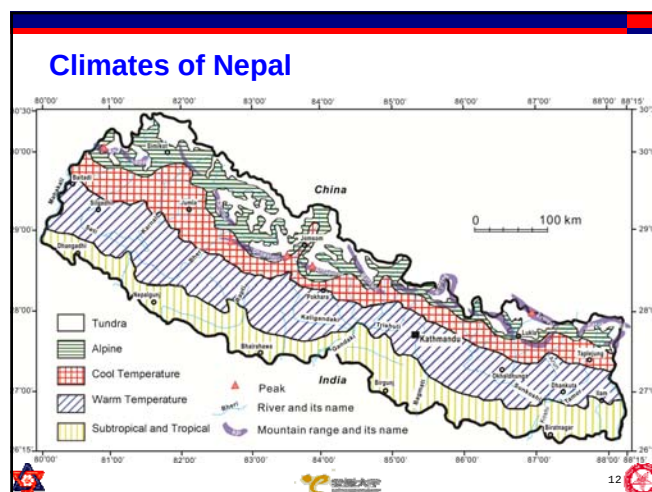
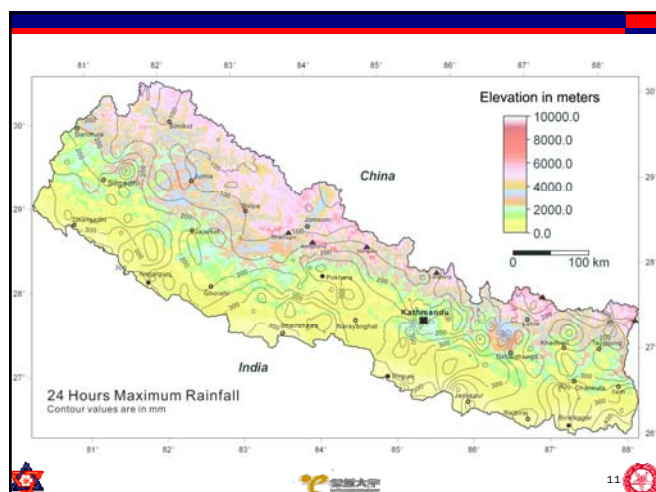
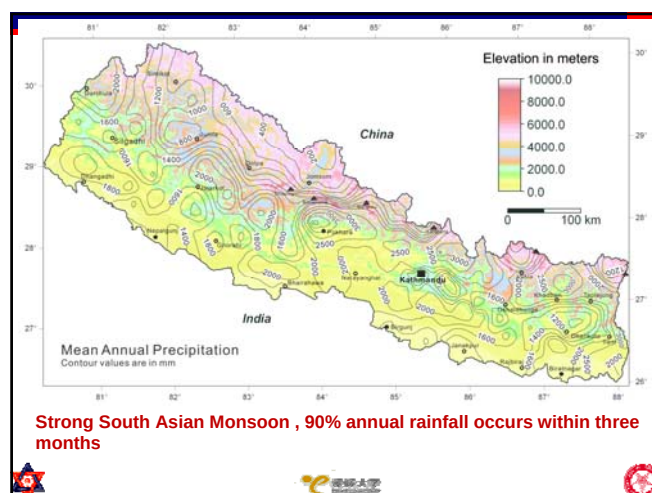
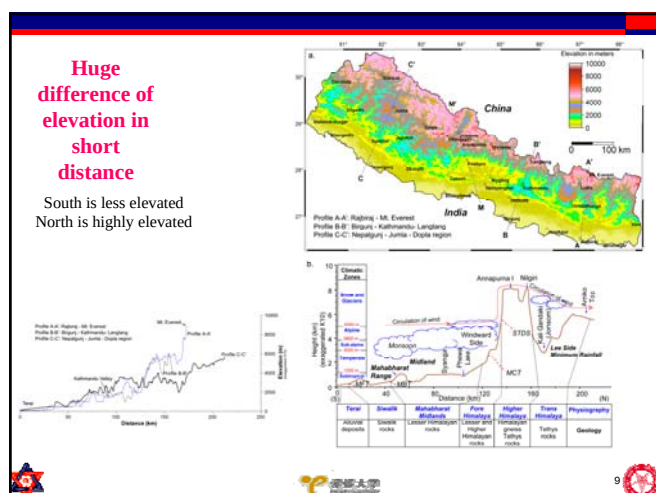
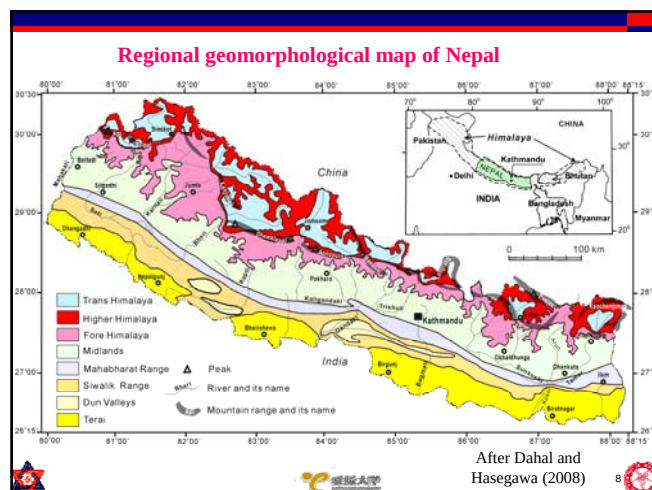
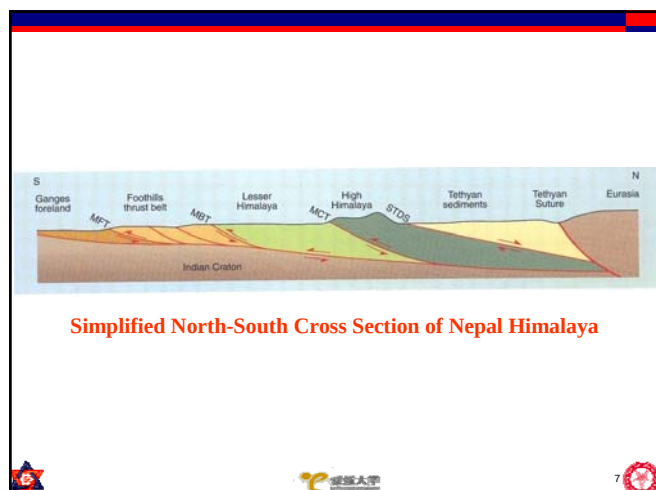
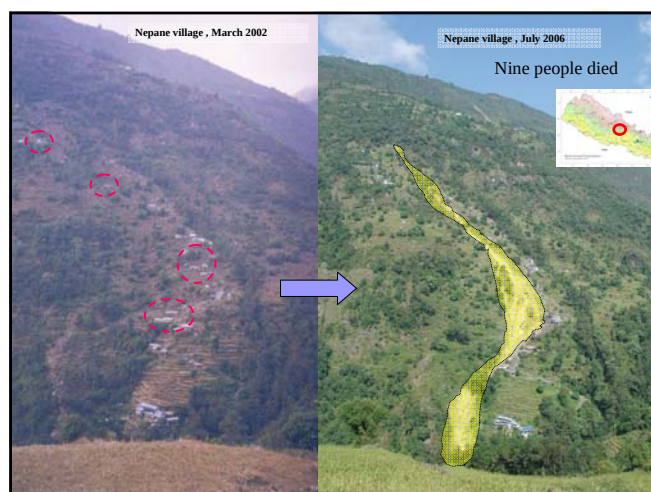
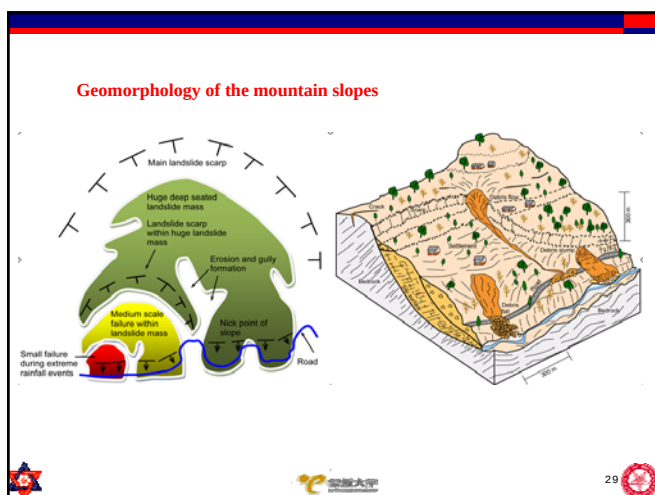
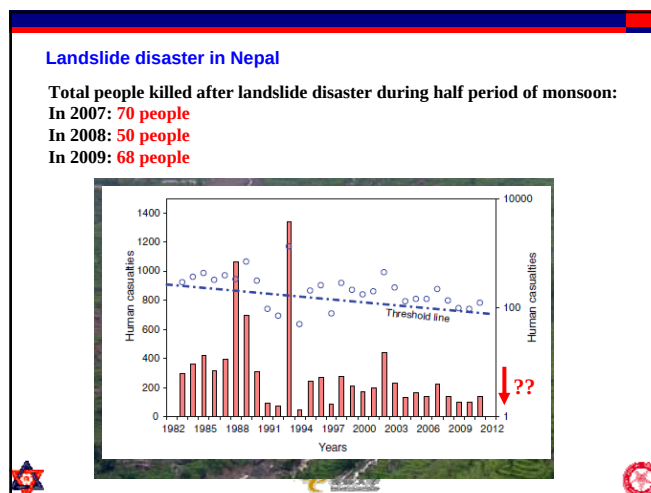
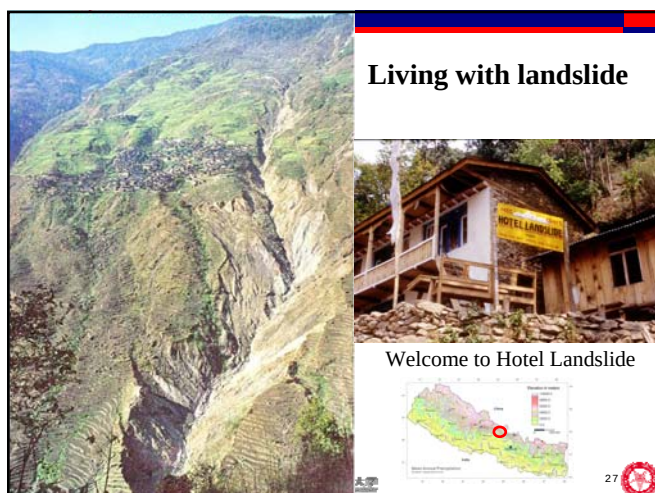
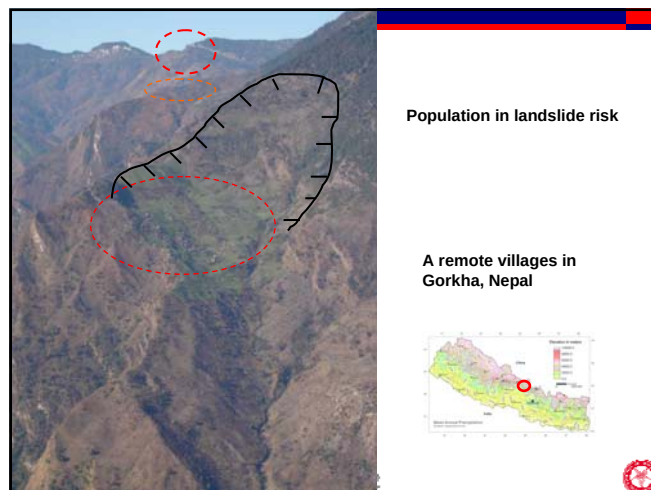
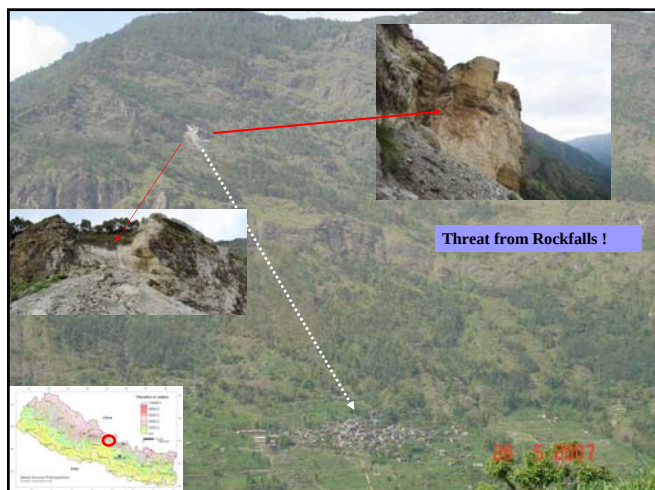
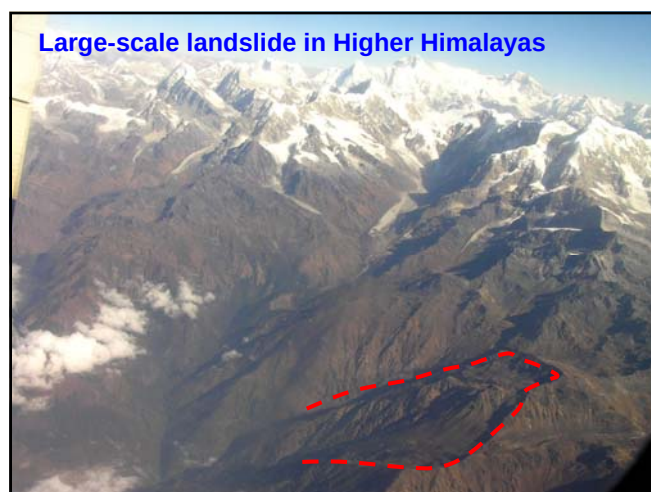
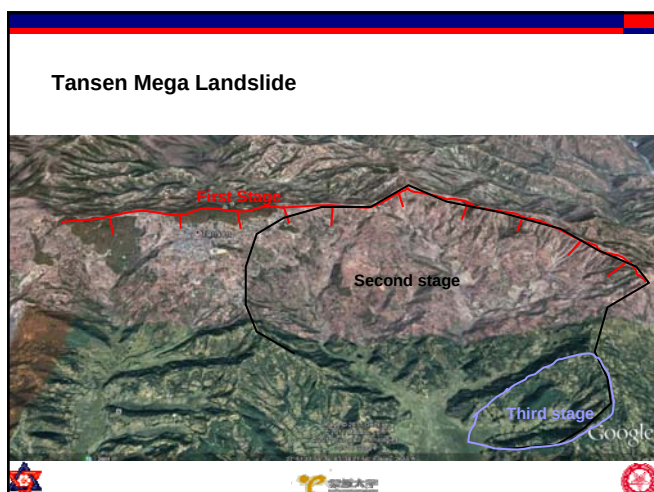
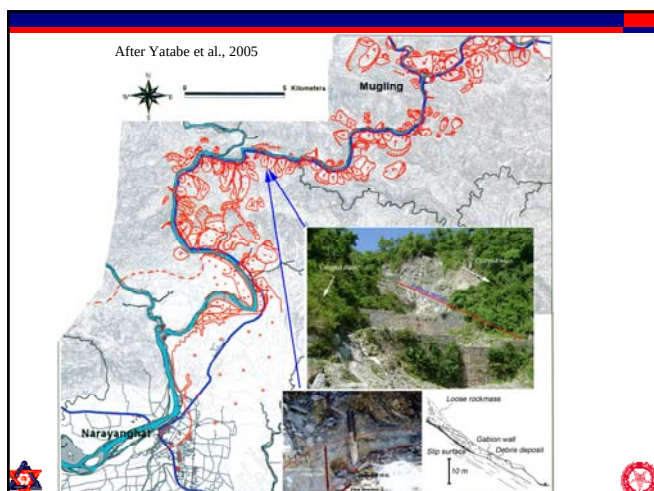
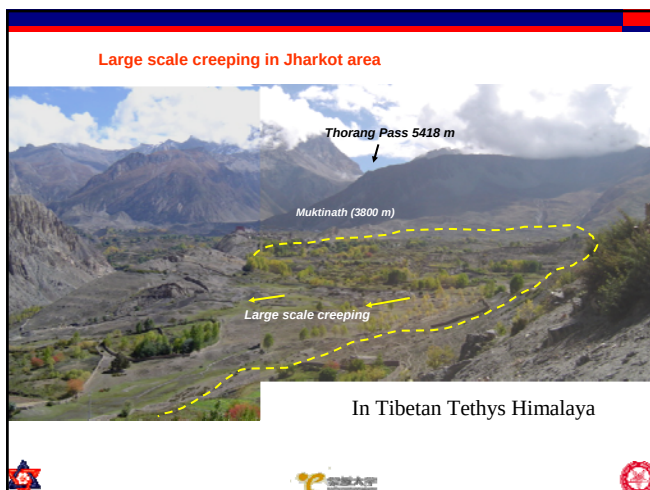
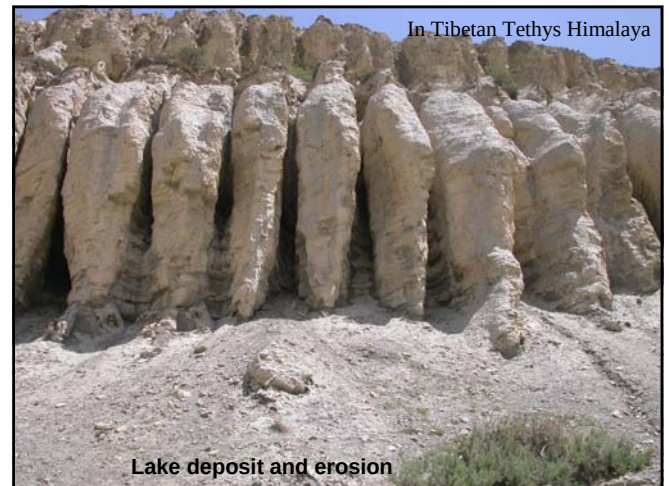
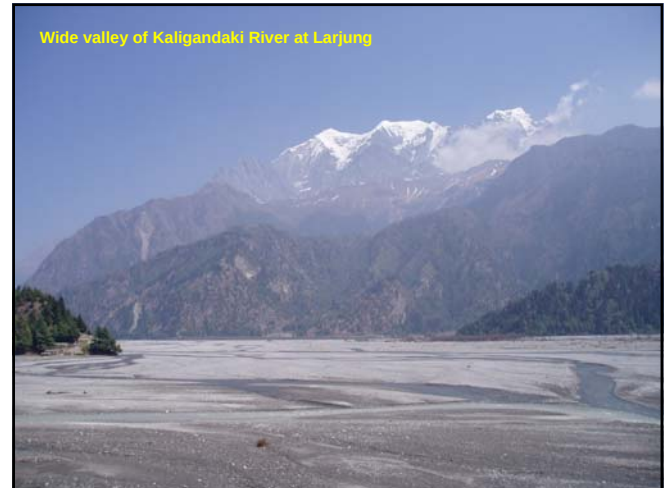
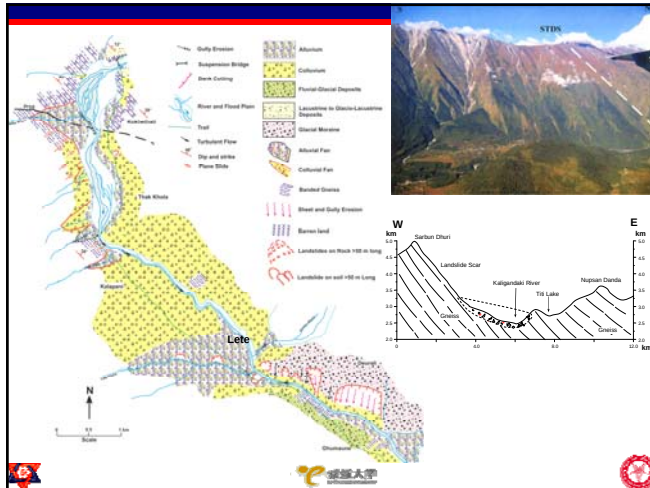












