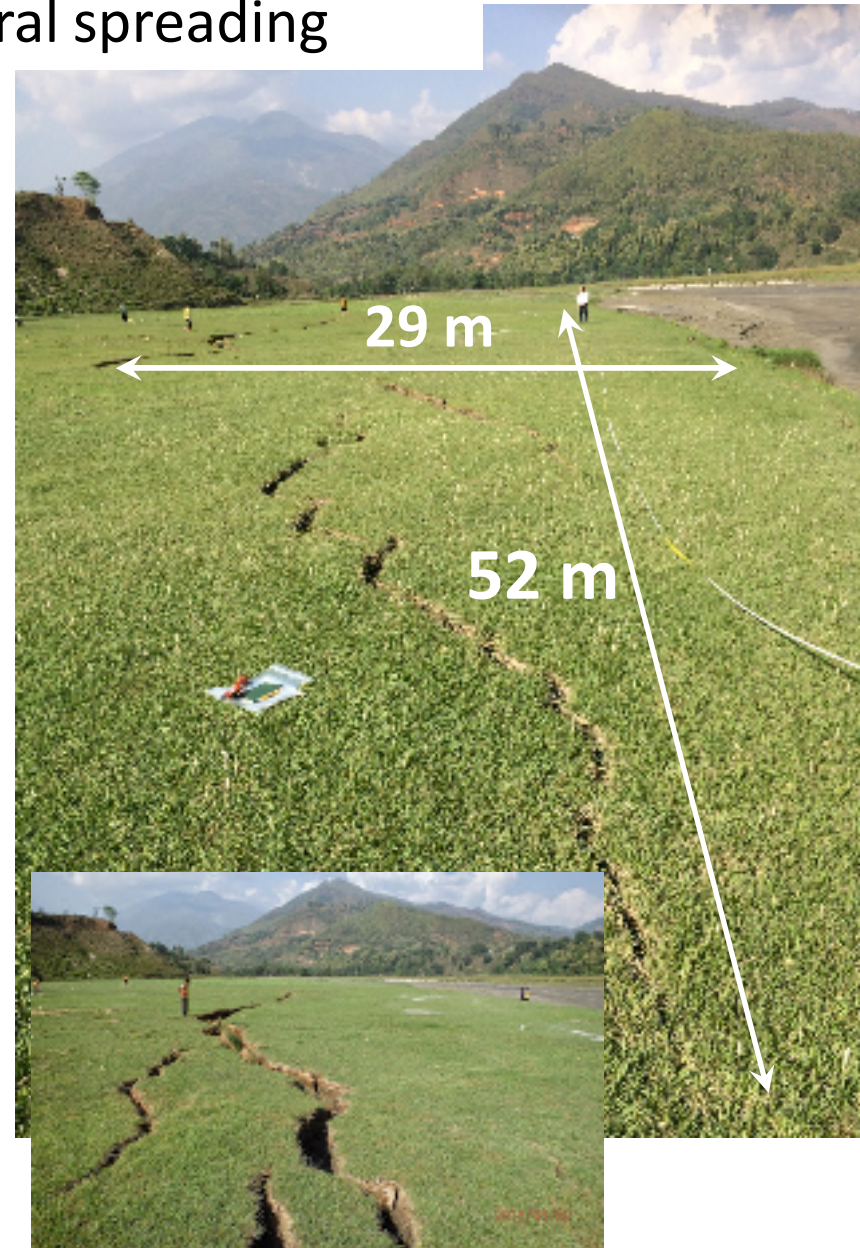


Soil liquefaction

Liquefaction-induced
lateral spreading

