The impact of earthquake and monsoon induced Landslides on Rural and Remote Transport Infrastructure. A case study from Nepal.

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Presentation Outline

- Background to Nepal
- Transport Infrastructure-Rural vs Remote
- Monsoon vs Earthquake Induced Landslides
- Case Study 1-Ariniko Highway
- Case Study 2-Remote Communities
- Disaster Resilience Scorecard
- Summary/Conclusions

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The Problem

- Estimated approximately 1 Billion people access to rural and remote transport (roads and trails)infrastructure
- Nepal it is estimated to be around 1 million people
- Tourism (including trekking) relies on these roads, trails and remote access, with tourism contributing US$ 0.5 billion (5% GDP)
- Data poor-Limited data on both hazard and impact
- Perception Nepal population resilience-
- Community engagement more out of need than choice

Central Settlement	Nearest Market	Transport	Time (Hrs)	Remoteness
Bhanjyangkharka	Battar	1	6	5
Dhandakharka	Battar	1	7	5
Shyamryang	Battar	2	3.5	5
Talukasheri	Battar	1	24	5
Katanche	Battar	1	12	5
Negi & Caule	Battar	2	12	5
Ghyangfedi	Battar	1	12	5
Panpra	Battar	1	12	5
Sisipu	Battar	1	12	5
Bolung	Battar	1	12	5
Uppra	Battar	2	12	5
Chettang	Battar	1	12	5
Prabhudanda	Battar	2	3	5
Koiralachet	Battar	2	3	5
Aapchaur	Battar	2	3	5
Simtang	Battar	1	4	5
Mathilosimtang	Battar	1	4	5
ShikharbesiTole	Battar	1	4	5

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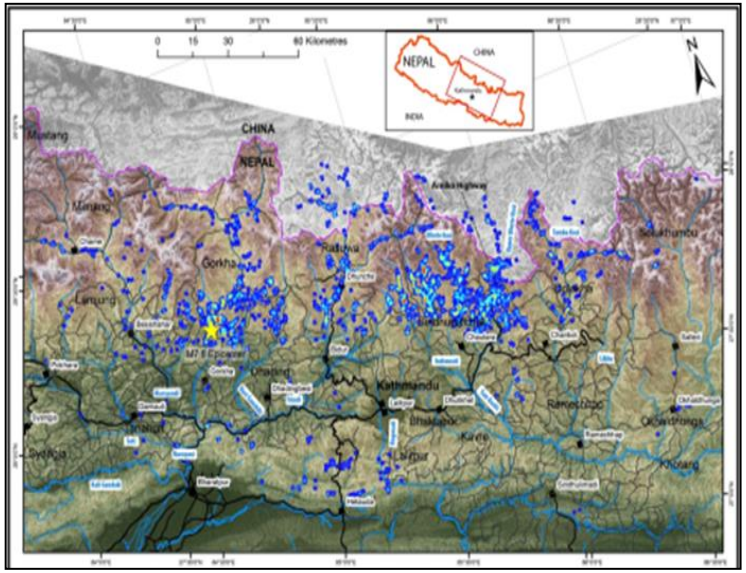
Introduction

- 2015 Gorkha Earthquake
- Over 3500 individual landslides mapped
- Largest individual landslide within Langtang Valley (Avalanche induced)
- 10% of fatalities due to landslides?
- Major road and infrastructure largely unaffected (Gorkha-Kathmandu-Chautara)
- Significant Impact on rural and remote access



- Monsoon Induced Landslides
- Annual occurrence
- 100’s of landslides annually
- 100’s of fatalities annually
- Largest recent Jure Landslide with over 400 fatalities
- Impacts all levels of transport infrastructure