1. Labor intensive method Applied for construction of early roads in Nepal Labor groups employed as labor contract, no work contracts No heavy equipment used except work tools Mostly full cut roads, Structures and embankments minimized Side casting of surplus material permitted, Blasting for rock breaking	Road Construction Practice in Nepal
2. Conventional Mechanized Road Construction Practice Applied in highways, feeder roads and urban roads Earthwork equipment used for cut, slope trimming and embankment construction Mechanized compaction of backfill and embankments Laborers used for minor works – drainage, slope finishing Blasting for rock breaking permitted	
3. Labor-Based Road Construction Method Mostly used for district roads and feeder roads Only light equipment used, no heavy equipment used Maximum use of local laborers for works Limited blasting permitted for rock breaking	
4. Low-cost Environment-friendly or Green Road Method Stager construction of road (1 m, 2 m, 3 m and 4m) in combination with bioengineering Only local laborers used through community based organizations Balanced cut and fill principle – no haulage of surplus material Bioengineering measures as an integral part in each stage Natural compaction principle – no artificial compaction Only local material used except some gabion wires Use of cement discouraged Blasting for rock breaking not permitted Road formation out cambered for sheet flow – no side drains Equipment may be used only for graveling and pavement Prevailing method for rural and agricultural roads Also applicable for construction of highways and feeder roads Method is inherently poverty focused and uses poorest people	