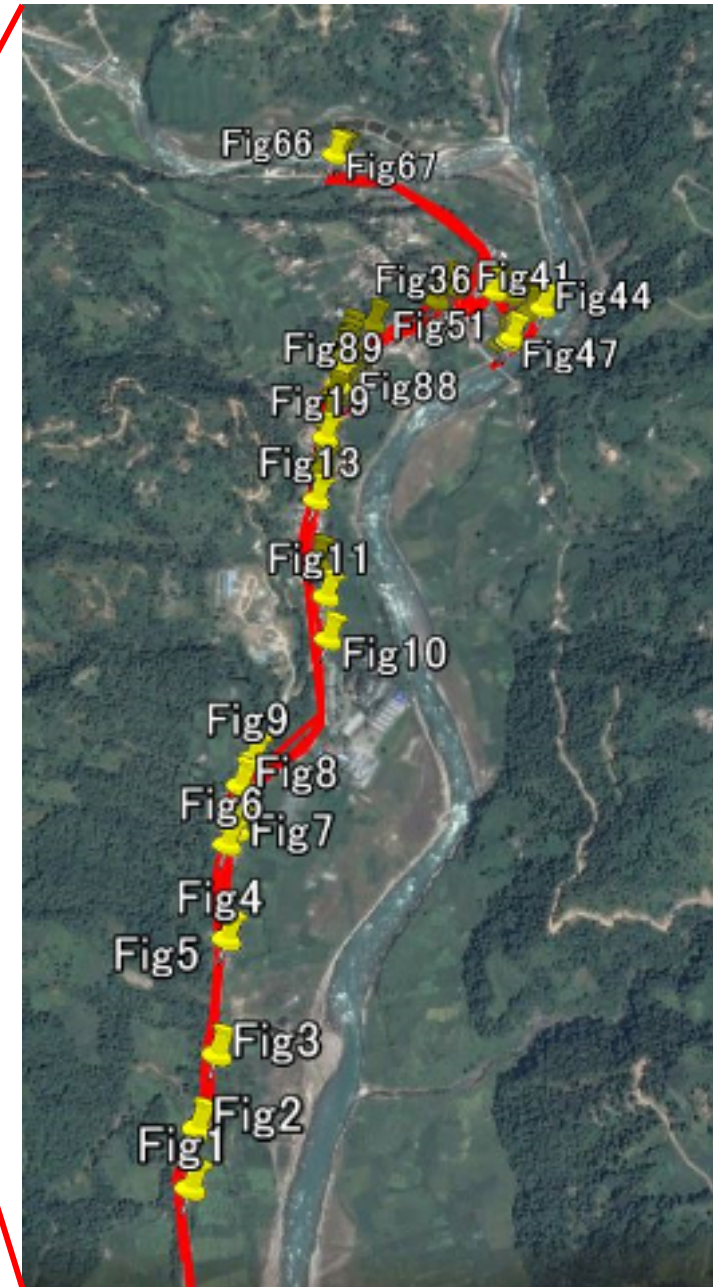


Sand
boiling



On the way to Melamchi

- 90 km from Mw=7.8 (4/25)
- 40 km from Mw=6.7 (4/26)