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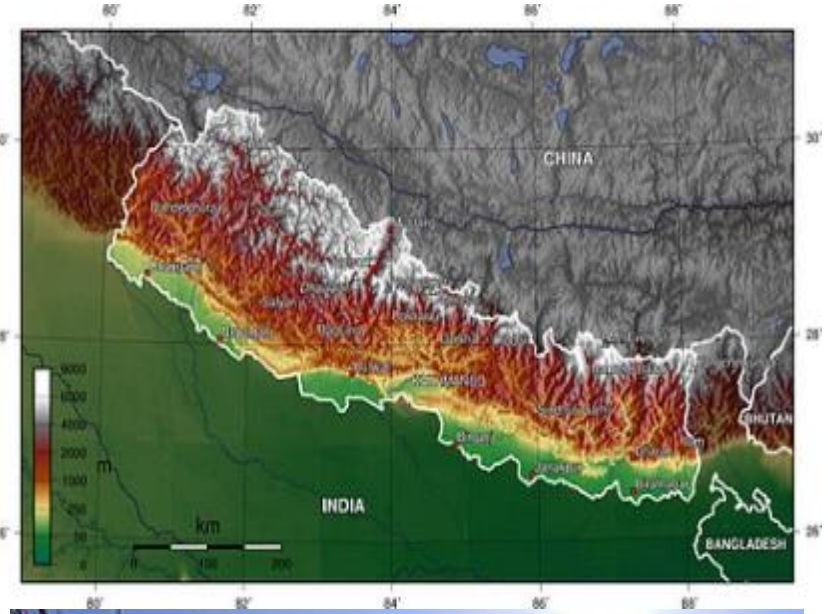
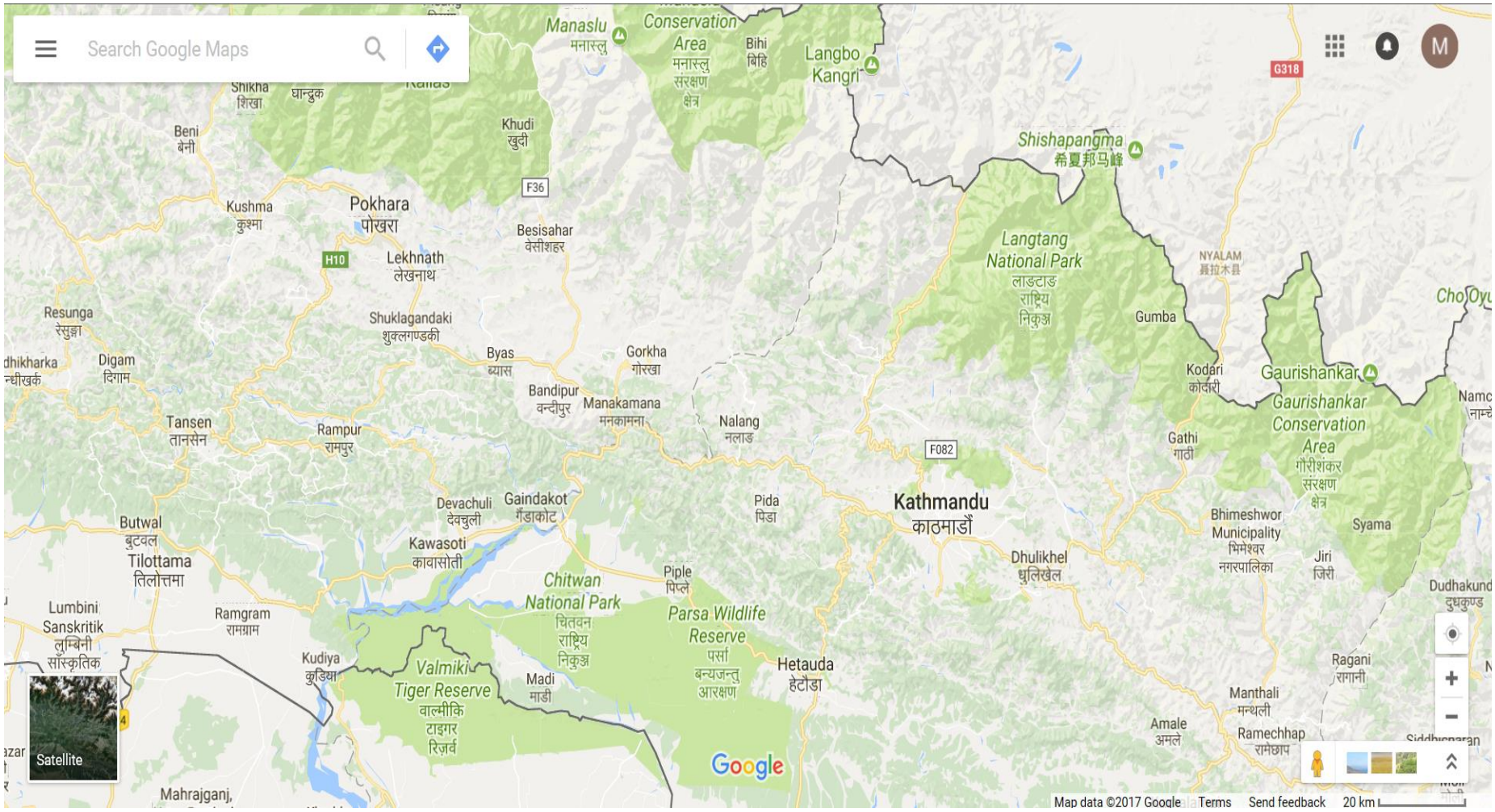
Nepal-Country Profile