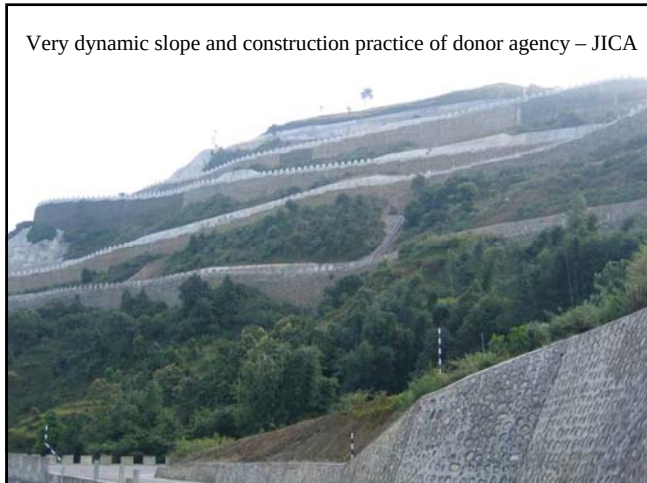
(Modified after Adhikari 2004)

Very dynamic setting and construction practice of donor agency – JICA

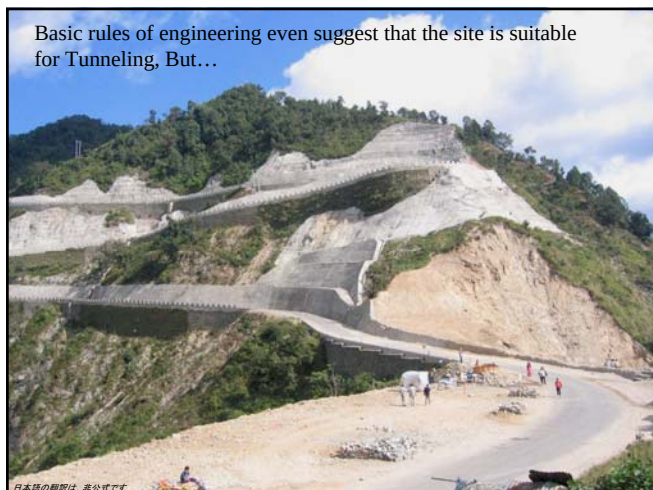


2. Conventional Mechanized Road Construction Practice
We even capture course of River, Dhulikhel-Nepalthok Road

Very dynamic slope and construction practice of donor agency – JICA

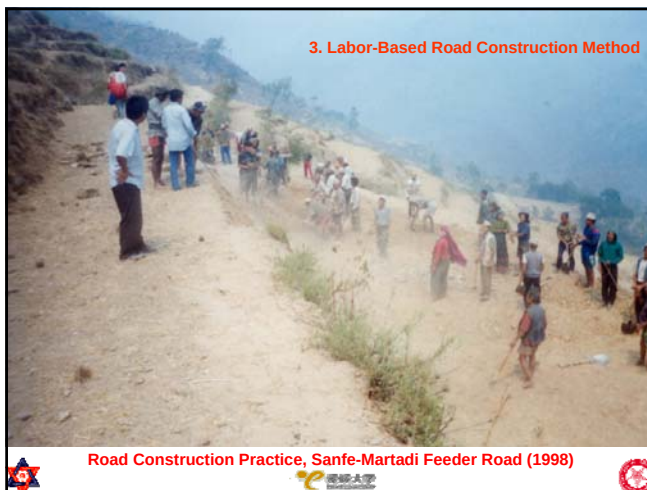


Basic rules of engineering even suggest that the site is suitable for Tunneling, But...