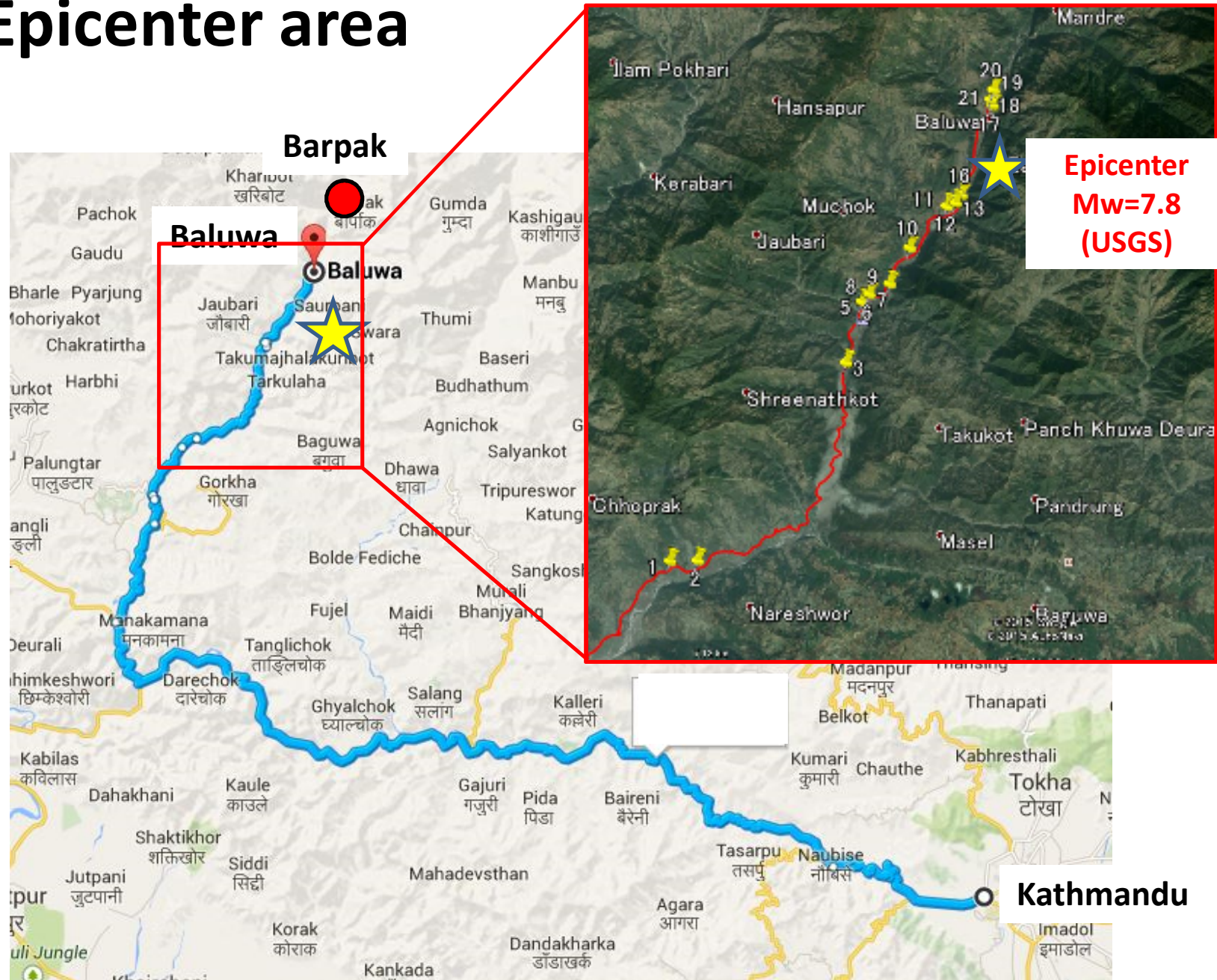


Melamchi



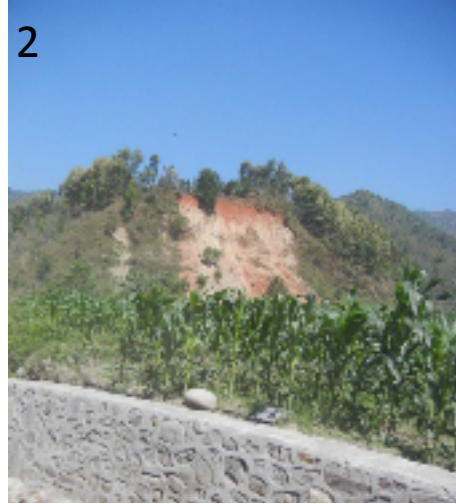


4. Epicenter area





Typical damaged building



Landslide



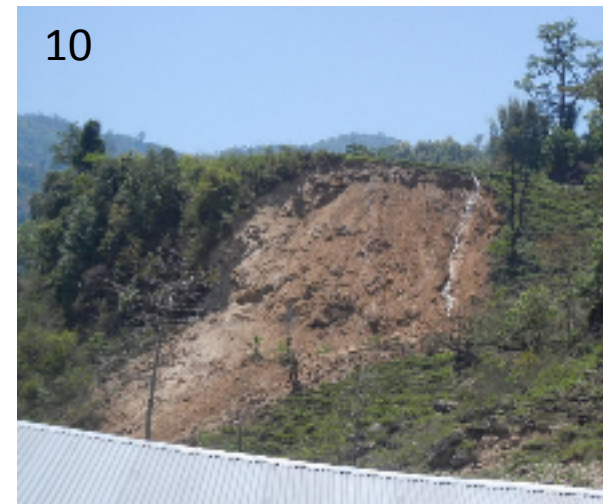
Weathered rock



Weathered rock



Boulder (hard rock)