Locations



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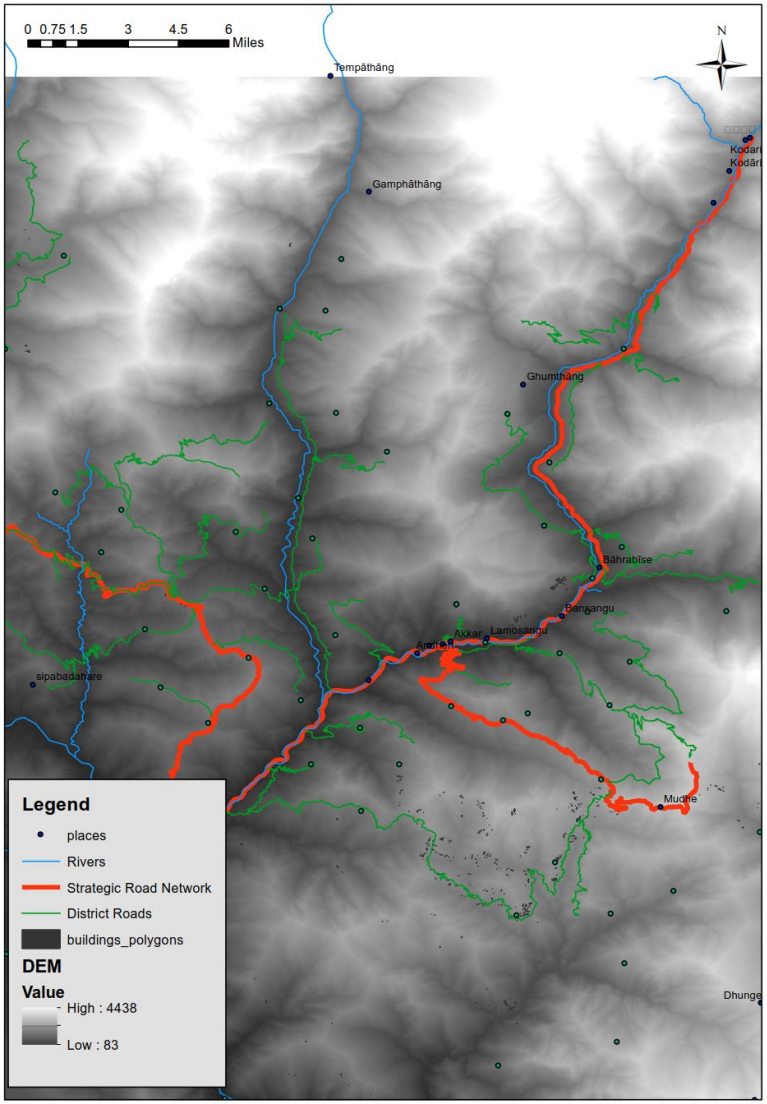
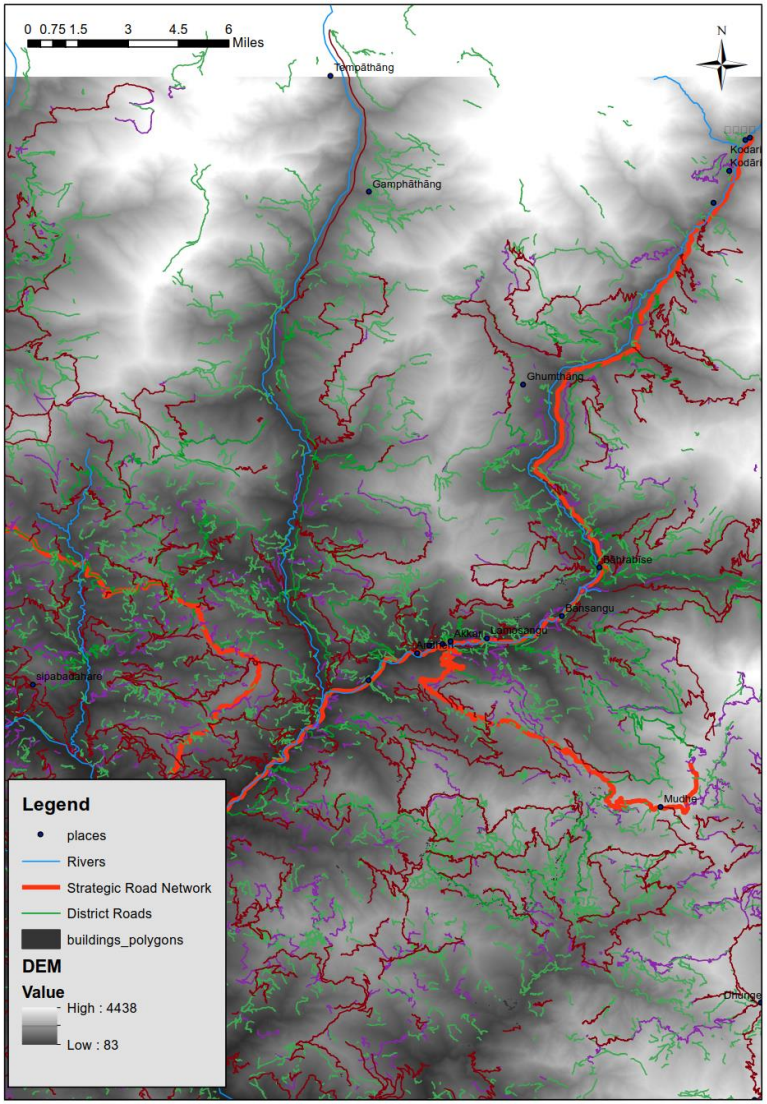
Transport Routes