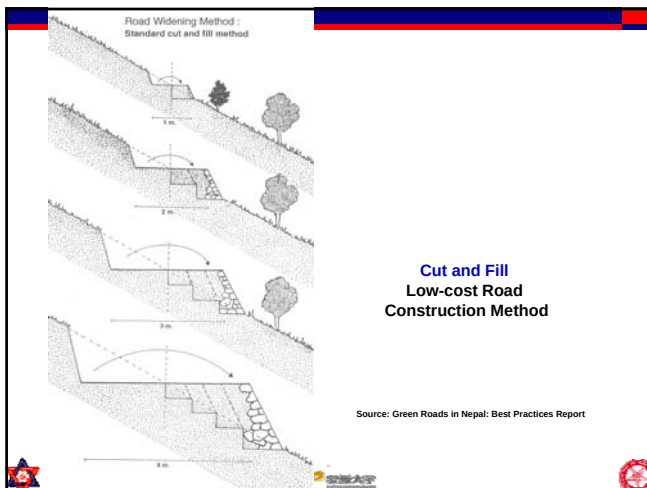
日本道の観望は、多公式です

3. Labor-Based Road Construction Method



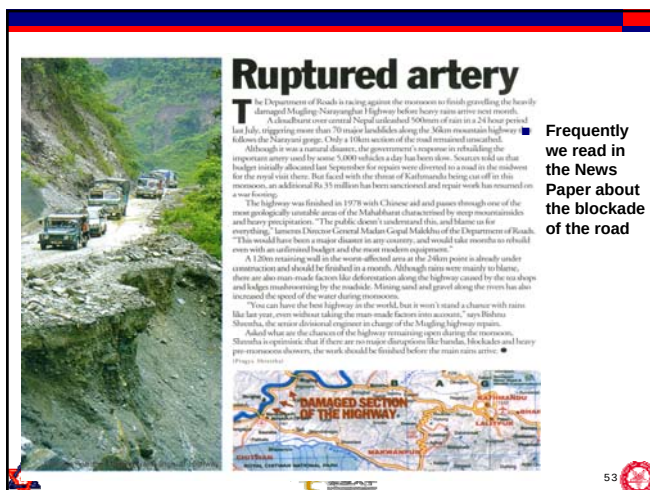
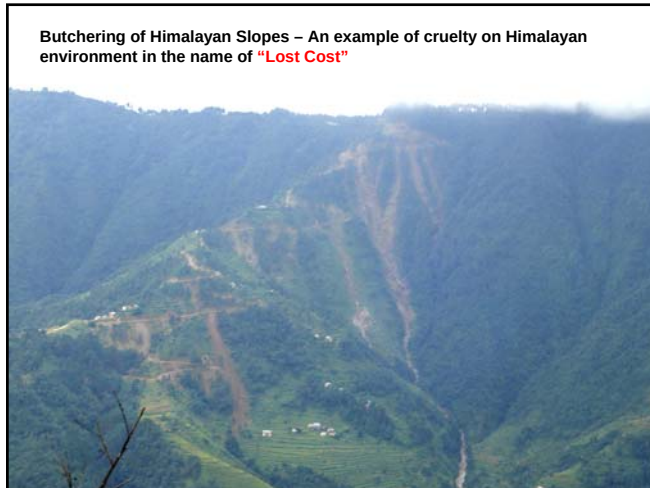
Road Construction Practice, Sanfe-Martadi Feeder Road (1998)

4. Low-cost Environment-friendly or Green Road Method



Cut and Fill
Low-cost Road
Construction Method

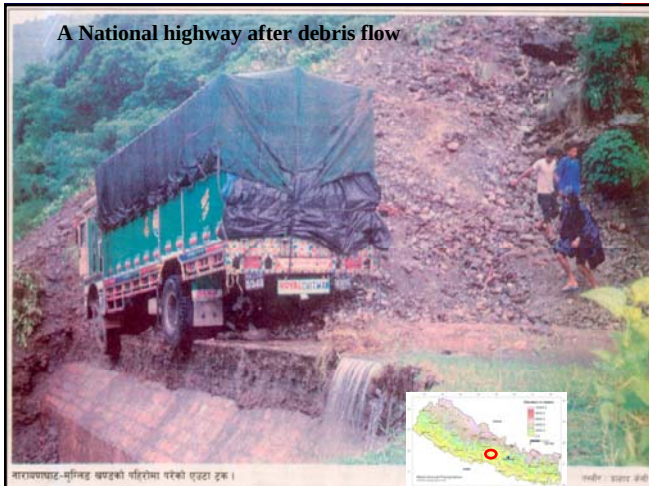
Source: Green Roads in Nepal: Best Practices Report



Problems in Road

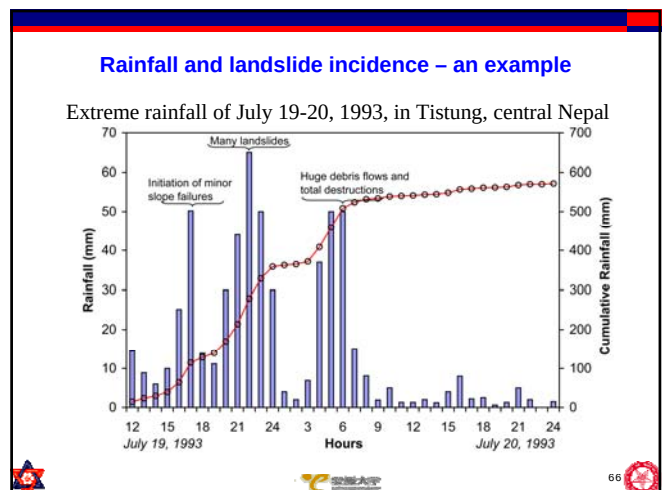
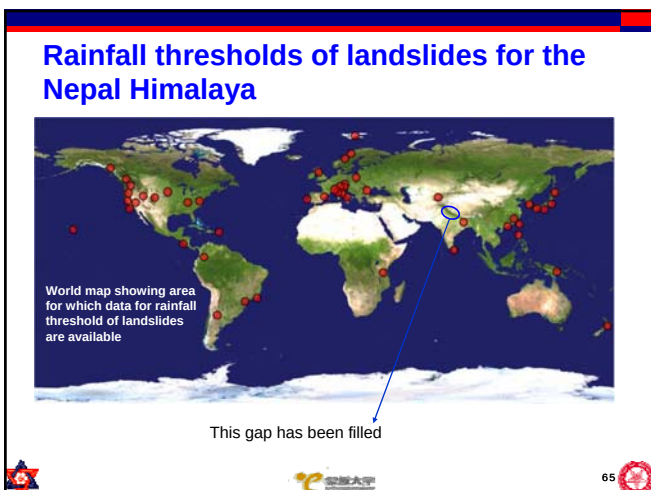


A National highway after debris flow

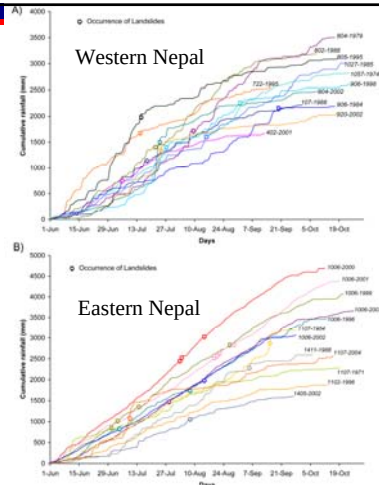


Butwal-Tansen Road, near Siddhababa





Rainfall and landslide occurrence



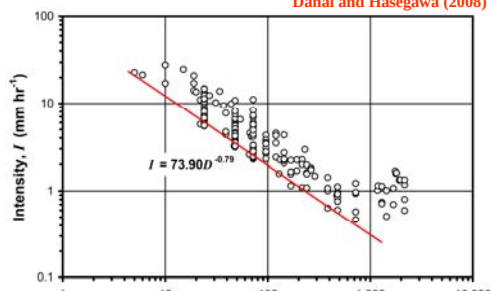
Shallow landslides in Pokhara, 2007

Sarangkot Peak



Rainfall Threshold of Landslides for the Nepal Himalaya

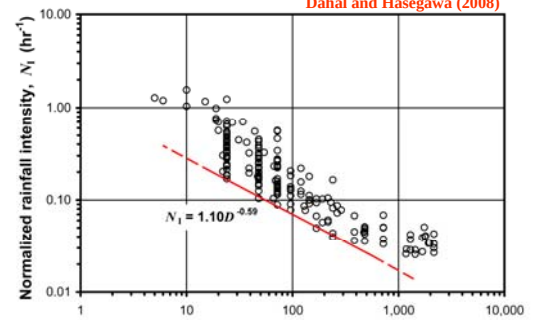
Dahal and Hasegawa (2008)



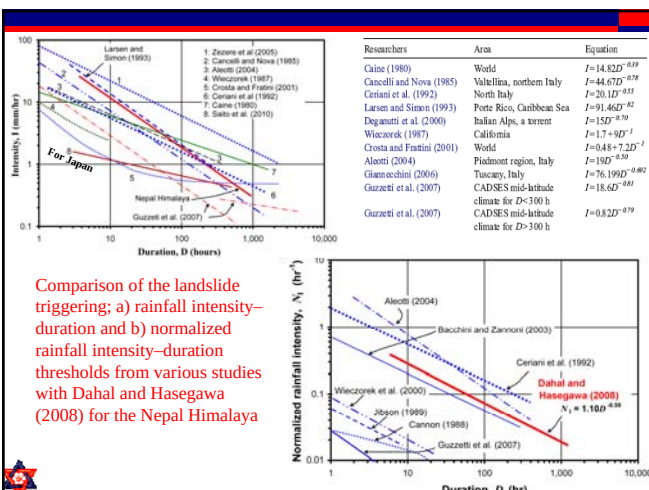
$I = 73.90D^{-0.79}$ Duration, D (hr) 193 landslide data