Weathered limestone

Cut slope

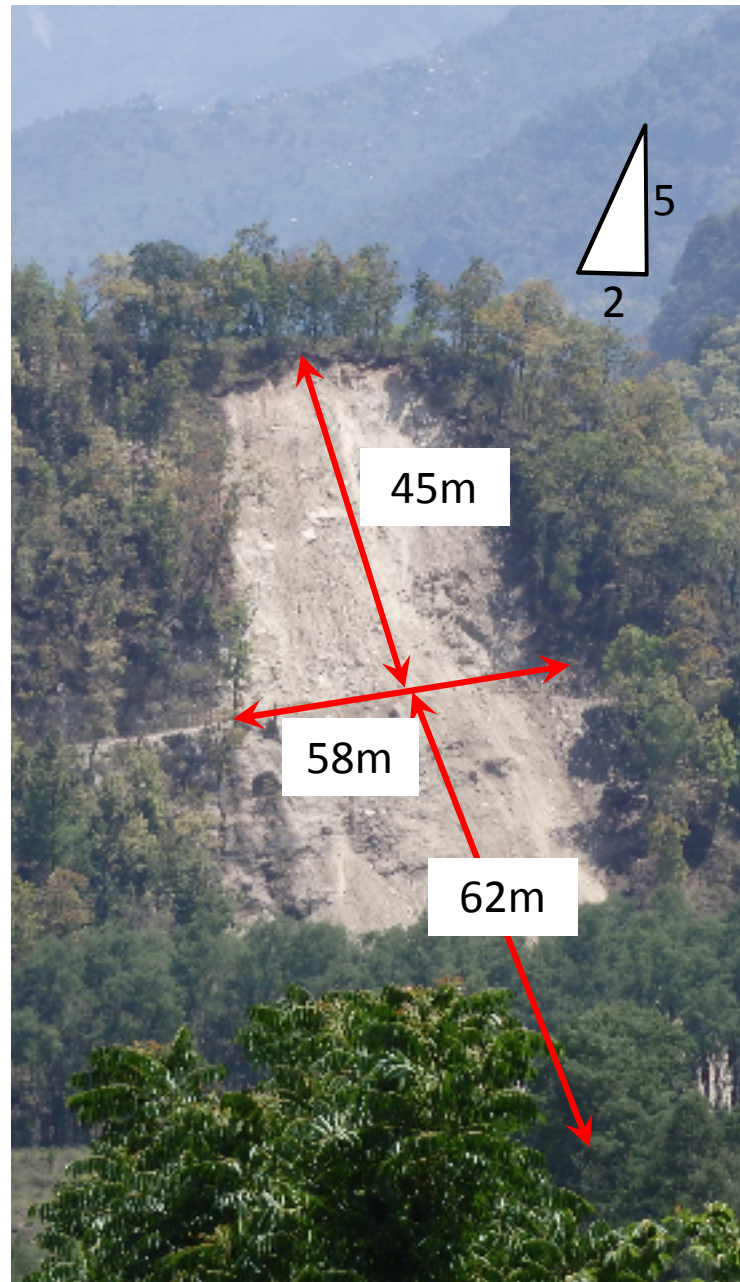
Soft rock



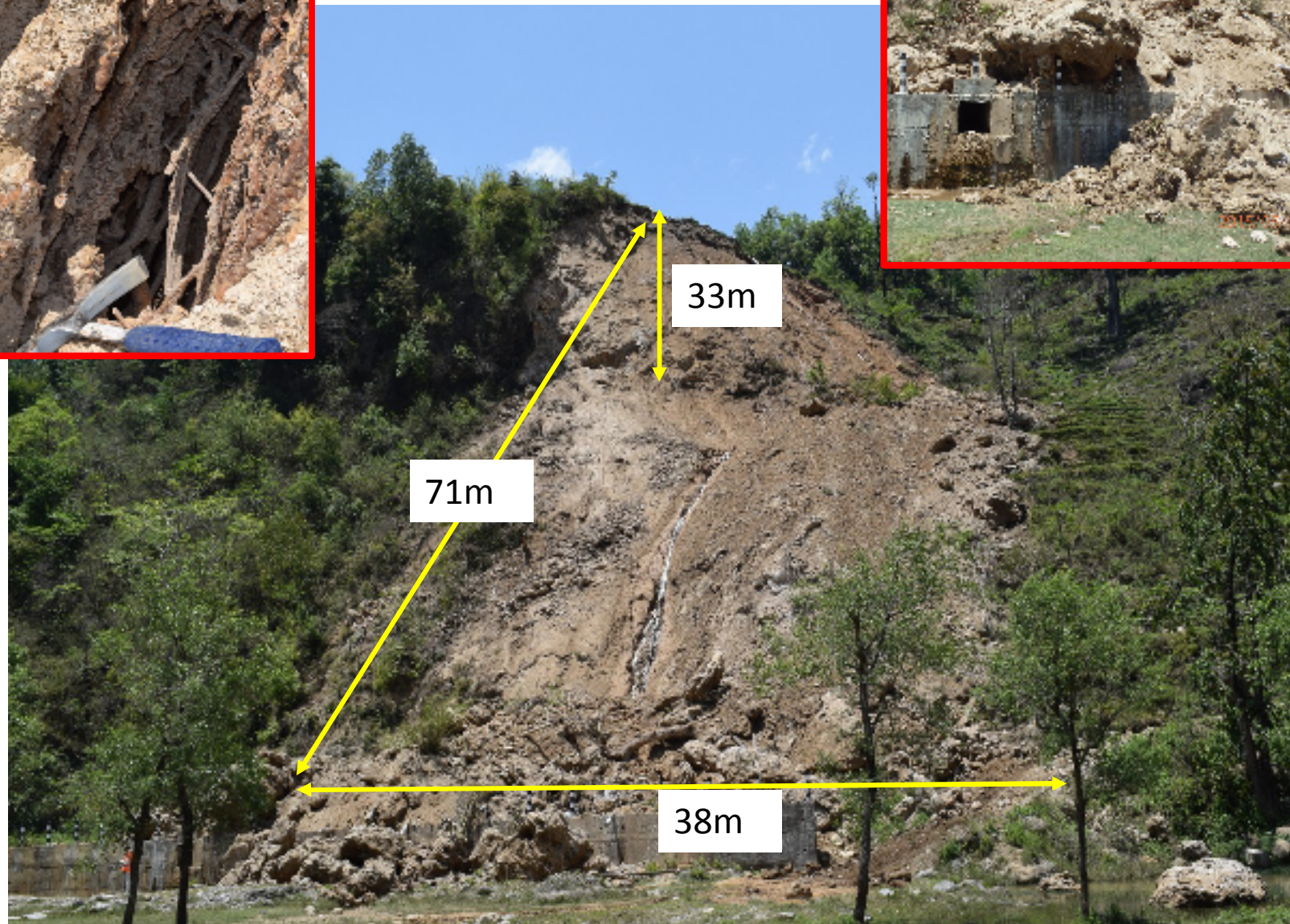
Landslides