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Road Network-Strategic

- Managed by Nepal Department of Roads
- Predominantly tarmac to district centres
- Limited impact from earthquake, but significant impact from other triggers
- Some asset management
- Maintenance reactive
- Some geohazard assessment >20 years old
- Currently undertaking and planning further roads

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Road Network-District/Village Network

- Under the control of DoLiDAR
- Typically from District centres
- Typically Earthen or gravel
- Heavily impacted by monsoons and EQ landslides
- Villages fund new roads
- Little to no thought on geohazards
- Then adopted by DoLiDAR

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Road Network-Trails

- Under the control of DoLiDAR
- Extensive network
- Several days walk to road head for some villages
- Critical lifeline for access to markets, health care and schools
- Significant impact from both EQ and monsoon landslided
- No of people along routes and financial metrics unknown

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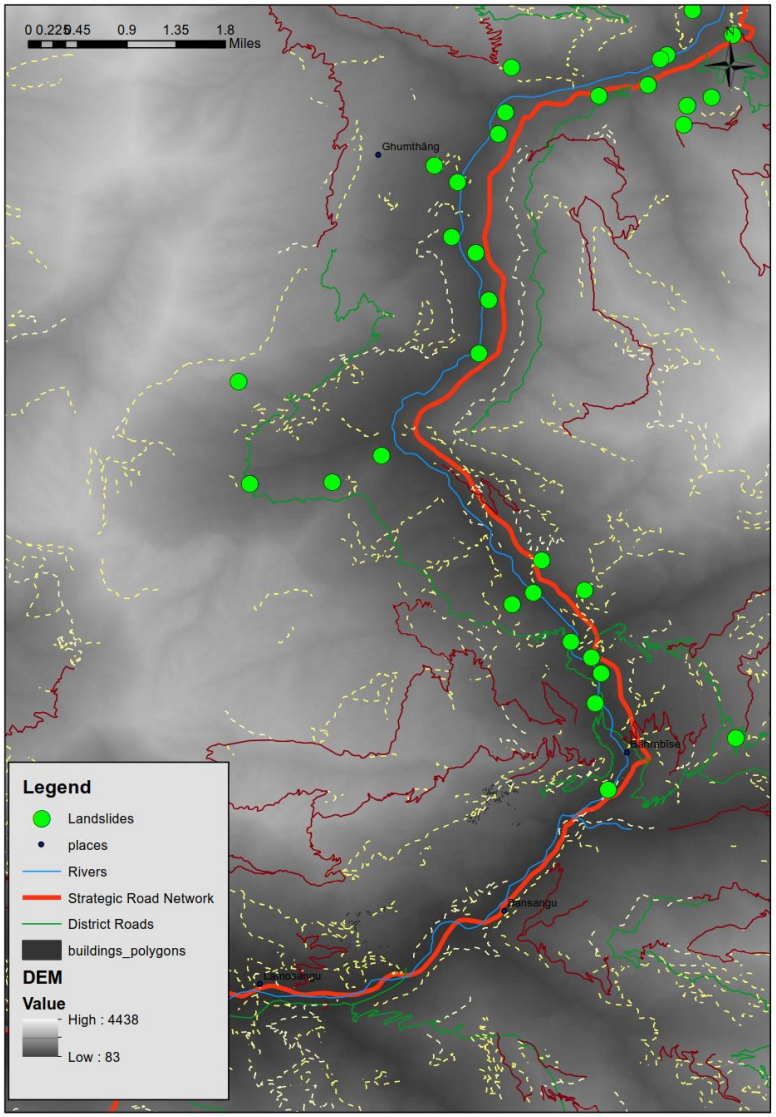
Ariniko Highway - Monsoon Induced Landslide