Normalize rainfall intensity-Duration threshold

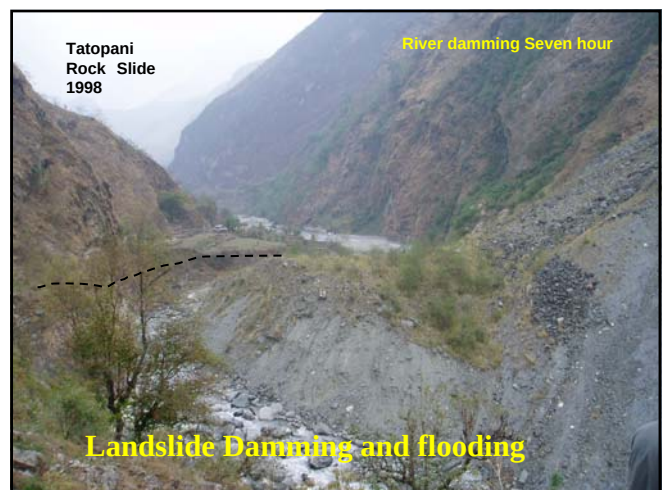
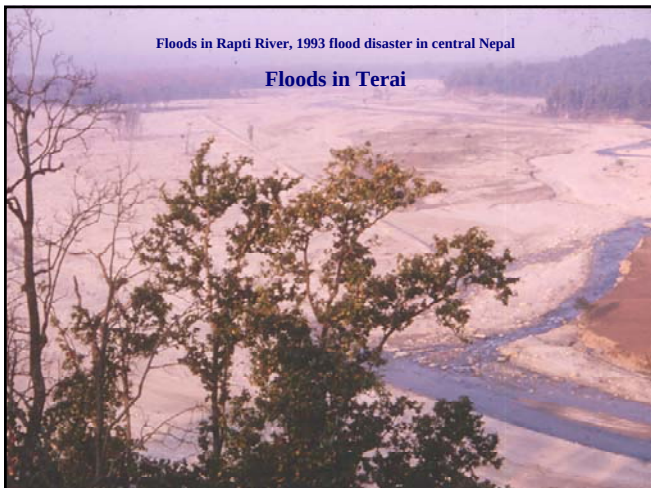
Dahal and Hasegawa (2008)

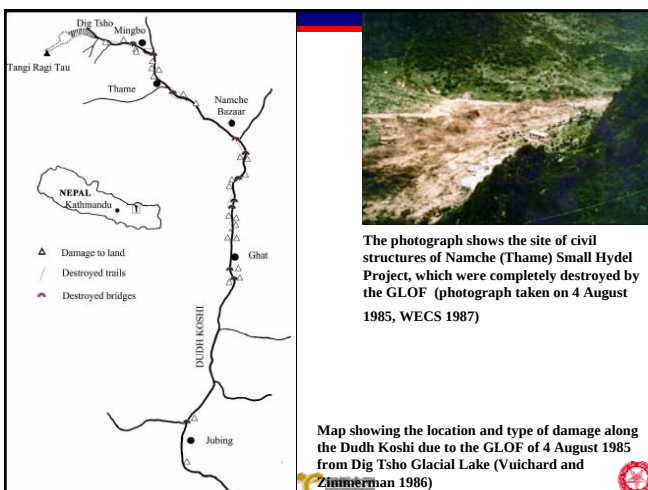
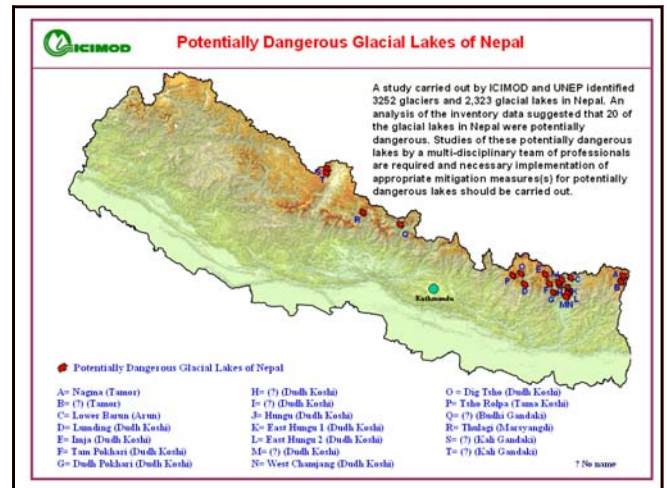
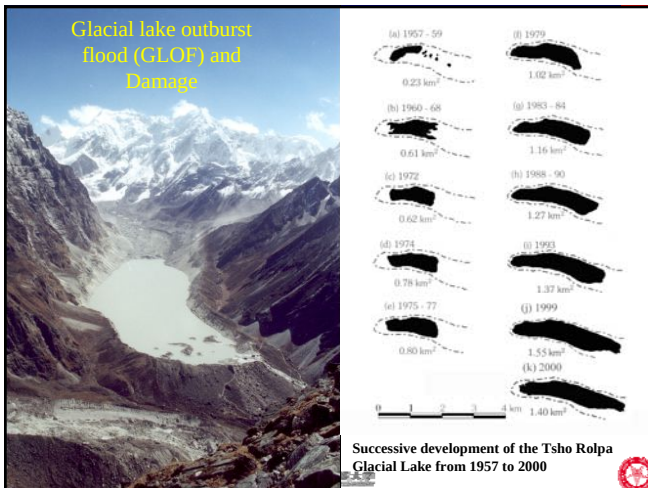


$NI = 1.10D^{-0.59}$ Duration, D (hr) 193 landslide data



Floods and landslides

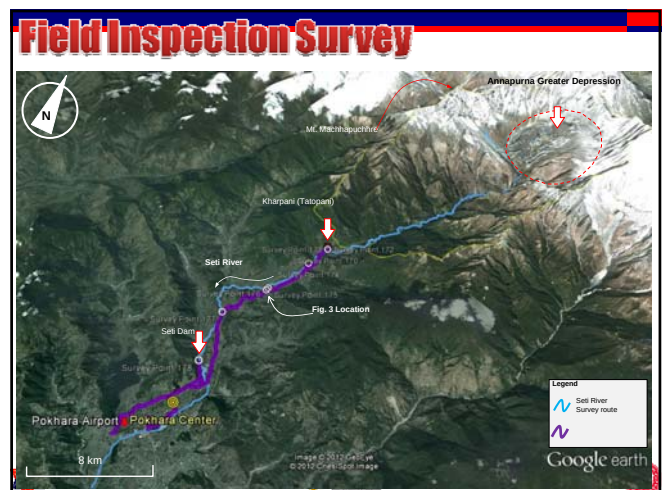


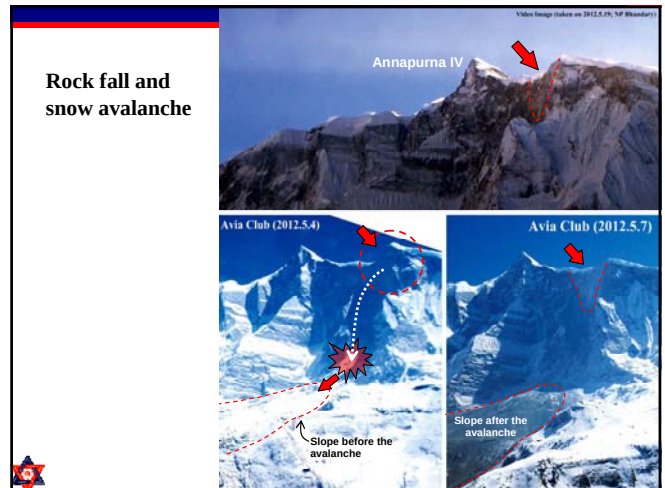


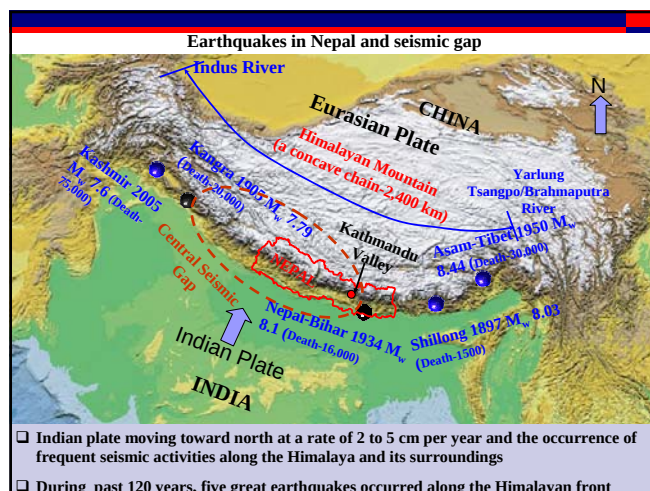
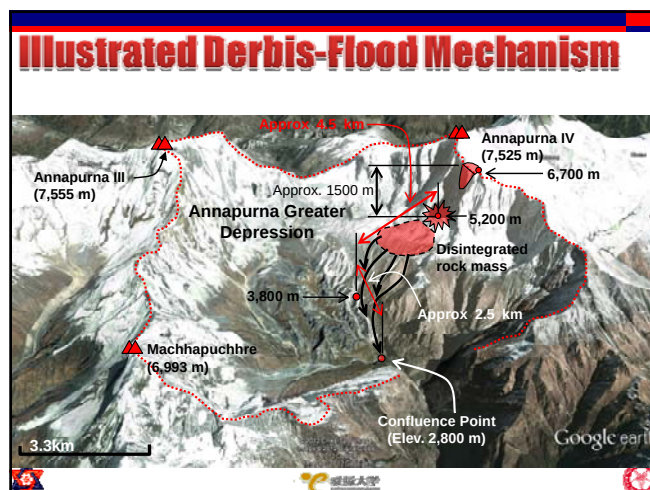
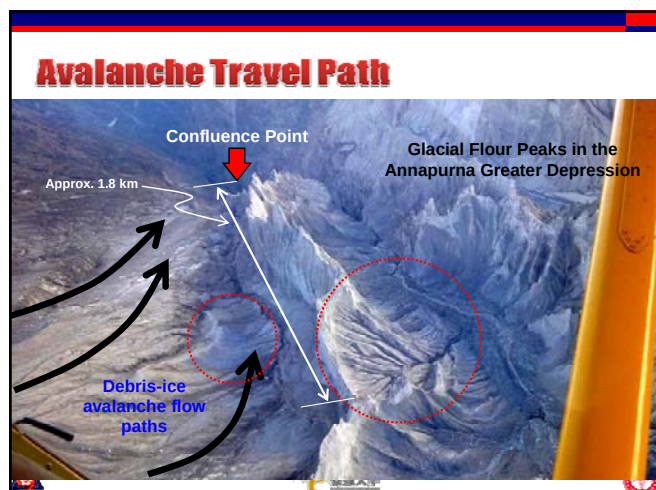
Glacial lake outburst flood (GLOF) and Damage