Landslide #1

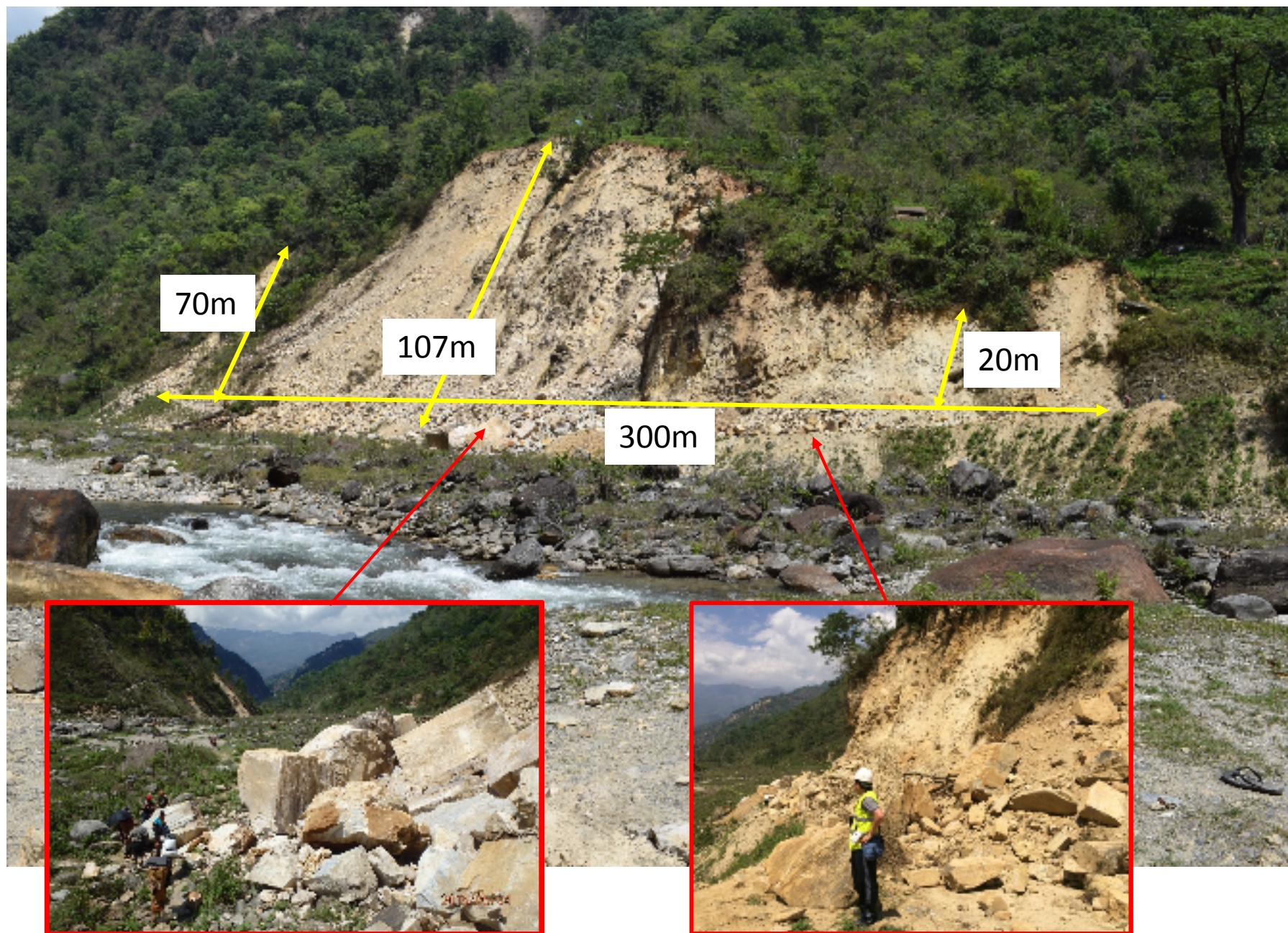


Landslide #2



Landslide #3







Very unstable!!!

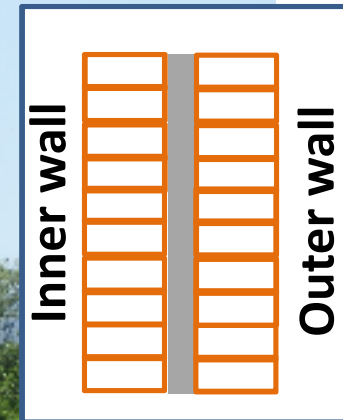


5. Pokhara valley

Distance from epicenter:

- 71 km from Mw=7.8 (4/25)
- 86 km from Mw=6.6 (4/25)
- 205 km from Mw=6.7 (4/26)