- Originally the only legal crossing point between Nepal and China
- In 2013 trade was in excess of US$200 million
- Bringing in taxes in excess of US$ 30 million
- Supported significant number of local jobs
- 100's of shops/business
- Closed in 2016/2017 due to landslides

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Ariniko Highway – Monsoon Induced Landslides

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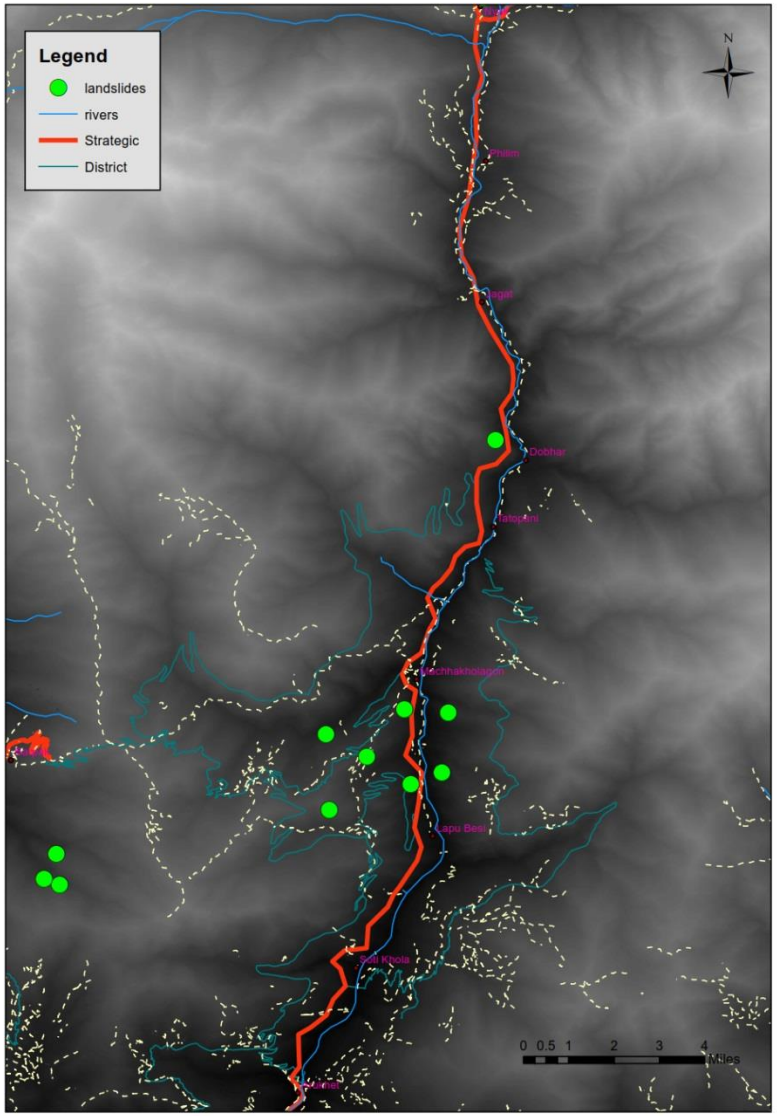
Remote Communities- Earthquake Induced Landslides



- Location of study area along Mansalu Trekking circuit
- Over 20,000 trekkers annually prior to earthquake
- Several million income to local economy
- No Figures post-earthquake, but significant parts of route & infrastructure remains closed
- Difficult to assess wider impact i.e. access to market