Glacial lake and burst







Earthquakes in Nepal

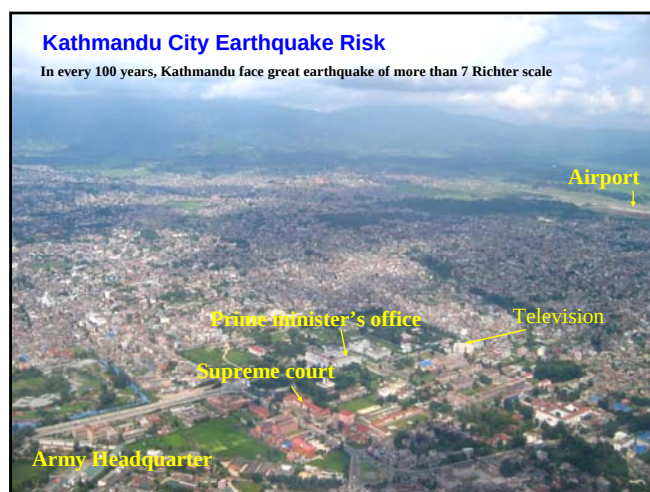
a. Magnitude-Frequency Data on Earthquakes in Nepal and the Surrounding Region in the period of 1911-1991 (modified after BCDP, 1994)

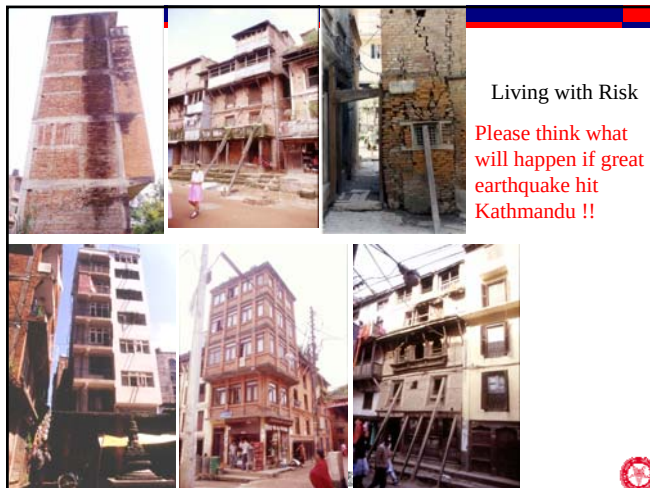
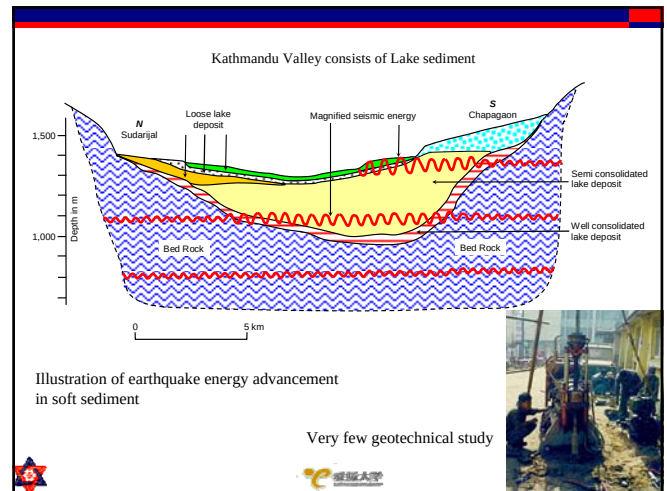
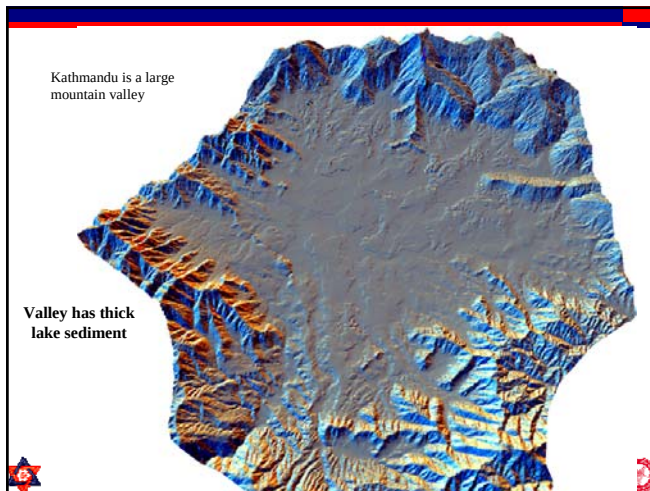
Earthquakes of Magnitudes in Richter Scale	5 to 6	6 to 7	7 to 7.5	7.5 to 8	>8
No. of Events	41	17	10	2	1
Approximate Recurrence Interval, yr.	2	5	8	40	81

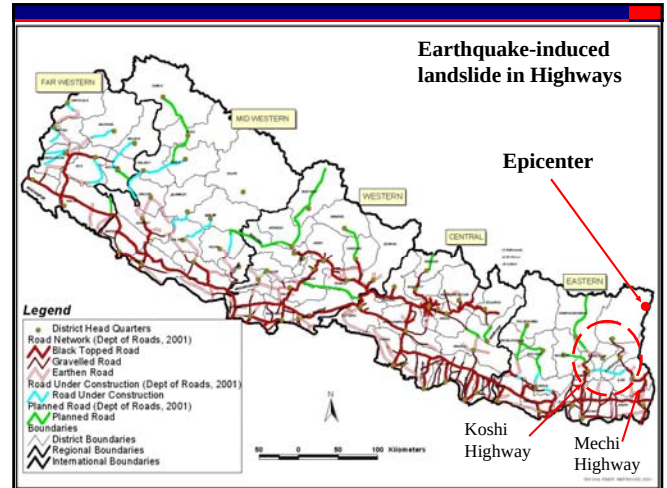
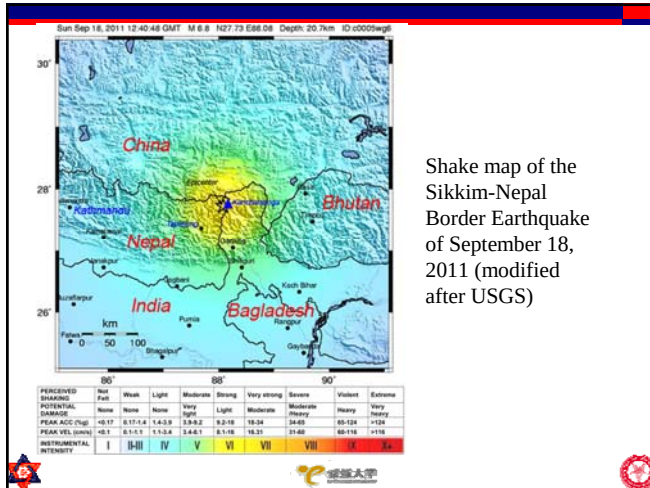
b. Past earthquakes and damage records