Marginal damage only to a few houses

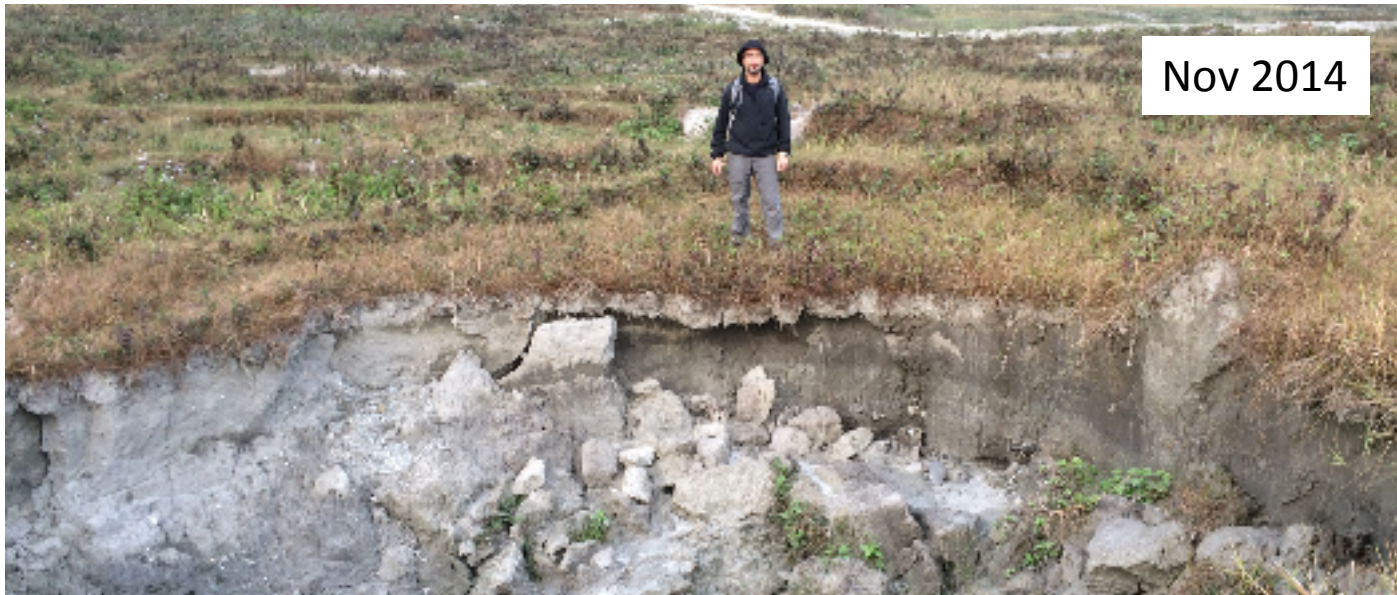


Armala area - sinkhole



Muddy water was observed after the earthquake

No new sinkholes and no change in sinkholes size



6. Bridges

Trishuli



Kathmandu



Melamchi



Baluwa (Epicenter)



7. Summary

- Survey damage was conducted in Kathmandu city, Trishuli, Melamchi, Epicenter area and Pokhara city
- In Kathmandu city, most of structural damage was observed in the city center (heritage buildings and old masonry houses) and in the north-west area along the ring road (non-engineered RC building, loss of bearing capacity of soft soils)
- Ground failure induced the settlement of an embankment along the Araniko Highway, sinking and tilting of a number of RC buildings

- In Trishuli, liquefaction was observed. However, most significantly, cracks along the upstream side of the earth dam are of concern
- In Melamchi, damage to houses and landslides were widely observed (close to $M_w=6.7$ epicenter of 4/26)
- In the epicenter area, many villages were completely devastated and a number of landslides could be observed
- In Pokhara valley, only minor damage to houses were observed. In Armala area, no new sinkholes were formed
- No damage to bridges was observed during the survey

8. Concluding remarks

- House inspection should be done as early as possible
- Inspection of the landslide area is also important because damaged rocks as well as large cracks still remain on the slope. Survived slopes could have further damage (aftershocks/during rainy season)
- We couldn't reach the mountain area where a natural landslide dam is reported. Need helicopter or long trekking
- The damage to the roads and buildings in the Kathmandu valley would be linked with ground condition
- Damage distribution in the fault area corresponds well with the characteristics of the earthquake (i.e. heavy damage in the east area while no damage in east (and south) area from the epicenter

**Thank you very much
for your kind attention!**

Acknowledgement

Pokhrel P. (Tribhuvan University, Nepal)

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Newspapers)