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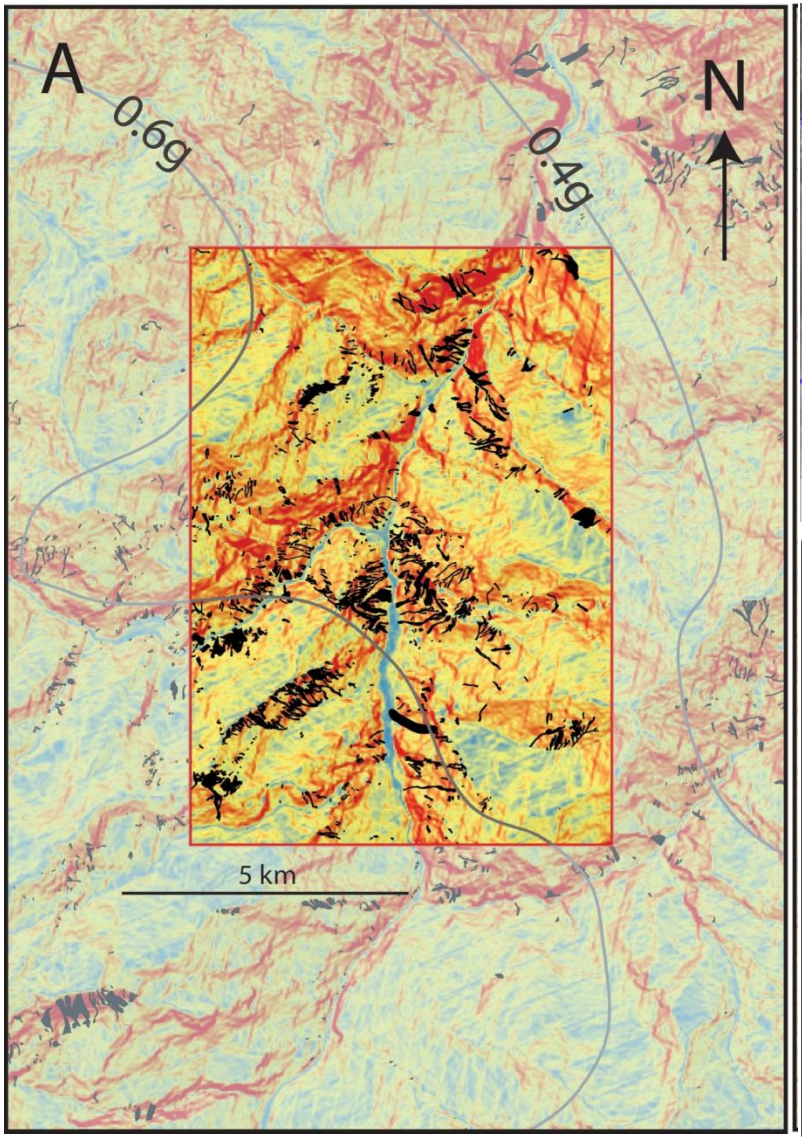
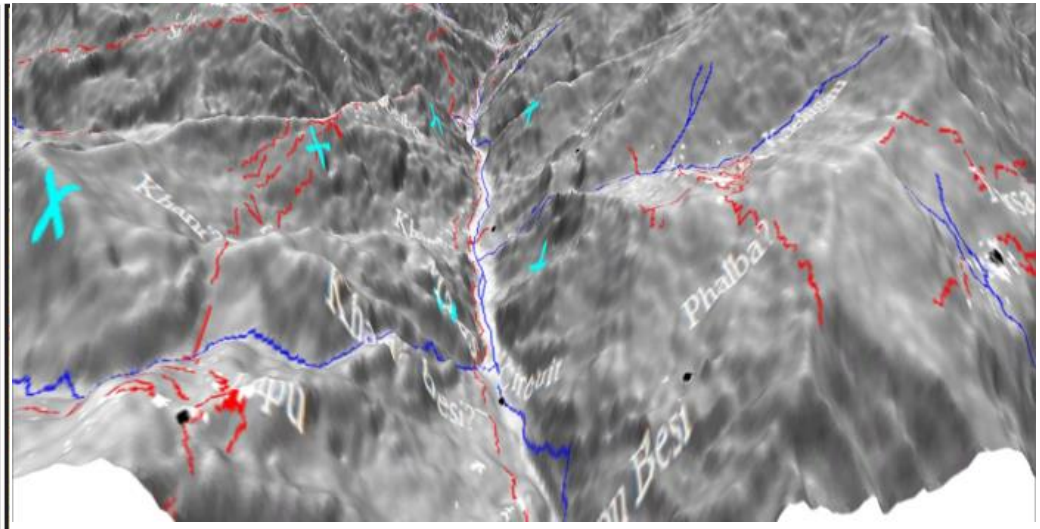
Remote Communities- Earthquake Induced Landslides





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Remote Mountain Communities

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Risk Analysis vs Resilience of Systems