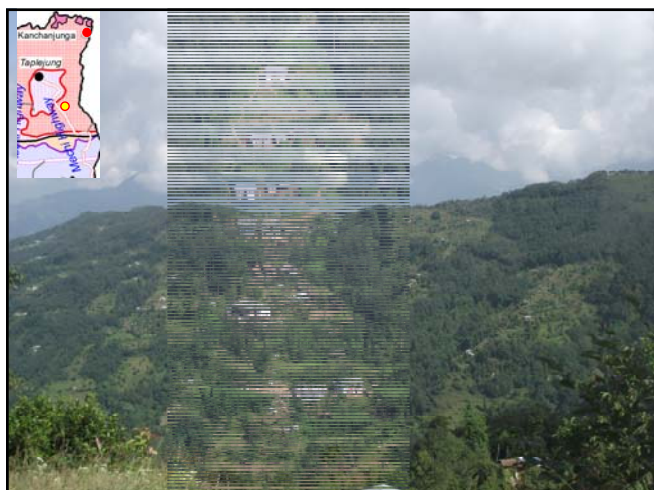
Year	Epicerter	Magnitude	Deaths	Houses Destroyed
1934	East Nepal	8.1 (M_w)	8,519 people died out of which 4,296 died in Kathmandu Valley alone	Over 200,000 buildings and temples etc. damaged, about 55,000 buildings affected in Kathmandu Valley (12,397 completely destroyed).
1936	Annapurna	7.0 (M_i)	Record not available	Record not available
1954	Kaski	6.4 (M_i)	Record not available	Record not available
1965	Taplejung	6.1 (M_i)	Record not available	Record not available
1966	Bajhang	6.0 (M_i)	24	6,544 houses damaged (1,300 collapsed)
1980	Chainpur	6.5 (M_i)	103	25,086 buildings damaged (12,817 completely destroyed)
1988	Udayapur	6.5 (M_i)	721	66,382 buildings damaged
2011	Sikkim/ Nepal border	6.9 (M_i)	6 died and 30 injury (2 died in Kathmandu valley alone)	14,544 house damaged (6,435 completely destroyed)

M_i - Richter Magnitude, M_w - Moment Magnitude







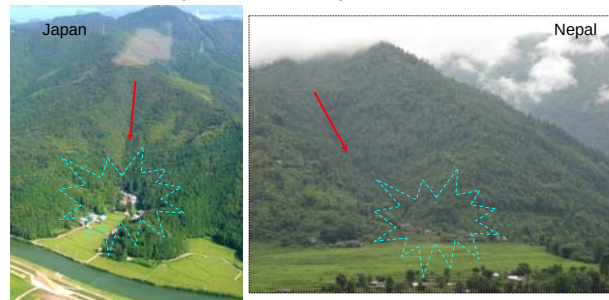


Mitigation and Management practice

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People's perceptions towards debris flow risk...

Same either developed or under-developed countries



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Hazard and susceptibility mapping practice for landslides and flood hazard mitigation

The predictive modeling approach for landslide hazard study

White box model vs Black box model

- Heuristic qualitative approach: ✓
- Statistical quantitative approach: **Black box model** ✓
 - Data driven multivariate statistical analysis and
 - Experience driven bivariate statistical analysis.
- Deterministic approach: hazard analysis in true sense, highly white box model

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Management of landslide hazard zones

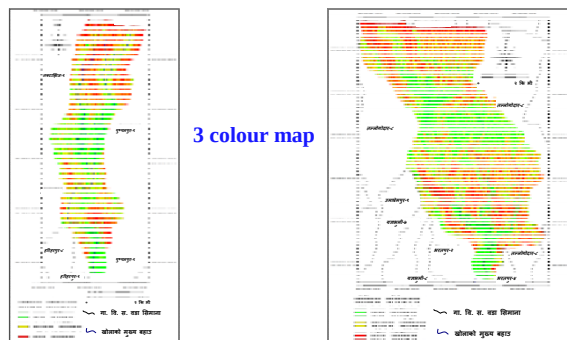
Community participation

- Till date no definite initiation from government, only few works
- The hazard maps should be brought into the knowledge of local people in order to aware and motivate them in proper land use and disaster management practices.



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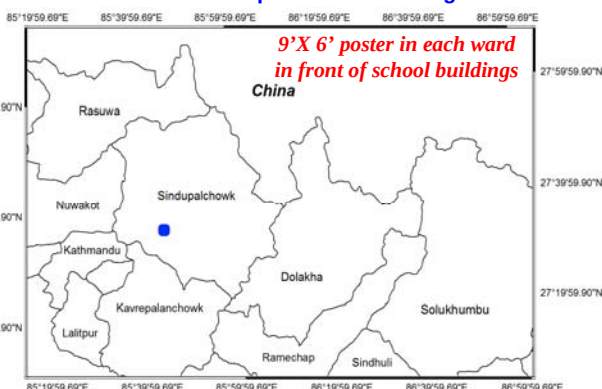
Landslide hazard map prepared in Nepali language to use in community level



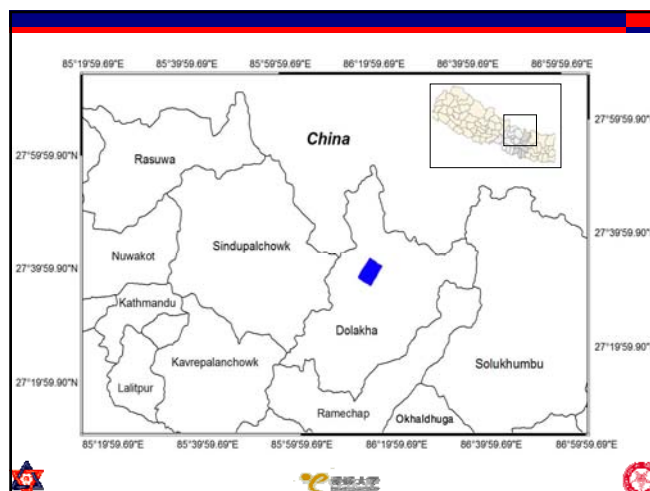
The three colours presented in maps could energize people's feeling towards Siwaliks degradation and aware them to manage.

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Landslide hazard map of Basbari-Badegau VDC



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Flood hazard map- Koshi River

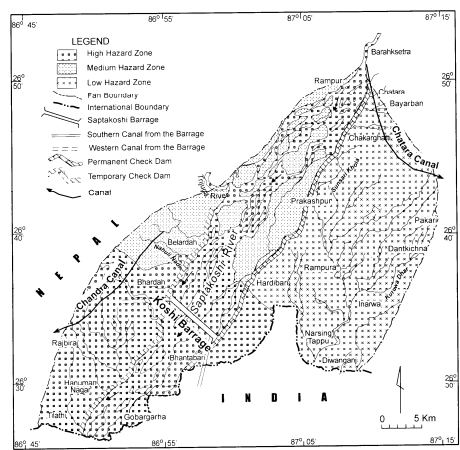
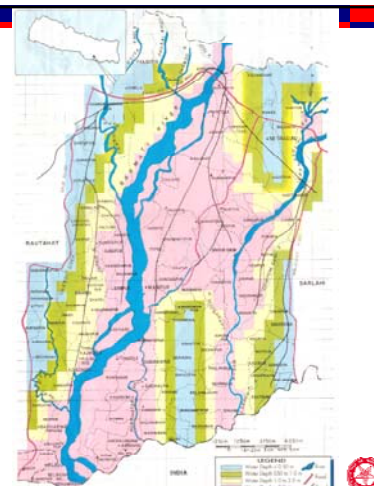
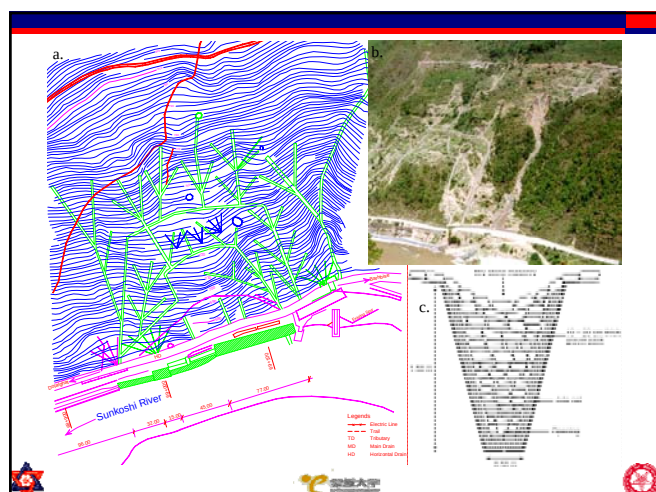
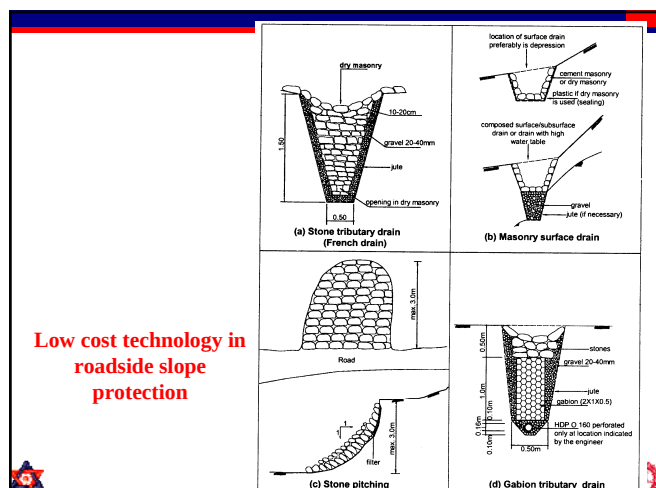


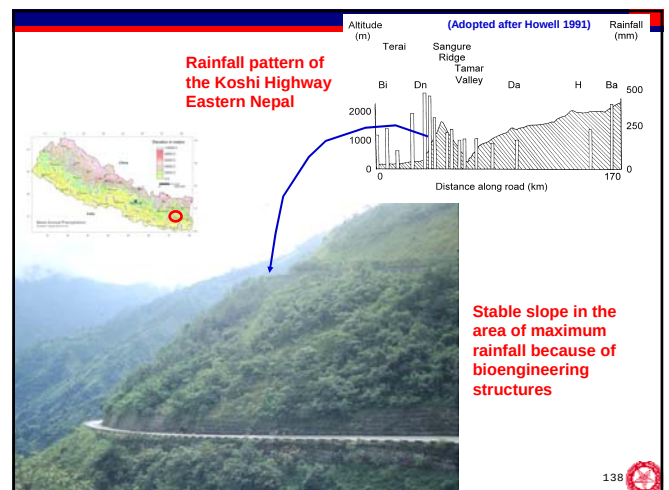
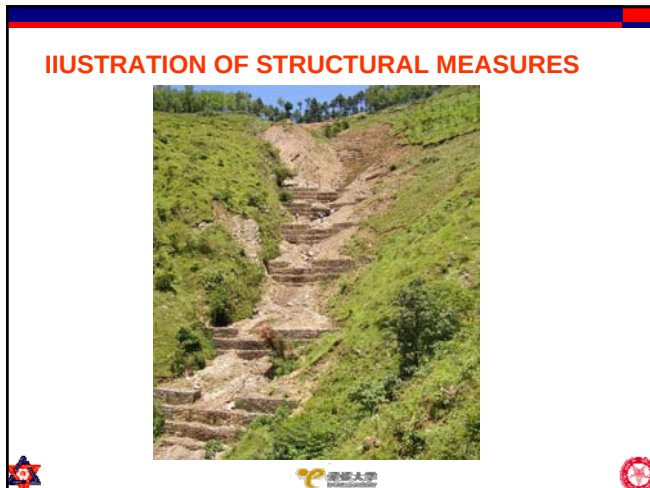
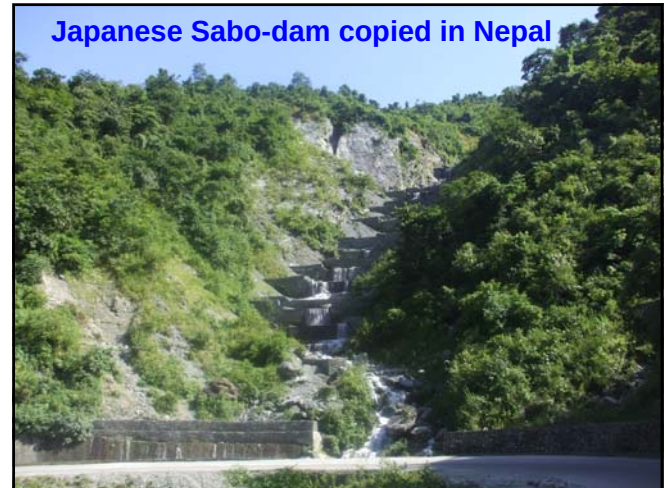
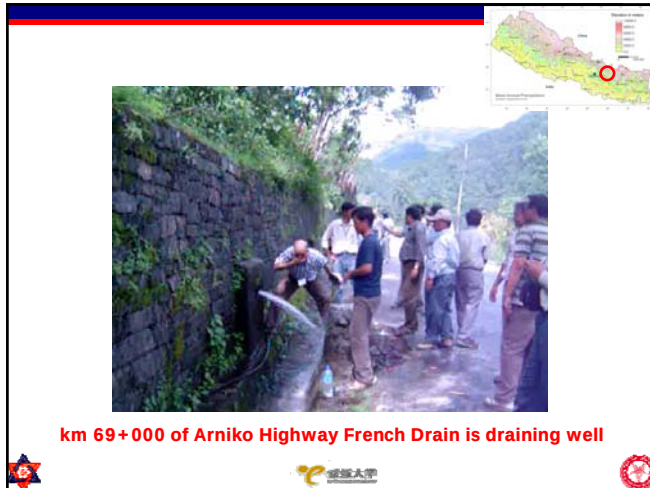
Fig. 18: Flood hazard map of the Saptakoshi alluvial fan.

Flood hazard map- Bagmati River

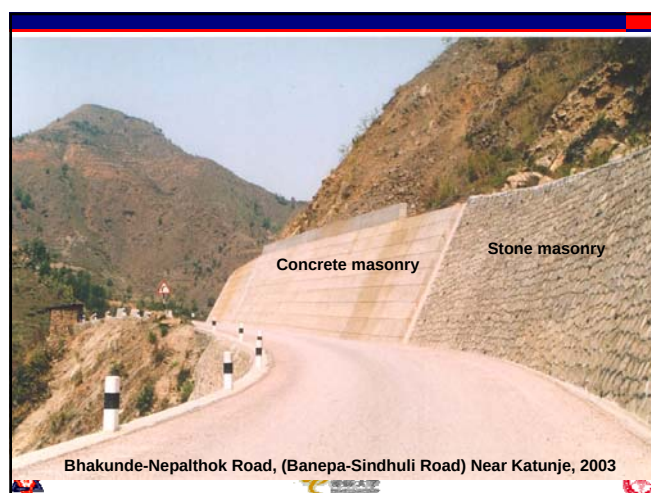
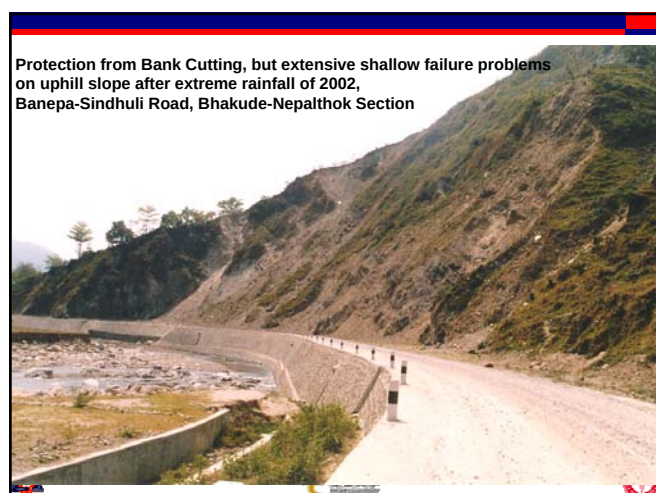


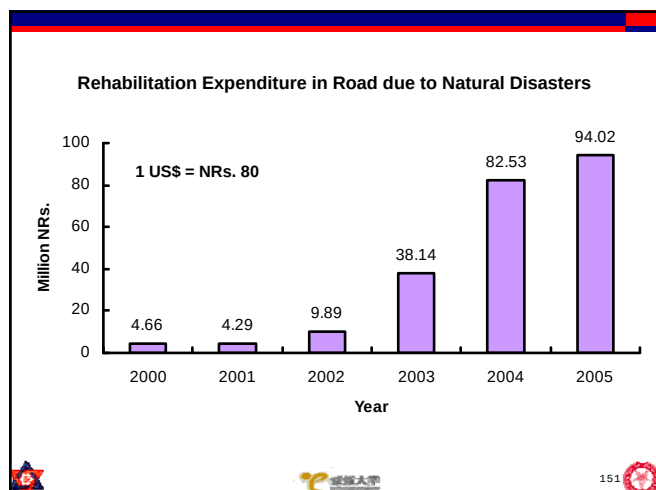
Engineering approach of geo-disaster mitigation











Concluding remarks

- Highly dynamic physical processes dominate the mountainous terrain of Nepal, and therefore, mitigating geo-disaster is a challenge.
- Monsoon rainfall is the main trigger of landslides and floods in Nepal
- Construction, maintenance and rehabilitation of infrastructure under the unique Himalayan condition require innovative and more pragmatic approach compared to less critical terrains in other parts of the world.
- Land management code should be implemented in coordination with landslide and flood hazard zonation map of the area
- “Low cost” infrastructure is not always right for low income countries like Nepal

Concluding remarks contd.

- Over the years, Nepal has gained both good and bad experiences in geo-disaster mitigation:
 - in design and survey of geo-disaster mitigation programs,
 - in the fields of hazard and risk assessment,
 - in low cost rural road engineering – how much bad and how much good
 - in community based river training work, and
 - in slope maintenance incorporating indigenous techniques.
- The governmental agencies involved in geo-disaster management must change their status from implementer to facilitator.
- Government should enhance institutional capacity building at local level to enable local bodies to undertake the immense responsibility of geo-disaster mitigation.
- Positive people perception for geo-disaster mitigation and community participations in mitigation program are very important for geo-disaster management in Nepal



Temple city Kathmandu



Mt. Everest



Amazing Jomsom

Thank you very much for your kind attention !!



Beautiful Pokhara

Welcome to Nepal