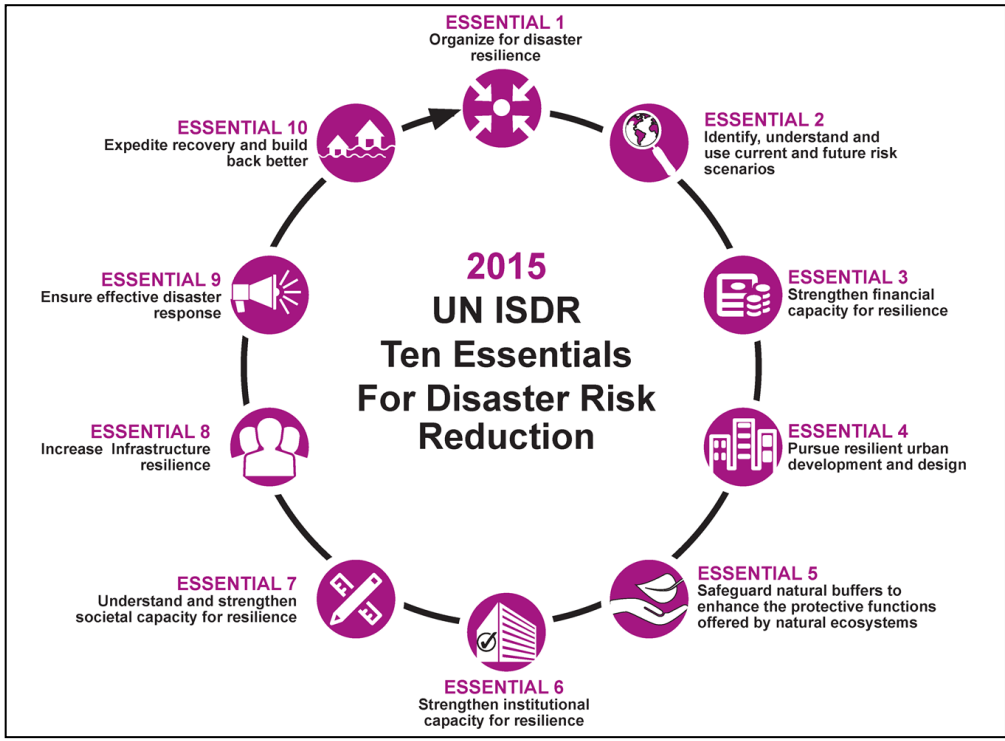
With limited data classic risk assessment approach difficult to apply

Alternative to investigate the resilience of systems (roads) to landslides occurrence

Resilience defined as the ability to recover

Typically applied to cities and have applied to Kathmandu

Can it be applied to an individual system



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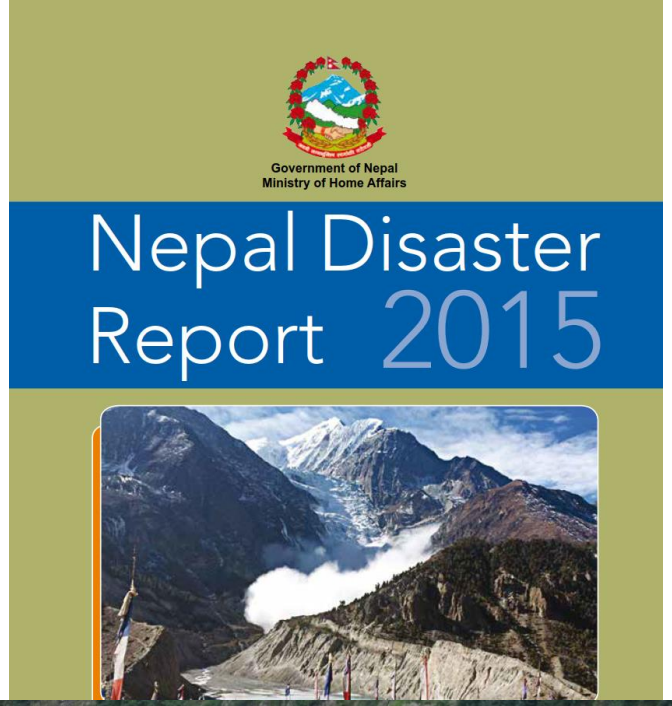
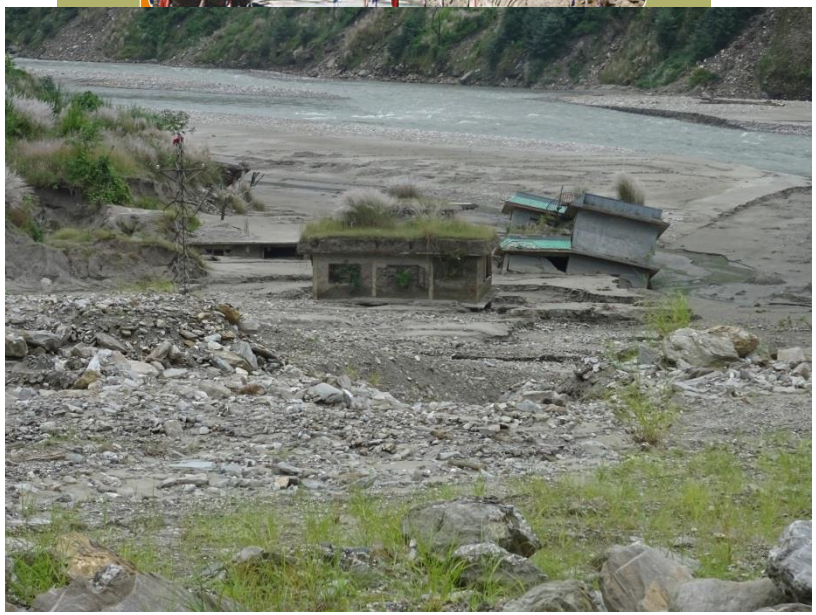
Disaster Resilience Scorecard

Essential 2 Current and Future Risk

- Annual disaster report-reactive
- Assessment governed by investors as part of funding of roads/access
- National Government projects less rigorous
- Little understanding of cascading hazards posed by landslides
- Geohazard Assessment of strategic roads >20 years old
- Rural and remote limited assessment
- School of thought that roads are increasing hazard and vulnerability, especially with ad hoc construction.
- However, increasing understanding that assessment need to be undertaken





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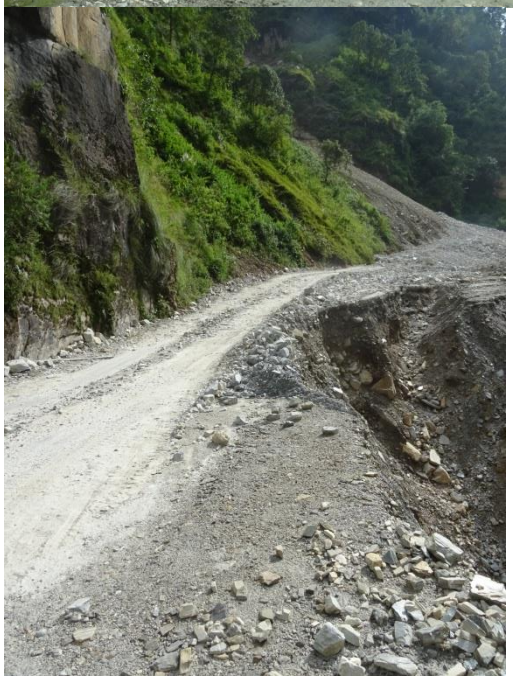
Essential 8 Critical Infrastructure-Roads

- Post Event Strategic and District Roads typically reopen within few days to weeks
- Although some larger events closed roads completely
- More rural and remote access can take longer
- Perception that the impact of earthquake induced landslides on very remote not addressed and may take many years
- Appear to be more resilient to annual monsoon events
- Difficult to prioritise beyond strategic and district roads due to limited data and assessment
- Response needs to be pro-active rather than reactive
- Roads creating slope preconditioning



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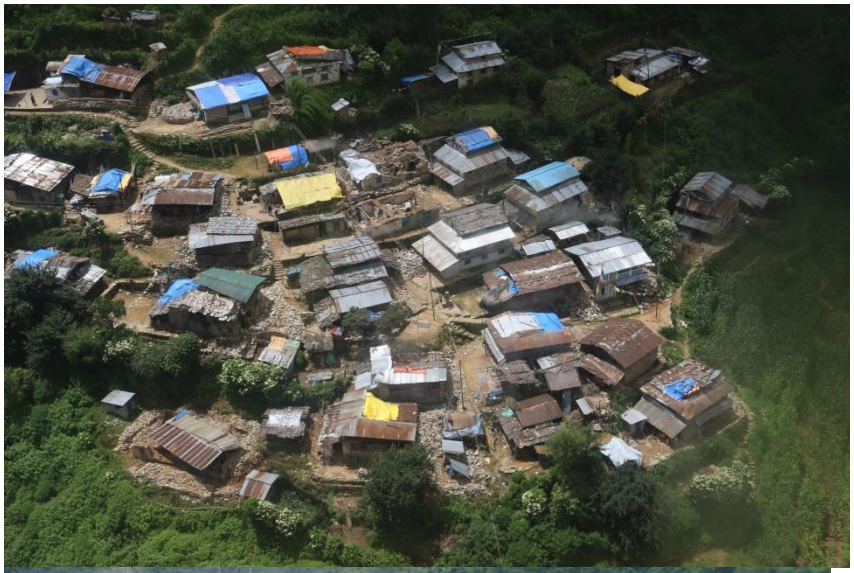
Essential 4 Resilient Urban Development

- Transport infrastructure critical to resilient urban development
- Land use planning improving, with development restricted in certain areas and certain conditions >20 degree slopes
- Resettlement plans take in to account geohazards including landslides of settlement, but to be seen if access considered.
- Massive historical legacy
- Issues with difference and understanding of developments linked to earthquake and monsoon induced landslides



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Summary/Conclusions

- Rural and remote access significantly impacted by monsoon and earthquake induced landslides
- Monsoon and earthquake induced landslide pose different problems both spatially and temporarily
- More resilient to annual monsoon landslides
- Problem is how to access and prioritise
- Assessment of resilience on option, but certainly not the best
- But need data to support assessment
- Not all doom and gloom as significant effort ongoing to improve resilience and assessment to a range of hazards

Thank you